Title: Disseminating the outcomes of educational research to inform mathematics teachers' practices

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Disseminating the outcomes of educational research to inform mathematics teachers' practices

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Disseminating the outcomes of educational research to inform mathematics teachers' practice.

A thesis submitted in partial fulfillment of the
requirements for the award of the degree

Doctor of Education

From the

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by

Gail Hood
Graduate Diploma of Computer Science
Graduate Diploma of Media Studies
Bachelor of Arts
Trained Primary Teachers Certificate

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Declaration

I, Gail E Hood, declare that this thesis, submitted in partial fulfillment of the requirements for the award of Doctor of Education, in the Faculty of Education, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged below. The document has not been submitted for qualifications at any other academic institution.

Signed:

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Gail E Hood

August, 2009

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Abstract

Between 1999 and 2003 the Trends in International Mathematics and Science Study (TIMSS) Video Study (Mathematics) analyzed approximately 100 randomly selected eighth-grade classes from each of seven countries. Findings are published in two written reports and a set of twenty-eight public released lessons. The development of an online course aimed at disseminating the study's research methodology and findings to mathematics teachers to inform their practice is the focus of this study.

A design-based research paradigm was selected to guide the development, implementation and evaluation of the course. The four cyclic stages of design-based research are identifying and analyzing the problem; developing a solution informed by existing design principles; testing and refining the solution in practice; and producing design principles from the solution to inform future practice. The design principles from the last stage provide the means for the study to contribute to research and are the focus of the main research question: *What are the design principles for developing online professional learning to disseminate the outcomes of educational research that will inform teachers' practice?* The three sub-questions address more specific aspects of the study: (1) What is the impact on teachers' mathematical knowledge and practices of an online professional learning resource that focuses on analyzing culturally diverse mathematics lessons from high-achieving countries? (2) What is the impact on teachers' understanding of educational research and its application to practice, of an online course designed around the findings and lesson videos of a major mathematics education research project? (3) What structures support flexible delivery methods of an online, interactive course for teacher professional learning?

Each stage of the design-based research for this study has been examined through three lenses - technology, content and pedagogy, and implementation – that, blended together, form the solution to the problem. The technology used for the solution was online interactive video-centric software developed in-house specifically for teacher professional development. The online course at the centre of this study was the first to use the software and so its development and testing was critical for the new software. The content of the course had as its basis research findings and public-release lessons selected from the TIMSS Video Studies. The pedagogy used in the course was informed by guiding principles developed from extensive literature research into teacher professional development and video cases. The main requirement for implementation was that the course delivery should be flexible, catering for individuals or groups either online or in blended formats, both facilitated or non-facilitated.

Data collected during the cycles of testing and refinement, Stage 3 of the design-based research, included videotapes of all face-to-face sessions, questionnaires, observers' notes, participants' responses to the online tasks and forums, participants' journals and general emails. Analyses of this data occurred at two levels – one during the cycles of Stage 3 and the second after the completion of Stage 3. The first of these resulted in refinements being made to the solution before the next cycle of testing and the second, augmenting the first analyses, provided foci for the reflections of Stage 4. From these reflections, the design principles of Stage 4 were produced.

In all, sixteen design principles were produced from the research. Apart from technical issues with the software and video, the four technology-based design principles focused on the support (online, printed and helpdesk) and online scaffolding needed by end-users. Content and pedagogy of the course afforded eight design principles including the adoption of situated learning and its focus on authentic activities; opportunities for knowledge construction; the use of video-cases incorporating content and pedagogical content knowledge, lesson exploration, lesson analysis, and expert input; and links to practice. Four design principles covered implementation addressing flexibility of delivery, scaffolding, facilitation and the printed course guide.

The design principles are central to the main research question. In relation to the sub-questions, the study found that there was an impact on teachers' mathematical knowledge and practices; and that teachers had become more aware of the TIMSS research and how it related to their practice. The structures to support flexible delivery are addressed in the implementation design principles and further in the design and implementation of facilitator training, resources and materials. The findings from the study have been used to guide the development of similar online, video-centric courses. Suggested areas for future research conclude the study.

Acknowledgments

I would like to acknowledge the assistance of my supervisors Professor Barry Harper and Professor Tony Herrington for their guidance and support during my study. I greatly appreciate their insights, efforts, good humour, patience and perseverance.

Many thanks go to UCLA Professor Jim Stigler, the founder of LessonLab Inc., Santa Monica, where this research was conducted. Working with Jim at the forefront of educational research was a privilege. My thanks to everyone else at LessonLab, in particular, Paul Grudnitski and Aisha Sims, co-developers of the LessonLab software used in the research, and Dr Hilary Hollingsworth, an Australian colleague who helped me begin the journey.

I wish to recognize many other people who contributed to this research in the US including the other course authors Professor James Hiebert, University of Delaware, Professor Carolyn Kieran, University of Quebec, Nanette Seago, WestEd, and Professor Diana Wearne, University of Delaware; Paige Kuni from Intel Corporation (who sponsored the project); and Judy Yost from the Institute of Computer Technology. Perhaps most importantly, I wish to thank the teachers who participated in the testing cycles. Without their willingness to be part of the project, to agree to face-to-face sessions being videotaped, to open up their online responses to scrutiny, and to provide critical feedback on the experience, this research would not have been possible.

My thanks go to the University of Wollongong, Faculty of Education staff for their support. Special thanks to students past and present who have helped through the process, in particular Dr Gerry Lefoe, always so generous.

Special thanks go to my family and friends especially my daughters Sonja, Ingrid and Nicola and their families. I will be for ever indebted to my partner David Rasmussen, who came on this journey with me, providing amazing personal and professional support.

I dedicate this work to my parents Cliff Rechter (1918-1979) and Betty (nee Cato) (1921-1993) and wish they were here to share the moment.

Chapter 1 Introduction to the Study

1.1 Introduction

Between 1999 and 2005, the researcher worked at LessonLab, Inc., a small educational research company founded by Dr James Stigler, a Professor in the Department of Psychology, University of California Los Angeles, in Santa Monica, US. LessonLab's major research at the time was the TIMSS 1999 Video Study.

TIMSS, Trends in International Mathematics and Science Study (previously known as Third International Mathematics and Science Study), was developed by the International Association for the Evaluation of Educational Achievement (IEA) to measure trends in students' achievement in mathematics and science (Institute of Education Sciences). The study is conducted on a 4-year cycle, involving approximately 40 countries with students from levels 4, 8 or 12 and with different component studies depending on the cycle (for details see Appendix 1.1). One such component, the TIMSS Video Study, was conducted first in 1995 and again in1999, with Stigler being chief researcher on both occasions.

The TIMSS 1999 Video Study had a mathematics and a science component. The Mathematics study analyzed videotaped lessons and artifacts from 638 eighth-grades in seven participating countries - Australia, Czech Republic, Hong Kong SAR, Japan[1], Netherlands, Switzerland and United States. The videotaping commenced in 1999, and following extensive analyses, the results were published in 2003.

One of the objectives of the study, (Hiebert et al., 2003, p.15) was: "To develop methods for communicating the results of the study, through written reports and video cases, for both research and professional development purposes." The research conducted for this doctoral study is about the development of one such method for teacher professional learning. In this case, the objectives were to design an online course that would enable users to understand the research and its findings; to gain a deeper understanding of some of these findings in context by analyzing lessons from the

[1] Japan participated in the Science component only in 1999 but the 1995 Japanese mathematics lessons were re-analyzed in the 1999 study.

study; and to be able to transfer acquired insights to their own practice where applicable. The outcome was a ten-hour course *TIMSS Video Studies: Explorations of Algebra Teaching*.

This study used a design-based research paradigm to develop, implement and evaluate the course resulting in design principles for online educational courses designed to promote research outcomes.

1.2 Design-based research

The term design-based research is used by, among others, the Designed-Based Research Collective (The Design-Based Research Collective, 2003). However many terms have been used to describe the paradigm. Reeves notes that these include "formative research" by Newman in 1990, "design experiments" originated in 1992 by Brown and Collins and "development research" by van den Akker in 1999 (Reeves, 2000, p.8). At that time Reeves favored "design experiments" but in 2006, Reeves and van den Akker used the term "design research" (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006). Peterson and Herrington examine the issue and reach the conclusion that "researchers are beginning to come to an agreement on the proper terminology" and that the "choice of a name for the DBR approach is important in that it leads to a proper definition." (Peterson & Herrington, 2005, p.3)

Reeves lists the central characteristics of design experiments as defined by Brown and Collins:

- addressing complex problems in real contexts in collaboration with practitioners;
- integrating known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems; and
- conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles. (Reeves, 2000, 2006)

Reeves further adds that two of the fundamental tenets of development research are: "collaboration among practitioners, researchers, and technologists, and dedication to providing direct benefits to all stakeholders within the context of research." (Reeves, 2000, p.10)

The following diagram, Figure 1-1, from Reeves illustrates the stages of design-based research, its cyclic nature and the essential role of existing design principles to inform the development of solutions to the problem being solved. After the cycles of testing and refining the solutions in practice, the design principles for the solutions are produced.

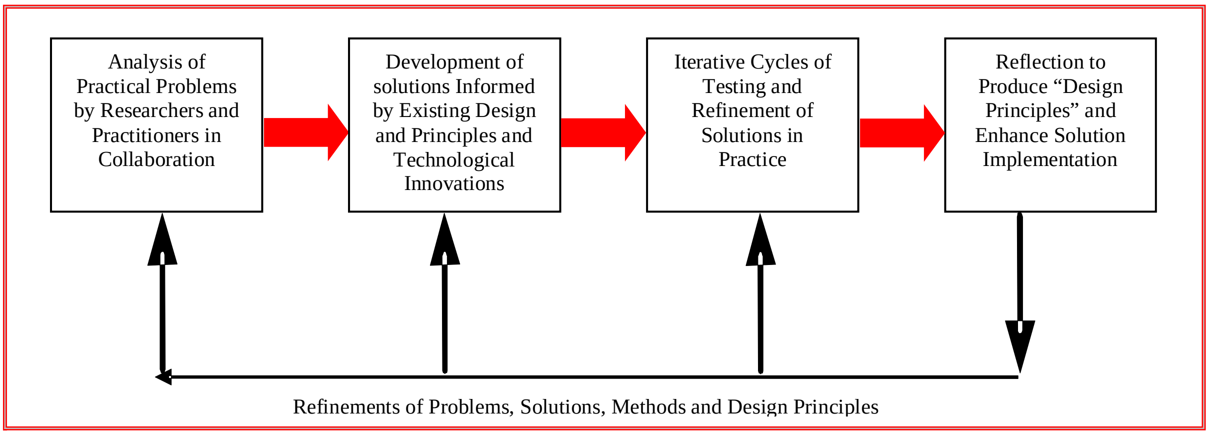


Figure 1-1 Design-based research (Reeves, 2006)

1.3 The study

The purpose of this research was to determine design principles that, when used to develop an interactive online professional learning course making use of a large video study of mathematics classrooms in seven countries, would enable practitioners to understand the results and the application to their practice.

The stages of the research align to the design-based research paradigm illustrated in Reeves' diagram, Figure 1-1, as follows.

1.3.1 Stage 1: Analysis of practical problems

The first stage of design-based research is the collaborative analysis of the problems by researchers and practitioners. During this time the scope and constraints of the research are analysed and guidelines set. Guidelines cover procedures to be followed, individual and team responsibilities, and an initial timeline for the project.

One of the most important outcomes of this stage is the set of design principles that will inform or guide the next stage of the research, the development of the solutions. Another is that researchers and practitioners must become comfortable with the technology to be used so that they understand its potential and any constraints that may apply.

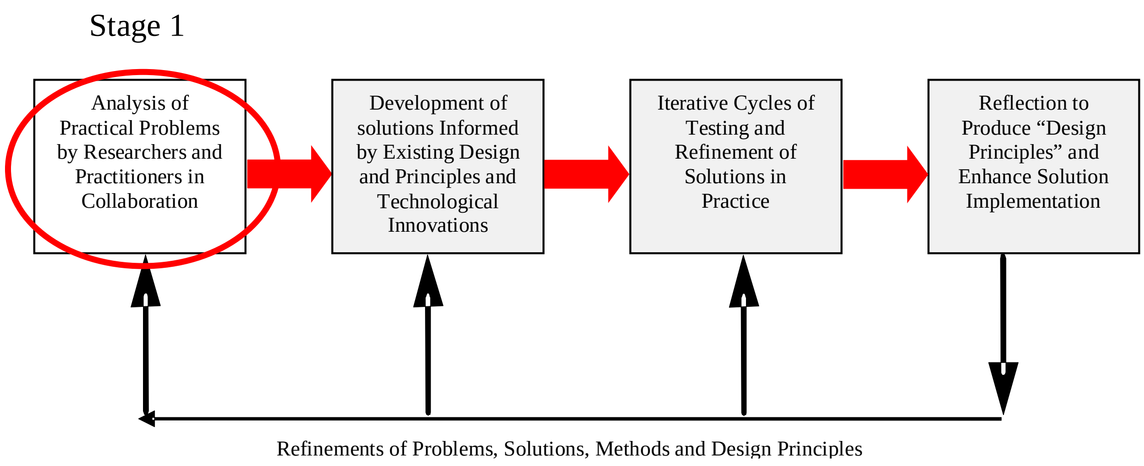


Figure 1-2 Stage 1 of design-based research

For this research project, the starting point of Stage 1 is taken from the initial design meeting in August, 2002, when the stakeholders met for the first time to start the analysis process. Prior to this, the stakeholders had agreed to the basic concept of designing and implementing a course for teachers based on the research and findings of the TIMSS Video Studies and on overall responsibilities. Stakeholders were LessonLab, Inc., Intel© Corporation's Innovations in Education Foundation and the University of California Los Angeles (UCLA).

Each stakeholder's team members provided expertise in one or more areas needed for this project – research in education, teacher professional learning both face-to-face and online, mathematics content and pedagogy and technology development and application. The team members thus satisfied one of the design-based research fundamental tenets as given by Reeves "collaboration among practitioners, researchers, and technologists" (Reeves, 2000, p.10) This expertise would be used to design the theoretical framework that would shape the solutions and their implementations.

The researcher was a member of the LessonLab team and had the range of experience required for this project. Experience included teaching mathematics at secondary and tertiary levels for many years in Australia; involvement with teacher professional learning in mathematics both face-to-face and online in Australia and America; and was a member of the team responsible for developing and implementing the LessonLab online software to be used for the project. The researcher had overall responsibility for the project.

1.3.2 Stage 2: Development of solutions

By the end of Stage 1, teams had been formed to take the project into the next stages, design principles to be followed had been agreed, and review processes and timelines put into place.

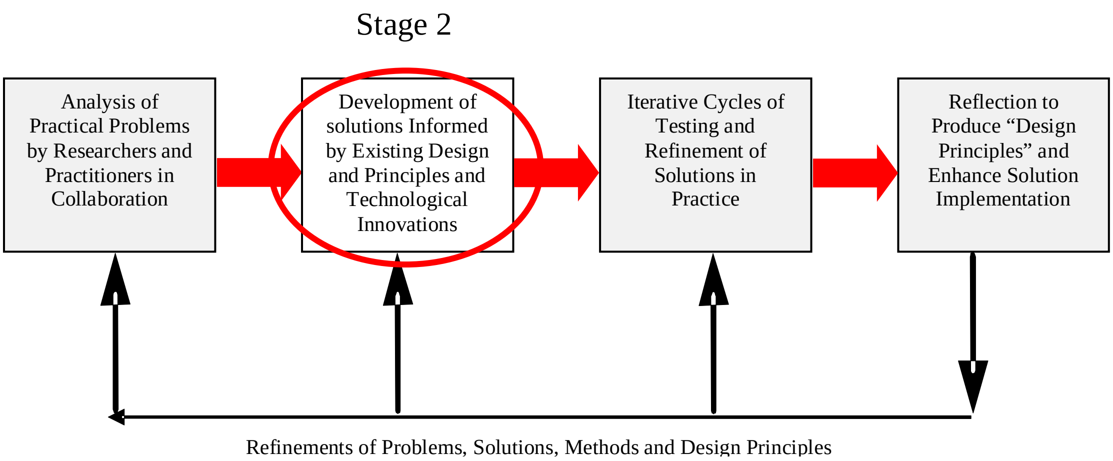


Figure 1-3 Stage 2 of design-based research

For this project, development of the solutions was conducted on three levels – the content and pedagogy, the technology and the implementation. Three teams were formed, one for each level. The researcher was a member of each team. During this stage, as the need for management of the overall project became more critical, the researcher took on this responsibility at LessonLab.

One of the major challenges faced by the content and pedagogy team was the scope and complexity of the underpinning research, the TIMSS Video Study. The mathematics portion of the TIMSS 1999 Video Study analyzed 638 eighth-grade lessons randomly collected from all seven participating countries (Australia, Czech Republic, Hong Kong SAR, Japan, Netherlands, Switzerland and United States). Selection, collection, analysis and reporting of the lessons took approximately four years to be completed. The results were published in a 236 page report (Hiebert et al., 2003), and a technical report of 533 pages followed later in 2003 (Jacobs et al., 2003). Twenty-eight public release lessons were released at the same time as the initial report.

Participants in the initial planning meeting in Stage 1 had agreed that the course should address the broad question "What does mathematics teaching look like in high-achieving countries?" with the focus being on algebra teaching. Students in the US are expected to achieve a pass in algebra to graduate from secondary school and many students, and teachers, find this a challenge. After extensive viewings and discussions, the group had selected seven public release lessons to be used in the course and designated which of these would play major (3) or minor (4) roles. It was agreed in principle that individual video-case studies would be built into the course around the major lessons. Suggestions had been made in Stage 1 about the research findings that may be included.

However, that still left the content developers with many questions to answer and challenges to face to achieve the objective of designing a 10-hour online course that would make mathematics teachers aware of the research and its findings, and would support transfer to practice. Questions and challenges included the following:

- What parts of the reports should be used to give teachers an understanding of the research methods and findings relevant to them?
- How can the selected public-use lessons be used to both illustrate the findings and show teaching in high achieving countries?
- Can teachers see beyond the cultural layers to the mathematics and teaching?
- Will teachers transfer the knowledge to their own teaching?
- What scaffolding can be provided to foster this transfer?
- What proportion of the course should be on the research and findings?
- What proportion on watching video?
- What proportion on understanding the mathematics?
- What proportion on pedagogy?
- What proportion related back to the participant's experience ?
- What proportion should be interactive?
- What should the interactive components look like?

The technology team worked closely with the content and pedagogy team as the course was the first built in the new LessonLab Course software (later known as Visibility™).

The software had been tested in-house as it was developed but this would be the first course presented via the internet to a large number of users who were diverse both geographically and in their experience with technology.

Prior to the development of the course software, online, interactive software for working with individual lessons had been conceptualized at LessonLab in 2000. Early in 2001 the first components of the lesson software were ready for testing. These components, known as LessonLab Builder and Viewer, consisted of an interface for storing and accessing digitized videotapes of lessons and their artifacts. The interactive components were tasks, for individual analysis and responses, and forums for group discussions. Links to the videos could be included by builders in the questions posed in tasks and forums, and by users in their responses and discussions. This aspect of the software was granted a United States Patent in 2005 (Grudnitski, Hood, Sims, & Stigler, 2005)

Lessons, tasks and forums are the building blocks of the Course software. Builders use these and other components, such as an online lesson planning tool, URL links and graphics files, as resources in their course. Resources are constructed and stored in a dedicated area and are then available to builders to use in course pages.

From April 2001, the researcher, and others, had used the lesson software in a wide variety of settings across America. During this period the software was refined, different types of tasks and forums were tested, a variety of implementation methods were trialed, support materials were developed and technical support systems were established. These formed the foundation of the course software.

The implementation team worked on different delivery models and support materials and designed the pilots to be used in the testing phase of Stage 3. In general the course was to be available to individuals wanting to learn about the TIMSS Video Studies for the cost of materials (CD-ROM and participant booklet) only and initially was to be delivered only online, with or without a facilitator. For an extra cost, participants could earn one continuing education unit (CEU) from UCLA.

After completing the course, individuals with a background in teacher professional learning in mathematics, could elect to train as facilitators. This would enable them to enroll participants to take the course as a group. Delivery modes would be more flexible with facilitators given the training and resources to personalize their own implementations by blending online and face-to-face segments.

The implementation team developed strategies for the variety of delivery modes planned, and designed support materials and facilitation training during Stage 2. The delivery modes and participant materials were to be tested during Stage 3. Facilitation training and materials would be piloted and then implemented after the course had been released.

While each team worked independently, each was dependent on the others and the overall solutions to the problem were only possible if each component worked. In some cases a solution relied on teams, and individuals outside of the project, working together. For example, the design and implementation of the online ordering system was the work of a group whose members were drawn from the implementation team, the technology team, and from LessonLab and Intel's accounting, marketing and technology divisions.

1.3.3 Stage 3: Iterative cycles of testing and refinement

During Stage 3 the solutions developed in Stage 2 were put through a cycle of testing and refinement in the environment for which they were designed. A team from LessonLab and Intel designed this stage ensuring that as many of the proposed delivery formats as practical could be tested. This team developed the evaluation methods, implemented the pilots, collected the data and reported back to the larger group. The researcher again had responsibility for this stage of the development for LessonLab.

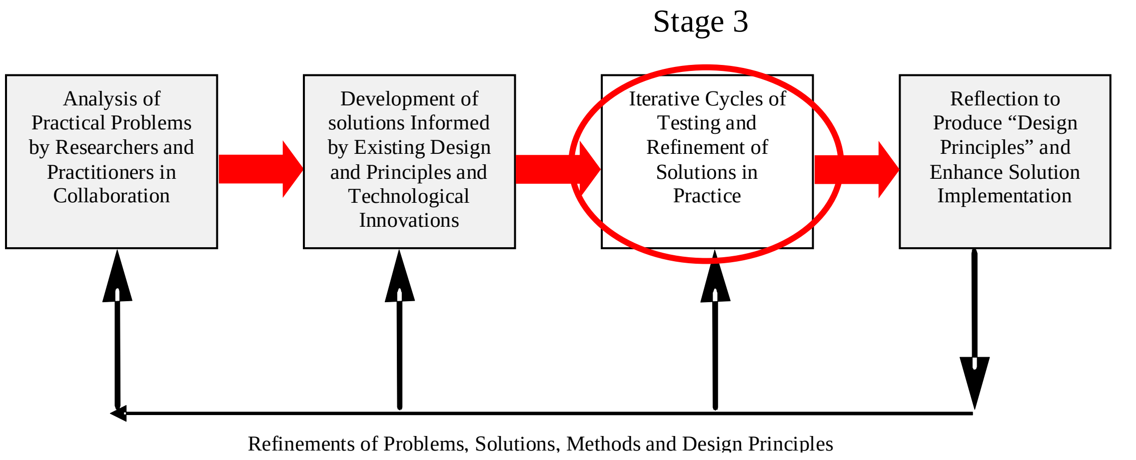


Figure 1-4 Stage 3 of design-based research

The three testing cycles consisted of four pilots conducted over three separate periods using four implementation methods. Each team had a role at the pilots and analyzed their component in detail. Refinements were made where necessary between each cycle until each team and the stakeholders were satisfied that a solution to the original problem had been successfully reached.

1.3.4 Stage 4: Reflection to produce Design Principles

At the end of Stage 3, the refined solution is deemed ready for general use. This did not mean that no more changes would take place – the cyclic nature of design-based research realistically represents the need to revisit any or all of the stages when the situation changes or when the benefits of further refinements become obvious.

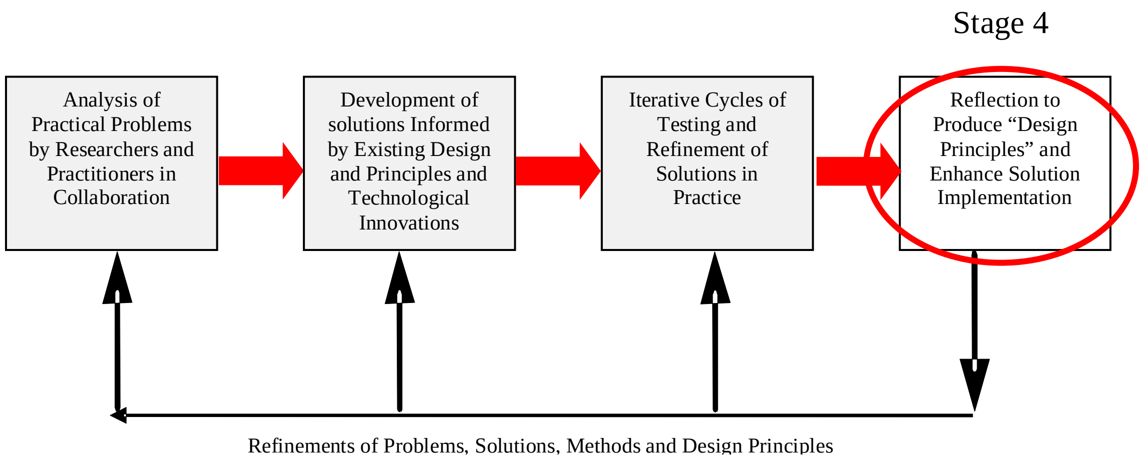


Figure 1-5 Stage 4 of design-based research

During Stage 4 the guiding principles, agreed to in Stage 1 and used to guide the development of solutions in Stage 2, were examined to see what they looked like in the refined solution. From this and any newly identified principles from Stage 3, a set of design principles was produced.

These were later used to guide the content and emphasis of the facilitation training piloted after the course had been launched. They also informed future courses developed for commercial release at LessonLab, Inc.

1.4 The research questions

It is the design principles that are at the centre of this study. These principles guide the overall development of the online course and its implementation. Three sub-questions addressed the study at a more specific level: the direct impact on teachers of analyzing multi-cultural classrooms; the success of this as a means to disseminate educational research; and the structures needed to support flexible delivery of courses.

The main question being addressed by the research is:
What are the design principles for developing online professional learning to disseminate the outcomes of educational research that will inform teachers' practice?

Sub-questions are:
What is the impact on teachers' mathematical knowledge and practices of an online professional learning resource that focuses on analyzing culturally diverse mathematics lessons from high-achieving countries?

What is the impact on teachers' understanding of educational research and its application to practice, of an online course designed around the findings and lesson videos of a major mathematics education research project?

What structures support flexible delivery methods of an online, interactive course for teacher professional learning?

1.5 Structure of the thesis

This chapter introduces the study and its main and sub-questions. It describes the framework, design-based research, used for reflection and links this to the stages of the study. Chapter 2, the literature review, aligns to Stage 1 of design-based research, the analysis of practical problems. It explores the scope of the content, and researches the elements of effective professional learning specifically in mathematics education, including video-cases and the interactive online technology platform. The outcomes from this stage are design principles that guide the development of the solutions and provide a focus for the testing and refinement cycles. Chapter 3 describes the development of the intervention, the solutions to the problem identified and analyzed in Stage 1. Chapter 4 discusses the methodology of the study and the iterative cycles of testing including an analysis of the data collected in each cycle and the refinements resulting. Thus Chapter 3 aligns to Stage 2 of design-based research and Chapter 4 to Stage 3. Reflection on the findings from Stage 3 of the study forms the basis of Chapter 5. The guiding principles from Stage 2 were examined before being accepted, modified or rejected. New principles were added. The production of a set of design principles completes Stage 4 of this design-based research. Chapter 5 further draws conclusions and recommendations in relation to the research questions posed in Chapter 1.

Chapter 2 Literature Review

The research for this study was conducted during 2002 and 2003 in California, United States of America. As background to the study, there will be a brief examination of aspects of education in the US at the time, including student achievement measures and teacher professional learning.

In summary the areas to be covered in this literature review are:

- The dissemination of educational research findings to practitioners, including their understanding of its application to practice.
- Teacher professional learning in general, and, more specifically
    - as applied to teachers of mathematics,
    - the use of video cases in teacher professional learning, and
    - the use and design of online courses for teacher professional learning.
- The implementation of online courses, flexibility of delivery and training of facilitators.

2.1 Background for the research

Concerns about educational achievement in the US have resulted in many proposals for reforms in US education. During the 1970s and 1980s these included a 'back to basics' movement and, in the 1990s, led to the development of national education goals and state academic standards (Campbell, Hombo, & Mazzeo, 2000, p.ix).

To understand why such concerns existed, it is necessary to briefly examine student achievement during that period.

2.1.1 Student achievement

The US Department of Education's National Center for Educational Statistics (NCES), has responsibility for providing information on the performance of US students in key subject areas. This basically comes from two sources: the National Assessment of Educational Progress (NAEP) and participation in international assessments such as Trends in International Mathematics and Science Study (TIMSS), Programme for International Student Assessment (PISA), and Progress in International Reading Literacy Study (PIRLS) (U.S. Department of Education National Center for Education Statistics, 2004). NAEP measures 4th -, 8th - and 12th - grade students' performances most frequently in reading, mathematics and science. TIMSS measures 4th - and 8th - grade students in mathematics and science; PISA measures 15 year-olds' reading, mathematical and science literacy; and PIRLS measures reading literacy of 4th-graders. While the four studies have obvious similarities and differences, they are conducted regularly enabling trends within each to be tracked and providing the means for international comparison within key content areas.

2.1.1.1 National Assessment of Educational Progress (NAEP)

While NAEP regularly tests a nationally representative sample of students in a variety of subjects, it has administered the same assessment in reading, mathematics and science regularly since the 1970s. This enables trends in student achievement to be mapped. Table 2-1 below, has a summary of the findings over this period, showing increases, decreases and stable periods for each subject and finally any significant differences between the first and last assessments (average scores shown for first and last years).(Data source: Campbell et al., 2000)

Table 2-1 Summary of NAEP Trends in student achievement (average scores)

	Age 17	Age 13	Age 9
Reading	1984-1992 higher than 1971 1999(288) sig = 1971(285)	1970s increase 1980s fluctuate 1999(259) sig > 1971(255)	1970s increase 1980-1999 stable 1999(212) sig > 1971(208)
Mathematics	1973-1982 decrease 1980s increase 1999(308) sig > 1973(304)	1978-1982 increase 1990s increase 1999(276) sig > 1973(266)	1970s stable 1980s increase 1999(232) sig > 1973(219)
Science	1969-1982 decrease 1982-1992 increase But 1999(295) sig < 1969(304)	1970-1977 decrease 1977-1992 increase 1999(256) sig = 1970(255)	1970-1973 decrease 1973-1982 stable 1982-1990 increase 1999(229) sig > 1970(225)

The executive summary within the NAEP 1999 Trends in Academic Progress report generalizes the findings as follows:

> Generally, the trends in mathematics and science are characterized by declines in the 1970s, followed by increases during the 1980s and early 1990s, and mostly stable performance since then. Some gains are also evident in reading, but they are modest. Overall improvement across the assessment years is most evident in mathematics. (Campbell et al., 2000, p. x)

2.1.1.2 International Assessment

The three international studies most pertinent to this research are TIMSS, PISA and PIRLS. While many factors can be explored in the vast array of data collected, this summary will concentrate on the trends evident in each, and indicate how they relate to national measurements.

2.1.1.2.1 **Trends in International Mathematics and Science Study (TIMSS)**

TIMSS is designed to measure achievements in mathematics and science in grade 4 (1995, 2003, 2007), grade 8 (1995, 1999, 2003, 2007) and final year (1995). TIMSS assessment is closely aligned to curricula of the countries and thus measures the learning of the concepts appropriate to the grade levels. Data on schools, curricula, pedagogy, lessons, teachers and students are collected and analyzed in order to understand the educational context in which learning takes place.

In 1995, half a million students from 41 nations participated in TIMSS including more than 33,000 students from about 500 US public and private schools. In 1999, assessment of grade 8 students was conducted in 38 nations. The TIMSS Video Study, the subject of this doctoral research, was part of TIMSS1999, and involved seven countries. In 2003, 46 countries participated in fourth- and/or eighth- grade levels while in 2007, 36 countries participated.

2.1.1.2.2 **Programme for International Student Assessment (PISA)**

PISA is an assessment of 15 year-olds administered by the Organisation for Economic Co-operation and Development (OECD) measuring achievement in reading, mathematics and science literacy. While the three areas are tested each cycle, one is emphasized each time. In 2000 this was reading, in 2003 mathematics and in 2006 science.

The object of PISA is to measure the skills and competencies of students near the end of their compulsory schooling, and how they apply these to real-world contexts. The emphasis on literacy in each subject, reading, mathematics and science, means that the assessment covers the mastery of processes, the understanding of concepts, and the application of acquired knowledge. Thus PISA draws from the curriculum and learning that may have occurred outside of the classroom, whereas NAEP and TIMSS measure mainly content from the school curricula.

2.1.1.2.3 **Progress in International Reading Literacy Study (PIRLS)**

PIRLS measures reading literacy of 4th grade students focusing on both achievement and reading experiences. In 2001, 35 countries participated and in 2006, 44 countries participated. As with the other studies, PIRLS is interested in the influence home, school and national administration plays in developing reading literacy and so participating students, teachers and school administrators complete extensive questionnaires.

2.1.1.2.4 International Comparative Summary

Data in Table 2-2 has been selected from TIMSS (4th- and 8th-graders mathematics and science), PISA (15 year olds) and PIRLS (4th grade reading) reports (sources http://nces.ed.gov/quicktables/ and http://www.pisa.oecd.org/). It summarizes the achievement of US students relative to students from other participating countries. The average scores for international and US students are included along with the number of countries participating in each study.

Table 2-2 Comparative assessments reading, mathematics and science

Subject/Grade/Age	Total Countries (excludes USA)	Number of Countries with average score relative to USA: Significantly higher	Not significantly different	Significantly lower	Internat'l Average	US Average
Reading						
4th-graders (2006)	43	10	11	22	500	540
4th-graders (2001)	34	3	8	23	500	543
15 year-olds (2000)	30	3	20	7	500	504
Mathematics						
4th-graders (2007)	35	8	4	23	500	529
4th-graders (2003)	24	11	0	13	495	518
4th-graders (1995)	25	7	6	12		518
8th-graders (2007)	48	5	5	37	500	508
8th-graders (2003)	44	9	10	25	466	504
8th-graders (1999)	37	14	6	17	487	502
8th-graders (1995)	40	20	13	7		492
15 year-olds (2006)	56	31	5	20	498	474
15 year-olds (2003)	38	23	4	11	500	483
15 year-olds (2000)	30	8	15	7	500	493
Science						
4th-graders (2007)	35	4	6	25	500	539
4th-graders (2003)	24	3	5	16	489	536
4th-graders (1995)	25	1	5	19		542
8th-graders (2007)	47	9	3	35	500	520
8th-graders (2003)	44	7	5	32	473	527
8th-graders (1999)	37	14	5	18	488	515
8th-graders (1995)	40	9	16	15		513
15 year-olds (2006)	56	22	12	22	500	489
15 year-olds (2003)	38	18	9	11	500	491
15 year-olds (2000)	30	7	16	7	500	499

2.1.1.2.4.1 Mathematics

Between 1995 and 2003, US students in grade 4 showed no measurable change in mathematics achievement. However, between these years they did not keep up with improvements by their peers in other countries. In 1995, seven countries were significantly higher and twelve significantly lower. In 2003 US students in grade 4 scored significantly higher than students in thirteen countries but significantly lower than eleven countries Further analysis of the fifteen countries that participated in both the 1995 and 2003 studies, shows US students were outscored by students in seven countries in 2003 and by four in 1995 (Lemke & Gonzales, 2006).

In grade 8, the relative performance in mathematics improved significantly between 1995 and 2003. In 2003 nine countries performed significantly higher than the US, in 1999 this was fourteen and in 1995 twenty. This trend was also confirmed within the twenty-two countries that participated in both 1995 and 2003 (12 countries significantly higher in 1995 and 7 countries in 2003).

The most recent figures from 2007 show that in the US, students in both grade 4 and grade 8 improved in mathematics achievement in 2007 compared to 1995. In this period, grade 4 students improved by 11 score points and grade 8 students by 16 points (Table 2-2).

Findings on the mathematics literacy of 15-year olds, PISA 2000, PISA 2003 and PISA 2006 were that the US scored significantly lower than 8 countries in 2000, 23 countries in 2003, and 31 countries in 2006. As the 2003 focus was mathematics literacy, these results give the strongest picture of achievement in this area. In this year, the US performed below the OECD average on each mathematics literacy subscale representing a specific content area (space and shape, change and relationships, quantity, and uncertainty). In 2006, mathematics a minor focus, US students scored lower than the OECD average on the mathematics literacy scale (474 vs. 498)

2.1.1.2.4.2 Science

Between 1995 and 2003 in TIMSS science, grade 4 students showed no measurable change in science performance while grade 8 students showed some improvement. 2003 scores have students at both levels performing measurably above the international average with grade 4 students performing higher than 16 countries and lower than 3, while in grade 8 they perform higher than 32 countries and lower than 7. However, as with mathematics, grade 4 science students did not keep up with their peers between 1995 and 2003. Of the other fourteen countries that participated in both years, US grade 4 students scored higher than thirteen countries in 1995 but only eight countries in 2003.

The results were better for grade 8 students when compared with the other twenty-one countries - they scored higher than eleven countries in 2003 compared with five in 1995. (Gonzales et al., 2004; Lemke & Gonzales, 2006)

When the figures for 1995 are compared to the 2007 figures, there is no detectable change between science achievements in the US for either grade 4 or grade 8 students. Of the sixteen countries that participated in both of these years, in grade 4 almost half (7 of 16) showed improvement in science while almost a third (5 of 16) declined. For grade 8 the figures were a quarter (5 of 19) improved and only 3 declined.

Science literacy was a minor focus of PISA 2000 and PISA 2003 and a major focus in 2006. In 2000, the US 15-year olds scored significantly higher than 7 countries, significantly equal to 16 countries and significantly lower than 7. In 2003 18 countries scored significantly higher than the US and in 2006 the figure was 22. In 2006, US students (489) scored lower than the OECD average (500) on the combined science literacy scale (Table 2-2).

2.1.1.2.4.3 Reading

PISA 2000 had reading literacy as its focus when testing 15 year olds. Looking at all countries assessed, 12 scored statistically higher than the OECD average; 5 including the US, were not statistically different from the average; and 14 were statistically below the average. In Table 2-2, figures are based on multiple comparisons rather than the OECD average. When measured this way, only 3 countries are significantly higher than the US, 20 have no significant difference and 7 are lower. In PISA 2003, 11 countries were significantly higher than the US.

Grade 4 students' reading was measured in PIRLS 2001 and results indicate that only 3 countries scored significantly higher than the US, 20 were equivalent and 7 lower. In 2006, 10 countries were significantly higher, 11 equivalent and 22 lower. Overall scores between 2006 and 2001 were not significantly different for US students.

2.1.1.3 Student achievement conclusion

Despite some fluctuations in the average scores of reading, mathematics and science during the thirty or so years of national assessment, there have been modest improvements in most subjects over the three age groups tested (9, 13 and 17). Science in the middle and upper years has not recovered from the decline it suffered in the 1970s, and reading has shown improvement in the upper years.

Looking at the overall achievement of US students in international assessment, students perform relatively well in reading literacy at all levels and in mathematics and science at lower grades. While some improvement is evident nationally in mathematics and science at the middle levels, there is concern that this may not be keeping pace with international peers. Trends over the assessment periods indicate that generally more countries are achieving significantly higher than the US at this level. Results in the higher years in mathematics and science are disappointing.

In all areas US students are not achieving in the top groups that are measured as significantly higher than the international averages. In PISA 2000 and 2003, the US was the only English speaking country to not be in the significantly higher than the OECD average in all three areas, reading, mathematics and science. Concerns about this has led to further studies and calls for increased spending and reforms in the curriculum, school organization and teacher education in the US.

2.1.2 Expenditure on education, US

To see if the lower achievement levels may be due to lower spending on education, US expenditure can be measured against other countries. Public spending on primary and secondary education measured in the countries that participated in the 1995 TIMSS studies shows that only one country, Norway, with international dollar expenditure per capita of 1111 spends more than the US (1040). Four countries, Denmark (998), Canada (981), Switzerland (907) and Iceland (902), are slightly below in spending (Beaton et al., 1996).

A 2002 study conducted by the US Department of Education's National Center for Education Statistics examined the results and economic indicators of a selection of six G8 countries from the TIMSS 1999 Study (Sherman, Honegger, & McGivern, 2003). The study reported that, of the six countries, three scored statistically higher in the TIMSS grade 8 mathematics achievement than the US (502) – Japan (579), Canada (531), and Russia (526); one was statistically equal – England (496); and one lower - Italy (479). In 2007, Japan (570) was statistically higher than the US (508), England

(513) and Russia (512) were statistically equal, and Italy (480) was lower (Canada did not take part in 2007).

Looking at the total expenditure (ppp) per student in secondary schools by country (Figure 2-1 below), it can be seen that the US spent more than any of the other G8 countries and increased spending from 1994 to 1998.

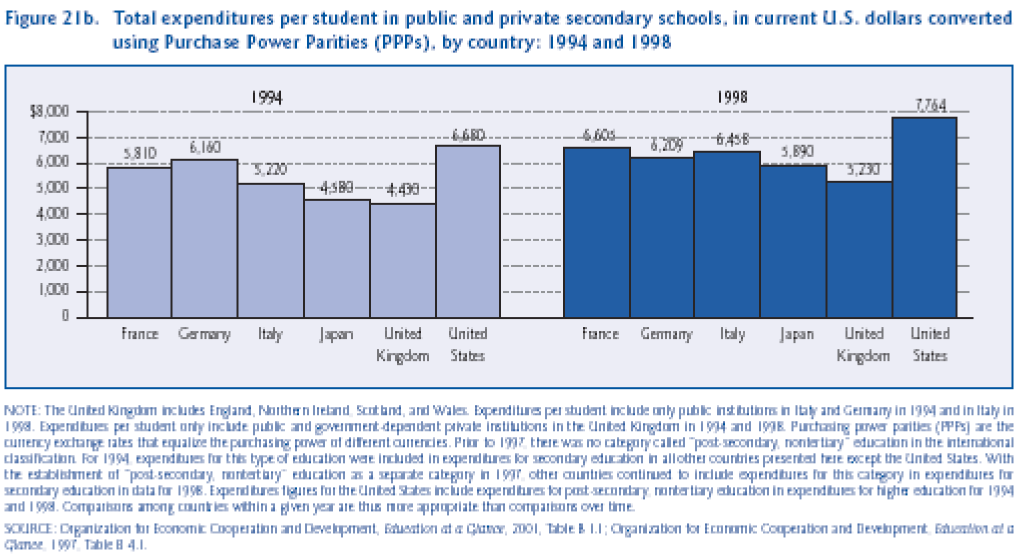


Figure 2-1 G8 Countries Total expenditure per student

It is interesting to note that Japan and the United Kingdom have similar spending amounts and patterns but quite different levels of achievement in the TIMSS 1999 year 8 mathematics. Japan is at the top of this group scoring 579, and United Kingdom with 496 is ranked statistically with the US (502). Italy (479) is statistically lower than the US, and hence Japan and the UK, but spends more than both of these countries and has a substantial increase in spending between 1994 and 1998 (see Figure 2-1). A more recent publication on the percentage of gross domestic product spent on education shows that the spending trend has continued (D. C. Miller, Sen, & Malley, 2007). The lowest spending country in the above group, Japan, consistently achieves in the top groups in most international assessments. These studies suggest that the achievement differences are not directly related to the amount spent on education per student.

2.1.2.1 Expenditure on teacher professional learning, US

In one of many attempts to quantify how much is spent in the US on teacher professional learning, Killeen, Monk and Plecki, 2002, compiled data from two sources, the Census Bureau's Survey of Local Government Finances: School District Finances (a school district fiscal report compiled by the US Census Bureau), and the Common Core of Data (demographics of US school districts compiled by the National Center for Education Statistics). By considering three years of data 1991-1992, 1994-1995, and 1997-1998 they were able to see trends despite the problems presented by the source data. Problems included a lack of clear categories to cover professional learning and data missing for some periods in some states. The authors believe that, if anything, the categories they included would underestimate spending on instructional staff support.

In general this study found that spending on instructional staff support during this time was around 3% of total general expenditures, equating to about $200 per student. This was stable through the three periods measured. There was evidence of variation between States with higher spending levels among larger more urban schools. This may parallel the presence of greater opportunities for professional learning in urban areas including greater access to higher education institutes (Killen, Monk, & Plecki, 2002, p. 23; Little et al., 1988, p. 6).

The scale of spending on teacher professional learning is also addressed in Stout's paper in which he examines policy and practice on staff development (Stout, 1996). He cites two studies that look at spending in specific areas. Little et al. estimated spending on staff development costs in California in 1986-87 to be $368 million or about $1700 per certified staff member while Miller, Lord and Dorney found figures of $1700 to $3500 in four school districts (Little et al., 1988; B. Miller, Lord, & Dorney, 1994; cited in Stout, 1996).

As with expenditure on primary and secondary education, levels of spending on teacher professional learning appear to be adequate. A closer examination of what is being done in this area seems justified.

In a paper published by the Albert Shanker Institute, Richard Elmore writes that "spending more money on existing professional learning activities, as most are presently designed, is unlikely to have any significant effect on either the knowledge and skill of educators or on the performance of students" (Elmore, 2002, p.6). Elmore based this claim on the notion of professional learning covering a vast array of activities, anything conducted once the teacher is 'on the job' and that many of these do not seem to connect to, or change, schools or teachers' practices.

2.2 The outcome

As a result of the international and national studies, many proposals for reforms in curriculum, structure and school organization have been forthcoming. School organization, rigorous testing and other measures of accountability have been targeted. Text books, and other materials, with prepackaged lessons were developed to guide teachers. However, evidence suggests that after 15 or so years of reforms, few changes have occurred within the classroom and most teachers continue to teach as they always have (Sparks & Hirsh, 1999).

This 'tidal wave' of reforms is also discussed by Ball and Cohen in *Developing Practice, Developing Practitioners* (Ball & Cohen, 1999). They recognize the complexities of instituting changes in education. While, as discussed in 2.1.2.1 above, spending on teacher professional learning is substantial, it appears that it is not bringing about the changes that reformers are seeking. Too often the in-service sessions or workshops are superficial and fragmented offering only 'advice and tips of things to try'.

2.3 The teaching culture

The difficulty of bringing about significant change in teaching is not surprising when one considers teachers' pre-teaching experiences. The cultural notion of teaching was one of the findings of the TIMSS Videotape Classroom Study 1995 (Stigler, Gonzales, Kawanka, Knoll, & Serrano, 1999). In their book, *The Teaching Gap*, Stigler and Hiebert reflect further on this and its relevance to teachers and teaching in America. They observe that many people expect to see the patterns found in the Japanese lessons due to their centralized system and relatively homogenized population, but, are surprised that this is also the case in the US. The culture of teaching comes from a shared knowledge base, or cultural script, most of which comes from the thirteen plus years spent as students before the, relatively, short time of formal teacher training (Stigler & Hiebert, 1999).

This influence was documented and referred to as the "apprenticeship of observation" by Lortie in 1975 (Lortie, 1975, p.61). Interviews he conducted with teachers verified his belief that the entire school experience contributes to the professional preparation of teachers. In many cases, the experiences teachers have over their sixteen years as students (primary, secondary and tertiary) are more powerful than their pre-service experience. Two major restrictions Lortie sees is that the student experiences only a very limited view of teaching from a “specific vantage point” and, like being in an audience their participation is more likely “imaginary rather than real”. While students are influenced by some teachers more than others, this is unlikely to be in an analytical way and so what they learn about teaching is likely to be “intuitive and imitative rather than explicit and analytical” (Lortie, 1975, p.62).

Elmore extends this idea stating that “the organization and culture of American schools is, in most respects, the same as it was in the nineteenth and twentieth centuries” (Elmore, 2002, p.4). Further, teachers work very much in isolation, rarely being exposed to others’ teaching and with few opportunities for new ideas or practices to enter their domain.

The National Commission on Teaching and America’s Future (NCTAF) report in 1996 cited statistics that may further explain why this traditional approach to teaching continues. Annually over 50,000 untrained teachers enter teaching; in general 23% of teachers do not have even a college minor in their main teaching field and with mathematics this rises to more than 30%; and in high poverty schools the proportions are even higher (cited in Loucks-Horsley & Matsumoto, 1999, p. 258). These teachers initially only have their experiences as students to guide their teaching, and with a lack of content knowledge are likely to rely heavily on transmission approaches to teaching, set texts and/or prepackaged lessons.

2.3.1 The education tradition

Concerns about education, teaching and student learning have been evident in educational literature since universal education became the norm. Consider briefly some of the thinking in the US that pertains to the current situation.

During the early 1900s in the US, Dewey wrote extensively on education addressing his concerns about traditional education. Dewey saw traditional school methods and the uniform curriculum offered at the time, as very rigid, failing to allow for student diversity. The majority of students were offered very basic education with more advanced topics being the privilege of those with higher social standing. "Useful knowledge on the other hand was confined to those who had to work for a living". (Archambault, 1974, p.5)

Dewey's writings foresaw many educational movements that developed, particularly in the US, during the second half of the 1900s. When writing about science education in *Science,* 1910, Dewey talked about the difference between knowledge and information emphasizing the importance of constructing knowledge. "Only by taking a hand in the making of knowledge, by transferring guess and opinion into belief authorized by inquiry, does one ever get a knowledge of the method of knowing." Further he advised that it was not enough to just use laboratory methods within teaching if it did not encompass active experimentation and testing, that is, application of scientific method. "Many a student has acquired dexterity and skill in laboratory methods without its ever occurring to him that they have anything to do with constructing beliefs that are alone worthy of the title of knowledge." (Archambault, 1974, p.189)

In his 1933 publication *How We Think: A Restatement of the Relation of Reflective Thinking to the Education Process,* Dewey again revisited the notion of teachers promoting reflective thinking in students rather than suppressing intellectual curiosity in favour of a one way flow of information from the teacher with students expected to memorize things. "… the problem of method in *forming* habits of reflective thought is the problem of establishing *conditions* that will arouse and guide *curiosity*; of setting up the connections in things experienced that will on later occasions promote the flow of *suggestions*, create problems and purposes that will favor *consecutiveness* in the succession of ideas" In talking about the teaching of the day, Dewey focused on the drill and practice methods prevalent then (and, still, today). "The tendency is to take the shortest cuts possible to gain the required end. This makes the subjects *mechanical,* and thus restrictive of intellectual power. … Sheer imitation, dictation of steps to be taken, mechanical drill, may give results most quickly and yet strengthen traits likely to be fatal to reflective power. … his mistakes are pointed out and corrected for him …Practical skills, modes of effective technique, can be intelligently, non-mechanically *used* only when intelligence has played a part in their *acquisition*." (Archambault, 1974, p.230 & 236)

2.3.2 Research and teachers

Dewey was not only concerned about the effect teaching had on student learning, but also believed that unless teachers adopted reflective thinking into their own practice, they would be open to the whims of those in control. Teachers need to take responsibility for their teaching and the research done around it. In 1904 Dewey recognized problems for teachers created by authorities as they readily accepted one study after another, expecting teachers to move quickly to adopt new methods or devices. This problem is compounded by teachers' willingness to accept such changes without informed challenges.

> The tendency of educational development to proceed by reaction from one thing to another, to adopt for one year, or for a term of seven years, this or that new study or method of teaching, and then as abruptly to swing over to some new educational gospel, is a result which would be impossible if teachers were adequately moved by their own independent intelligence. The willingness of teachers, especially of those occupying administrative positions, to become submerged in the routine detail of their callings, to expend the bulk of their energy upon forms and rules and regulations, and reports and percentages, is another evidence of the absence of intellectual vitality. (Archambault, 1974, p. 321)

Eighty years on, this problem was revisited by Shulman and others (Shavelson, Webb, & Burstein, 1986; Shulman, 1986, 1987). Shulman discussed how the individual nature of teaching and learning can easily be ignored when empirical research on a small sector within the field is turned into school or district based policy. Limited empirical research conducted in education often results in a narrow selection of, say, teacher competencies being identified as desirable and these, in turn, becoming the focus of teaching standards. While researchers may recognize the findings from their research to be simplified and incomplete, often trivializing the complexities of teaching, policy makers are often eager to adopt standards that, they claim, are confirmed by research.

An example of this arose from the process-product research prevalent in the 1970s. In this research, the teacher behavior ('process') was measured against teacher effectiveness ('product'). Systematic classroom observations were generally used for the process measurements, and gains in student achievement for the product. General pedagogy, such as wait time, became more important than subject matter content knowledge. Findings from this research were far reaching as they were used to design instructional packages; influence teacher training and professional learning; and generate more of the same research studies.

The influence of research in teaching was one of the driving forces of the research questions of this study – the need to disseminate research findings to teachers in a way that would enable them to understand the research, its methodology, findings and limitations, and hence inform their practice. One challenge was how to do this in a way that empowered teachers and avoided the pitfalls of too narrow a focus or application of research findings as discussed above. Before considering the theoretical underpinnings that guided the development of the online course aimed at meeting these objectives, it is important to understand the core research.

2.4 TIMSS Video Studies

The research central to this study is the TIMSS Video Studies, an international project conducted in year 8 mathematics and science classrooms. The first study in 1995, concentrated on mathematics, whilst the second in 1999, also included year 8 science.

The 1995 study, involving analysis of videotaped lessons and artifacts from three countries - Japan, Germany and the US, resulted from concerns at the US's performance in the Third International Mathematics and Science Study (TIMSS) (see 2.1.1.2.1). Researchers wanted to see what teaching looked like in high achieving countries. The findings and methodology were published in a 183 page report in 1999, (Stigler et al., 1999).

One of the most important findings in the first study was that teaching is a cultural activity, that is, teaching varies far more across cultures than within cultures. However, since Japan was the only high achieving country in this study, an unwarranted conclusion was that emulating Japanese teaching must be the key to raising the achievement of students in the United States. From the TIMSS 1999 Video Study (Mathematics) report:

> The TIMSS 1995 Video Study included only one country with a relatively high score in eighth-grade mathematics as measured by TIMSS - Japan. It was tempting for some audiences to prematurely conclude that high mathematics achievement is possible only by adopting teaching practices like those observed in Japan. The TIMSS 1999 Video Study addressed this issue by sampling eighth-grade mathematics lessons in more countries—both Asian and non-Asian countries—where students performed well relative to the United States on the TIMSS 1995 mathematics assessments…(Hiebert et al., 2003, p.1)

To counteract these misconceptions, the 1999 study involved seven countries - Australia, Czech Republic, Hong Kong SAR, Japan, Netherlands, Switzerland and United States. The mathematics portion of this study included 638 eighth-grade lessons collected from all seven participating countries (including the lessons collected in Japan in 1995). In each country, the lessons were randomly selected to be representative of eighth-grade mathematics lessons overall and were taped across the school year. Selection, collection, analysis and reporting of the mathematics portion took approximately four years to be completed.

Average scores on the TIMSS 1995 and 1999 studies of these countries are provided below in Table 2-3. The notes at the bottom of the table include the statistical positions of the countries.

Table 2-3 Countries in TIMSS 1999 Video Study (Mathematics)

Average scores on TIMSS 1995 and TIMSS 1999 mathematics assessments of countries participating in the TIMSS 1999 Video Study participating countries		
	Average scores	
Country	1995[1]	1999[2]
Australia[3] (AU)	519	525
Czech Republic (CZ)	546	520
Hong Kong SAR (HK)	569	582
Japan (JP)	581	579
Netherlands[3] (NL)	529	540
Switzerland (SW)	534	-
United States (US)	492	502
International average[4]	-	487

-Not available.
[1]TIMSS 1995: AU>US; HK, JP>AU, NL, SW, US; JP>CZ; CZ, SW>AU, US; NL>US.
[2]TIMSS 1999: AU, NL>US; HK, JP> AU, CZ, NL, US.
[3]Nation did not meet international sampling and/or other guidelines in 1995. See Beaton et al. (1996) for details.
[4]International average: AU, CZ, HK, JP, NL, US>international average.
NOTE: Rescaled TIMSS1995 mathematics scores are reported here. Due to rescaling of 1995 data, international average not available. Switzerland did not participate in the TIMSS 1999 assessment.
SOURCE: Gonzales, P., Calsyn, C., Jocelyn, L., Mak, K., Kastberg, D., Arafeh, S., Williams, T., and Tsen, W. (2000). *Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999* (NCES 2001-028). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

2.4.1 Research reports and public-release lessons

Output from the TIMSS Video Studies consisted of reports and public-release lessons. Findings from the TIMSS 1999 Video Study (Mathematics) were published in a 236 page report (Hiebert et al., 2003) and a technical report of 533 pages followed later in 2003, (Jacobs et al., 2003).

Twenty-eight lessons, four from each country, were released for public use as part of the TIMSS 1999 Video Study. The lessons were selected to represent the findings from the TIMSS Video Study for each country. Each lesson video had subtitles (transcripts) available in English and the original language. Resources such as lesson plans and curriculum materials were included with each, along with a one page ‘lesson graph’ – an overview of the lesson content and structure. Commentaries, time linked to the video, were provided from the teacher and from country-specific researchers. The public release mathematics lessons, available as a four-CD-ROM set, are standalone and cross-platform, using software (Grudnitski et al., 2005), developed at LessonLab in Santa Monica, CA.

2.5 Theoretical underpinnings

An essential component of the first stage of design-based research, as discussed previously in 1.3.1, was to establish a set of design principles that would guide the following stages of the research. These guiding principles would evolve from an examination and understanding of the theory pertaining to the problem at hand. In this case the problem was how to disseminate the findings from a large international study to teachers in a way that would inform their practice. The solution was to be an online course for use in teacher professional learning with the public-release videotaped lessons as the core component. Delivery of the course was to be flexible ranging from fully online through a variety of blended face-to-face and online implementations. So to establish guiding principles for the three areas involved in this problem - technology, content and pedagogy, and implementation - the current theory for each of these needed to be examined.

2.5.1 What do teachers need to know?

As the overall objective was to produce a course for teacher professional learning, the first question to address was “What do teachers need to know?” In a discussion on the knowledge needed by teachers, *National Society for the Scientific Study of Education, Third Yearbook, 1904*, Dewey identified the two distinct areas of content and pedagogical knowledge, with an acknowledgement of their inter-connectedness.

> 1. Mastery of subject-matter from the standpoint of its educational value and use; or, what is the same thing, the mastery of educational principles in their application to that subject-matter which is at once the material of instruction and the basis of discipline and control;
> 2. The mastery of the technique of class management. (Archambault, 1974, p.318)

These two areas remained at the forefront of teacher education and educational research until the work by Shulman in the early 1980s when he identified the inter-connectedness of content and pedagogical knowledge using the term pedagogical content knowledge.

As mentioned previously, the process-product research period of the 1970s resulted in bias towards pedagogical knowledge (2.3.2). The emphasis was on student achievement gains, irrespective of content. The danger, as seen by Shulman, Dewey and others, was that this is best suited to skills acquisition leading to prescriptive teaching rather than teaching for understanding. Further, the assessment of teachers in most states in the US focused on basic skills, content knowledge and general pedagogical skills. Shulman argued with this approach "teaching is trivialized, its complexities ignored, and its demands diminished" (Shulman, 1987, p.6).

2.5.2 Teacher knowledge base

A movement towards the professionalization of teaching started. While advocates for reform claimed a knowledge base for teaching was necessary and already existed, Shulman noted the absence of specificity in reports current at the time. He addressed this point, acknowledging the work of Dewey, Piaget and others (Shulman, 1987, p. 4) and the contributions made from his own research on observing new teachers learning to teach, and on developing a national board for teaching.

Shulman listed the following categories as a minimum for a teacher knowledge base:

- content knowledge;
- general pedagogical knowledge with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter;
- curriculum knowledge with particular grasp of the materials and programs that serve as "tools of the trade" for teachers;

- pedagogical content knowledge, the special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding;
- knowledge of learners and their characteristics;
- knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of the school districts, to the character of the communities and cultures; and
- knowledge of educational ends, purposes, and values, and their philosophical and historical grounds. (Shulman, 1987, p.8)

It is the pedagogical content knowledge category that formally links the content and pedagogy aspects of teacher knowledge discussed by Dewey and others earlier. It is "the key to distinguishing the knowledge base of teaching" and is "the intersection of content and pedagogy, in the capacity of a teacher to transform content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background of the students" (Shulman, 1987, p.15)

Shulman included four sources for the teaching knowledge base: scholarship in content, materials and settings, educational research, and the wisdom of practice.

Three of these areas are very significant to this research study – content knowledge, educational research and the wisdom of practice.

2.5.2.1 Content knowledge

For teachers to promote the reflective thinking and construction of knowledge discussed by Dewey and many others since, they must have a deep knowledge of content. They must, for example, understand the content, what it means and how it connects to other ideas in that field and to everyday life. Within their classes, there will be students at different stages of development, with different bases and experience and with different learning styles. The teacher must be prepared for this and be able to provide appropriate activities and scaffolding for all students to eventually reach an understanding of the concepts. He or she must be able to employ effective and varied teaching strategies, and to understand student responses and/or questions. This depth of content knowledge combined with an understanding of student learning results in pedagogical content knowledge.

Providing the opportunity to reach such a point of understanding of the subject content was a guiding principle of this design-based research.

2.5.2.2 Educational research

The second focus adopted from Shulman's teacher knowledge base sources was educational research. This is behind the main question of this research – disseminating research outcomes in order to inform practice. Shulman emphasized that it is not just the research findings that are important for teachers, but more the opportunity for teachers to "enrich their images of the possible" (Shulman, 1987, p.11). As discussed previously, there is a danger that general teaching principles extracted from empirical research can lead to prescriptive practices or narrow criteria for judging teachers rather than providing understanding into the complexities of teaching and learning. However, research into cognitive processes, such as how the mind stores and retrieves information; and specific subject matter and student development, such as misconceptions in mathematics; can provide teachers with the means to reach such understandings.

2.5.2.3 Wisdom of Practice

By wisdom of practice, Shulman is referring to an understanding of "the maxims that guide" … "the practices of able teachers" (Shulman, 1987, p.11). Unless an effort is made to record and code such maxims, the profession does not build up a history of practice. This is not a static collection of cases but, as a history, will evolve as researchers and teachers learn more about teaching and learning.

The TIMSS Video Study, central to this research project, has coded hundreds of classrooms in seven countries and identified characteristics of teaching in those countries. Lessons were sampled randomly within countries giving a portrait of teaching experienced by the average student. The public-release lessons were selected to be representative of the findings for each country and as such enter the history of practice. While the lessons may not be of the best teachers, they do provide a database for analysis, comparison and contrast of teaching in other cultures.

The challenge was to move this new addition to the knowledge base from the realm of research to that of the practicing teacher – the focus of this doctoral research. It was expected that by exploring and analyzing these lessons, teachers would have the opportunity to add to their own understanding of teaching and learning, thus increasing their own "wisdom of practice" (Shulman, 1987, p.11), strengthening their own knowledge base of teaching.

2.5.2.4 Teacher learning

Ball and Cohen suggest that teachers need opportunities to "become serious learners in and around their practice" (Ball & Cohen, 1999, p.4). Teacher learning is often expected to just happen and there is a lack of validated theories on teacher learning to inform teacher education. Without access to a means of expanding their knowledge on teaching, teachers use their own teaching experience as the basis for change and ideas. Over time, practices of experienced teachers can become deeply embedded and new ideas or unfamiliar practices can be very challenging. Experience does not necessarily equate with expertise and in many cases this, and the pre-service experiences discussed above, can work against the improvement of teaching (Ball & Cohen, 1999; Elmore, 2002; Stigler & Hiebert, 1999). Effective teacher professional learning must provide the means for teachers to expand their professional knowledge of teaching and then to apply this new knowledge to their practice. Teachers need the opportunity to experience the unfamiliar thus opening the way for them to move "beyond their own personal and educational experience" by providing "productive disequilibrium" and a "new terrain for learning" (Ball & Cohen, 1999, p.15). Even when teachers have the impetus to change, it must be remembered that "change is a gradual, difficult, and often painful process" (D. M. Clarke, 1994, p.45). Critical also to the process of change is the support teachers need to sustain such changes in their, often very conservative, workplaces.

2.5.3 Expanding professional knowledge

So how can teachers move beyond their own terrain to the unfamiliar? How can they experience "productive disequilibrium"? The public-release lessons afforded the opportunity while still satisfying the overall objective of disseminating the research findings to inform practice. Videotaped lessons are the core of the TIMSS Video research and the public-release lessons were considered the central component of the online course. The lessons were to be used to make sense of some of the findings from the TIMSS research and to provide the opportunity for users to simulate basic processes used during analyses by the TIMSS researchers. Since the public-release lessons are from the seven countries in the study, it was expected that the ones chosen for the course would move teachers into unfamiliar terrains and, hopefully, challenge their own practice.

Further, by exploring and analyzing aspects of a variety of lessons for themselves, it was expected that course participants would not only reach some understanding of the research methodology but would be opened to a variety of teaching styles and classrooms and gain skills in lesson analysis that would transfer to their own teaching. Opportunities would be provided for participants to reflect on the experience, on their own learning, and to apply new ideas to their teaching and then share the outcomes in a supportive environment.

The planned use of video to simulate the original research methodology pointed to situated learning being an appropriate theoretical framework to guide the course development. The question was whether this framework applied to the other roles anticipated for the videotaped lessons.

2.5.3.1 Situated Learning

Collins (1988) defined situated learning as “the notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life” (Collins, 1988, p.2). Learning occurs as a function of the activity, the context and the setting, that is, it is situated. Lave and Wenger looked at situated learning in a variety of settings and concluded that acquisition of knowledge and skills was gradual with novices learning, often unintentionally, from experts. Social interaction is seen as a critical component of situated learning with the novices moving from the edges of the particular community into its centre as they become more expert in the practice, gradually taking on the expert role with a new band of novices. Lave and Wenger coined the phrase "community of practice" for these groups and "legitimate peripheral participation" for the process of learning (Lave & Wenger, 1991, p.29).

The social aspect of learning as a fundamental role in the acquisition and understanding of knowledge was also a major component of Vygotsky's theoretical framework. He wrote:

> Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (Cole, John-Steiner, Scribner, & Souberman, 1978, p.57)

While Vygotsky here is talking about children's learning, it aligns with the ideas of Lave and Wenger on novices or apprentices learning from the community of practice, often in a non-deliberate way. Knowledge can be acquired at a social level before being internalized at a deeper level and the process of knowledge acquisition is an ongoing one with roles changing in the community as the level of individual expertise evolves. By providing meaningful opportunities for online communities to move through these stages, knowledge can be actively constructed resulting in learning taking place (Oliver, Harper, Hedberg, Wills, & Agostinho, 2002).

2.5.3.1.1 Characteristics of situated learning environments

A list of critical characteristics for designers of situated learning environments was developed by Herrington and Oliver (1995) and used by them and others during the design of a multimedia resource for learning teachers of mathematics (A. Herrington, Herrington, Sparrow, & Oliver, 1998; J. Herrington & Oliver, 1995). These characteristics succinctly cover the features of situated learning and are a useful guide for designers. They are:

1. Provide authentic contexts that reflect the way the knowledge will be used in real-life.
2. Provide authentic activities.
3. Provide access to expert performances and the modeling of processes.
4. Provide multiple roles and perspectives.
5. Support collaborative construction of knowledge.
6. Promote reflection to enable abstractions to be formed.
7. Promote articulation to enable tacit knowledge to be made explicit.
8. Provide coaching and scaffolding at critical times.
9. Provide for integrated assessment of learning within the tasks. (J. Herrington & Oliver, 1995, p.3)

The use of video to provide participants with the firsthand experience of understanding the methodology used by the TIMSS researchers satisfies the authentic activities requirement of situated learning by modeling the processes, at a basic level, of the research conducted. The findings of the TIMSS Video Studies were predominantly from an analysis of data collected by researchers coding the videotaped lessons. Participants' explorations of the videotaped lessons will provide a different perspective for most, shifting them from being in front of the class to being observers, and researchers, of the classroom. By analyzing aspects of the lessons, participants will be made aware of the complexities faced by coders in collecting data for the study.

2.5.3.1.2 **Video and situated learning**

Apart from simulating the research conducted during the TIMSS Video Study, the question remains as to whether the more general use of video satisfies the authentic activity basis of situated learning. This was addressed by McLellan (1996) who suggested two other contexts acceptable for situated learning: virtual surrogates such as aircraft simulators; and anchoring contexts such as videos or computer programs (McLellan, 1996). The later context is satisfied on both counts in this research as it incorporates the use of video in an online computer program.

It would be impossible for teachers to visit classrooms from all of the countries included in the TIMSS Video Study but the use of video provided some access to all viewers. Transcripts translated into English, but also provided in the native language, completed the picture. As the target audience was educators, the videotapes would provide the means to satisfy the first four critical characteristics of situated learning listed above (2.5.3.1). The participants would come with an understanding of teaching and their own classroom and would use this knowledge to reflect on, and help make sense of, the lessons. Since each participant would bring their own perspective and experience, the group would be opened to a variety of ideas and views from which they could construct their own knowledge. By focusing on a videotaped lesson, participants would share a common experience and could replay segments as often as they wanted and examine the transcript in depth to facilitate this.

Expert knowledge and appropriate scaffolding would be built into the course to further promote collaborative construction of knowledge. The software's interactive tasks and forums were designed to support the online collaborative construction of knowledge. It was the content and pedagogy developers' job to set tasks, initiate forum discussions, and provide course content material at the right level at the right time to move participants through different learning stages to a point where they could reflect, construct their own knowledge, and transfer this to their own practice.

2.5.4 Video-cases

Within the situated learning framework three video-cases were planned to develop teachers' analytical skills. Each case would use one lesson as a focus and would provide activities and expert input to scaffold participants through the content and pedagogy of the lesson. "While each teacher will interpret the case in his or her own terms and focus on different aspects of the case, the case itself offers a common reference point and a shared experience"(D. Clarke & Hollingsworth, 2000, p.41).

The use of video in professional learning brings the classroom to the participants providing the opportunity to see within, without being there. Video can be stopped, replayed, and different segments or moments selected as a focus (or foci) within the professional learning domain (Ball & Cohen, 1999; Borko, Jacobs, Eiteljorg, & Pittman, 2008; Brophy, 2004; Cestari, Santagata, & Hood, 2004; Le Fevre, 2004).

2.5.5 Communities of practice

Communities of practice were mentioned above in the discussion on situated learning (see 2.5.3.1). On his website Wenger defines these as "groups of people who share a passion for something they do and learn how to do it better as they interact regularly." (Wenger, n.d.) He lists three characteristics that are crucial to communities of practice - domain, community, and practice. Members in a community of practice are committed to a shared domain of interest and this in turn results in a shared competency. The interest in the domain leads to members interacting, sharing and learning together as a community. The third characteristic of practice signifies that the members are practitioners with common experiences and problems, sharing a knowledge base built up over time. A community of practice is cultivated by these characteristics being developed in parallel.

While it was intended that the first implementation of the course would be for individuals and totally online, either with or without a facilitator, it was planned that the delivery would become more flexible once facilitation training was available at a district level. At this level the implementation could be a blend of online and face-to-face work, designed to meet the local needs. In both of these cases individuals join their peers in online groups and/or in face-to-face settings to share ideas through the interactive tasks and forum discussions. Thus, whatever the implementation, the three characteristics: domain, community and practice, should be present with many sub-communities of practice being formed and contributing to the larger community of practice of teachers.

2.5.6 Online technology

In the book, *E-Moderating: The Key to Teaching and Learning OnLine*, Salmon (Salmon, 2000) wrote that students learning online process information differently due to the asynchronous nature of the medium. Unlike many face-to-face situations, students in this environment have time to reflect and digest before joining in discussions. Students learning in a second language have time to review the terminology and those with other jobs can work at their own time, place and pace. This can result in very rich discussions and learning taking place but, as in all learning situations, this doesn't happen automatically.

Over an extensive period at the Open University, Salmon used cycles of research, testing and revision to devise a model for online teaching and learning (Salmon, 2000, p. 22-37). The online work at the Open University used computer mediated conferencing (CMC) but, the model seems applicable to other online learning.

Salmon's model identified five stages in successful online learning. For students/participants to reach each stage and progress to the next, they must have the opportunity to acquire the necessary technical skills, be given the right amount of facilitation and be provided with appropriate activities in the online course.

Stage 1: 'Access and motivation'. This is the starting point and is considered to be over when the first online posting has been submitted. During this period participants must ensure their hardware and software are configured correctly, gain access to the internet, register as a user online and navigate the software. For inexperienced information technology users, this can be a very challenging stage.

Stage 2: 'Online socialization' is the period where online communities start to form and individuals start to get comfortable sharing information publicly. For some participants the lack of verbal or visual clues found in face-to-face environments, can be depersonalizing and negative while others find it liberating. It can be expected that participants will feel comfortable with ‘going public’ online at different paces, some lurking or browsing at the edge while their confidence builds.

Stage 3: ‘Information exchange’ is the phase of the process where more information is shared and individual differences may become more obvious.

Stage 4: ‘Knowledge construction’ is the active learning that takes place after a period when interactions between participants have increased and more ideas, differing perspectives and viewpoints are exchanged.

Stage 5: ‘Development’ is the final stage where participants become responsible for their own learning. At this point they will often start to question or challenge both the materials and facilitator.

In this research, transfer of knowledge to teacher’s own practice will be an indication that participants have successfully reached Stages 4 and 5.

The team developing the content and pedagogy component of the solution used Salmon’s five stages to check that appropriate scaffolding was included to support participants moving from novice technology status to the constructive, critical thinkers of Stage 5.

A major objective of the technology team was to address the access aspect of Salmon’s Stage 1. As the participants would be expected to access the online course remotely and individually, the team would need to make this as stress-free as possible and provide (timely) help if problems arose.

Facilitators associated with the course, both online and face-to-face, would need to be aware of the stages and recognize when participants were at each one. Thus the facilitator training and materials, to be designed during Stages 2 and 3 of the design-based research (1.3.2 and 1.3.3) would need to incorporate Salmon’s theory on stages and the scaffolds used within the course to promote participants progression through these. Facilitator roles and responses change during the different stages and they need appropriate strategies to promote the journey.

2.6 Conceptual framework

Below is a list of the main conceptual influences on the design-based research drawn from the preceding discussion.

Knowledge needed by teachers
- Content
- Pedagogy (Dewey, 1904)
- Pedagogical content knowledge (Shulman, 1986)

Knowledge base of teaching
- Scholarship in content
- Educational research
- Wisdom of practice
- Materials and settings
  (Shulman, 1986)

Practices of experienced teachers
- Deeply embedded
- Own teaching basis for change
- Changes challenging
  (Ball & Cohen, 1999; Elmore, 2002; Stigler & Hiebert, 1999)

Experienced teachers need
- New terrain for learning
- Productive disequilibrium
  (Ball & Cohen, 1999)

Situated learning
- Context of learning reflects usage (Collins, 1988)
- Video is an authentic activity (McLellan, 1996)
- Critical characteristics (Herrington & Oliver, 1995)

Communities of practice
- Share, interact and improve (Wenger, n.d.)

Technology
- Scaffold online learning
  - Access and motivation
  - Online socialization
  - Information exchange
  - Knowledge construction
  - Development

  (Salmon, 2000)

The course content was guided by the need for teachers to have a sound understanding of both content and pedagogical content knowledge. The underlying material for the course was from the findings of the TIMSS Video Studies and hence addressed the educational research aspect of Shulman's knowledge base of teaching. Using the public-release lessons from the TIMSS 1999 Video Study, provided the means for teachers to move outside of their own teaching experience opening the way for a “new terrain of learning” (Ball & Cohen, 1999, p.15).

The use of the public-release lessons also satisfied the requirements of authentic activities and hence the research was able to use situated learning as its theoretical underpinning. The critical characteristics developed by Herrington and Oliver (1995), further guided the development of the course content. Guidelines for the users’ online experience were drawn from the five stages of online learning developed by Salmon (2000). The online course linked participants with other members from the teaching community of practice, into smaller communities where they could share and expand their professional knowledge base.

2.7 Guiding Principles

Using the conceptual framework as a basis, the collaborating teams discussed and agreed on the guiding principles that would inform Stage 2 of the design-based research – the development of an initial solution to the problem. The guiding principles were general and covered the three areas – technology, content and pedagogy, and implementation – pertinent to this research. The course content was to be centered on the findings and public-release lessons from the TIMSS Video Studies and would contain online interactive tasks aimed at encouraging participants to construct their own knowledge about the research, to develop skills for lesson analysis, and, in both cases, transfer this knowledge to practice. Overall the guiding principles developed by the group were as follows:

Provide opportunities for participants to:

- Construct own knowledge
- Increase content understanding
- Focus on pedagogical content knowledge
- Develop lesson analysis skills
- Transfer to practice
- Understand by doing, the research and its findings
- Collaborate with peers
- Experience authentic tasks online

Facilitate flexible delivery by

- Providing expert input on content and pedagogy
- Scaffolding participants through the online learning environment
- Devising strategies for a variety of online and blended implementations, facilitated or non-facilitated

Figure 2-2 below shows how it was thought these guiding principles may work and the links between them.

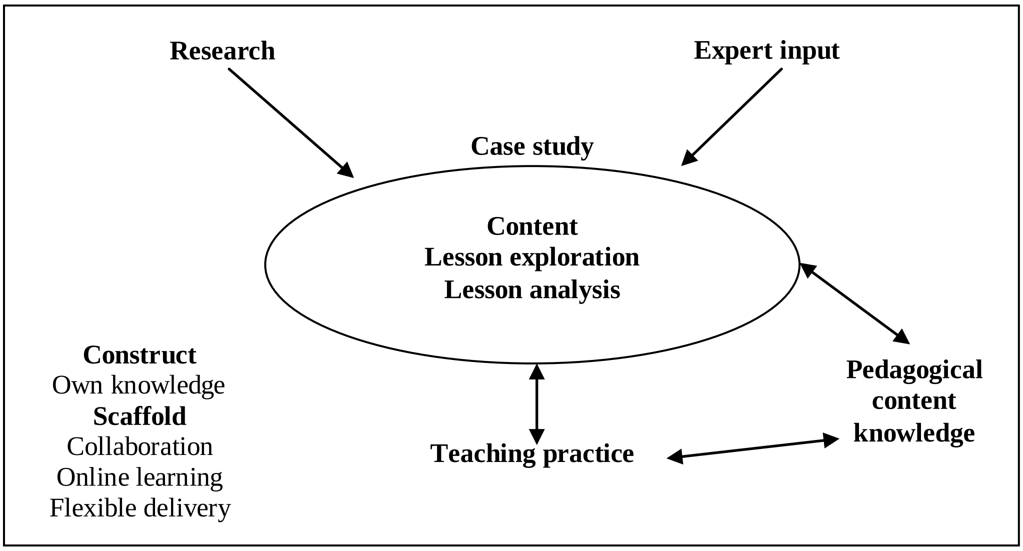


Figure 2-2 Guiding principles for the design-based research

Fundamental to the development of the lesson analysis skills was an understanding of the lesson subject content and pedagogy. Therefore it was envisaged that within the course there would be case studies, each covering the subject content, lesson exploration followed by analysis. Feeding into the case study are research and expert input. Both of these would inform the design of the material within the course, and also form part of the online course material. Pedagogical content knowledge is shown with a two-way arrow to the case study as the teachers would bring their current knowledge to the case study and the case study in turn would feed back into the teacher's pedagogical content knowledge. Similarly the two-way arrow between the case study and teaching practice represents the two-way flow of teachers bringing their knowledge to the case and the expected transfer of new ideas and insights back into their practice. The cyclic nature of the professional learning from the case study is completed by the two-way arrow, or flow, between the pedagogical content knowledge and teaching practice. Guiding principles for the philosophy behind the course, shown in the periphery of the diagram, include the notion of supporting participants to construct their own knowledge and scaffolding collaboration between participants, the online experience and the flexibility of delivery.

2.8 Conclusions

From the discussions above it has been shown that, at the time this research started, there were ongoing challenges in student achievement and teacher professional learning in the US. While spending seemed adequate, outcomes did not.

The conceptual framework used as a basis for the guiding principles for the next stage of the project was discussed above. These initial principles guided the development of the first solution to the problem of disseminating research outcomes to inform practice as will be discussed in the next chapter. After the testing and refinement cycles of this research (described in chapter 4), design principles emerged ready to inform future work in online professional learning.

Selecting guiding principles; developing the first solution; testing and refining the solution; and the publishing of the design principles are all stages of design-based research, the paradigm that guided this research as discussed previously in chapter 1. The reasons for selecting this paradigm will be addressed briefly below, as will the reasons why the researcher believes the online course developed during this research will make a positive contribution to teacher professional learning. At the end of the chapter the research questions will be revisited.

2.8.1 Researching online professional learning

The Journal of Teacher Education (JTE) sponsored a session at the 2006 annual meeting of American Association of Colleges of Teacher Education on Enhancing the Scholarship of Teacher Educators' Practice. In their editorial for the Jan-Feb 2007 issue of the JTE, the session organizers, Borko, Liston and Whitcomb, continued the session conversation. Their overall aim was to push the relatively new field of research in teacher education forward in order for it to have "a constructive impact on teacher education policy and practice" (Borko, Liston, & Whitcomb, 2007, p.1). They assess four genres central to empirical teacher education research – "(a) the effects of teacher education, (b)interpretive, (c) practitioner, and (d) design"(Borko et al., 2007, p.1).

The editors found that the first two of these are established genres while the latter two are more recent and hence the focus of articles in that issue of JTE. The first, effects of teacher education, research looks at the relationships between teacher education experiences and student learning. This research has a cause-and-effect orientation and aims for findings of a general nature whereas the second genre, interpretive, looks more specifically at particular situations which it “seeks to describe, analyze and interpret” (Borko et al., 2007, p.2) preserving complexities and diversity. A limitation of interpretive research is the lack of shared conceptual frameworks and designs making it difficult to compare or aggregate findings from different studies. Practitioner research, the label the editors give to research done by the teacher educators themselves, includes action research, participatory research, and self-study and teacher research.

The fourth genre discussed by Borko, Liston and Whitcomb is design research. It began as a reaction to the controlled laboratory conditions of traditional psychological experiments. In order to find out what works in practice, design researchers work on improving practice while informing theory. Iterative cycles of design, implementation and analysis are conducted. An initial set of conjectures on fostering learning mould the design which is then tested and redefined as necessary, during the cyclic process. Thus the outcome is a well-tested intervention and a contribution to theory via the final set of conjectures.

This last genre was the method followed during this research and was discussed previously, as design-based research, in Chapter 1.2. By following the stages of design-based research, the development teams on this project did develop a refined solution to the initial problem that worked in practice and, after reflection, did construct a list of design principles that informed future work and thus contributed to the theory of online learning.

2.8.2 Why will this work?

At the start of this chapter it was shown that despite seemingly adequate spending on education and teacher professional learning in the US, student achievements have not been improving overall (2.1.2.1). Much of the teacher professional learning has been found to been inadequate offering quick one-off fixes that have little effect on the teaching culture (2.2). So why did the collaborators in this research believe that the output, an online course, would work?

During the initial stage of the research, it was decided to use seven public-release lessons from six countries in the online course. Four lessons would take a minor role with only opening segments used while the other three would each be the focal point of one of three video-cases within the course (1.3.2). Thus the course was not showing one method and expecting whole-scale change; rather, by incorporating a variety of teaching styles all from high achieving countries, the course was promoting the idea that different teaching styles can be effective in the classroom. Another objective of using the three cases in the course was to provide teachers the opportunity, by repeating the process of content understanding, lesson exploration and then analysis, to develop lesson analysis skills that could be used in their practice. Within each case the mathematics of the lesson would be explored from different perspectives emphasizing the importance of a deeper understanding of both content and pedagogical content knowledge.

The overall objective, as discussed in chapter 1, was to address the question "What does mathematics teaching look like in high-achieving countries?" It aimed to broaden teachers' perspectives beyond their own teaching, looking at possibilities and encouraging them to think about and question their own practice. Parallel to this was the course's aim of increasing teachers awareness of educational research - the methodology, the findings and its place in their practice.

Since the online course was aimed to be delivered in a variety of flexible implementations, and, in particular, since individuals could register to take the course when, where and at a pace to suit them, it opened up many possibilities. Individuals when they registered would be assigned into the current active group and thus would have the opportunity to share ideas and learn with peers in a collaborative online community. Alternatively, groups could work with their own trained facilitators in flexible formats specifically designed to suit their needs. While the course content would be set, it was intended that it could work as an introduction to further professional learning such as another online course on a specific mathematics topic, lesson study or teachers videotaping, sharing and analyzing their own lessons.

2.8.3 The research questions

With Stage 1 of the design-based research completed and agreement reached on the guiding principles, the teams were ready to move on to the next stage of developing an initial solution to the problem ready for the testing and refinement cycles of Stage 3. During these stages data would be collected to inform the final stage of reflection to produce the design principles and enhanced implementation of the solution. By this point the questions posed by the researcher should have been addressed. The questions and their scope are provided again here.

The main question of this research, *What are the design principles for developing online professional learning to disseminate the outcomes of educational research that will inform teachers' practice?,* encompasses the challenge of disseminating research findings to practitioners, the broad area of teacher professional learning, and the more specific area of online delivery.

The sub-questions focus on specific components of the research. The first, *What is the impact on teachers' mathematical knowledge and practices of an online professional learning resource that focuses on analyzing culturally diverse mathematics lessons from high-achieving countries?,* focuses on professional learning for teachers of mathematics. The investigation is informed by the use of video cases, the role of lesson analysis and the skills required for such analyses, and the strengths and challenges of using culturally diverse lessons in teacher professional learning.

The second sub-question, *What is the impact on teachers' understanding of educational research and its application to practice, of an online course designed around the findings and lesson videos of a major mathematics education research project?,* builds on the dissemination problem addressed in the main question by emphasizing the application of the research findings to teachers' practices. As the research project is based on mathematics education, it also links to the first sub-question, with its focus on professional learning for teachers of mathematics.

While the intervention designed to address the main question was an online course, it was always envisaged that it should be suitable for delivery over a range of settings from face-to-face to completely online, both facilitated and non-facilitated. This is addressed in the third sub-question: *What structures support flexible delivery methods of an online, interactive course for teacher professional learning?*

Chapter 3 Design-Based Research Stage 2

3.1 Introduction

This chapter will focus on Stage 2 of the design-based research, the development of the solutions to the identified problem. In this case, the problem was how to disseminate the outcomes of educational research to inform teachers' practice and the solution was to design appropriate online professional learning. The individual components that together made up the solution will be examined separately. At the end of this stage the solutions were ready for the testing and refinement cycles, the subject of Chapter 4.

As described in Chapters 1 and 2, during Stage 1 of the design-based research an analysis of the practical problem of disseminating the outcomes of the TIMSS Video Study to inform practice had been conducted by the stakeholders. From this, video lessons and research findings for the course had been selected, the guiding principles were established, and the pedagogy and format of the course agreed.

3.2 Stage 2 Development of solutions

Stage 2 of design-based research involves turning the original practical problems into a practical solution informed by the decisions from Stage 1. The practical problems, as discussed in chapter 1, included the challenge of making the TIMSS 1999 Video Study with its extensive findings and reports accessible to teaching practitioners in a way that they would understand and use to inform their own practice. This challenge was compounded by the requirement that the course duration time be limited to ten hours and that it be accessible in a variety of formats including totally online and blended face-to-face and online, both facilitated and non-facilitated.

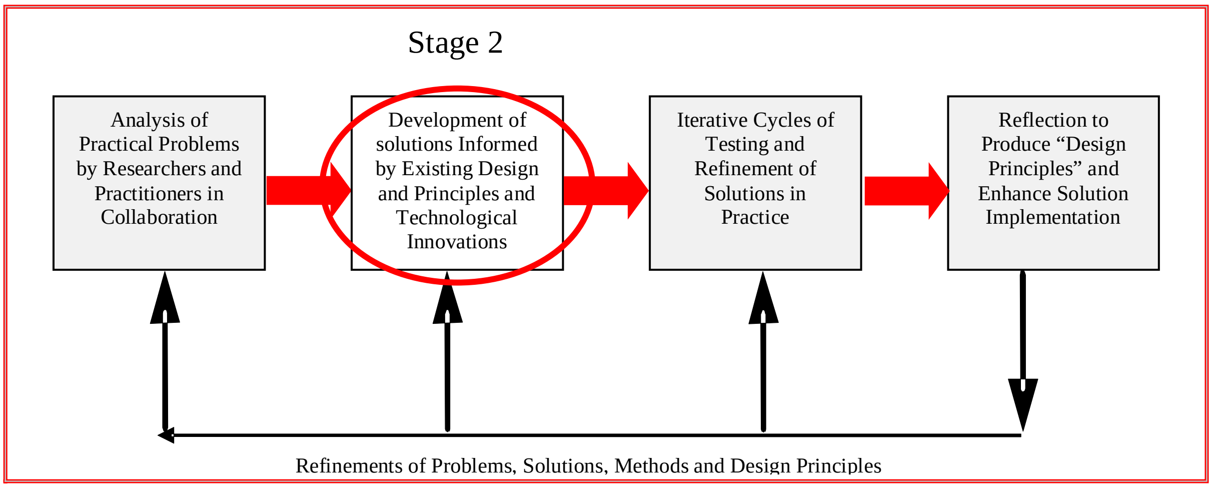


Figure 3-1 Design-based research Stage 2 (Reeves, 2006)

3.2.1 Components of Stage 2

An overall solution relied on the development and integration of three main components – content and pedagogy; technology; and implementation. Individually, each required analysis and development of solutions that were then evaluated and tested in practice, leading to refinements and further testing (Stage 3). While the development of solutions for each component was conducted independently, overall each was dependent on the other to varying degrees and at different times throughout the design research. Requirements of one component triggered refinements in another, and evaluation and testing often occurred concurrently especially towards the final stages of the process. The refinement cycles continued until the researchers and practitioners agreed that a satisfactory solution to the original problem had been found and that the design principles for that solution could be documented to inform future developments.

The adaptation of Stage 2 for this design experiment is shown below (Figure 3-2). After the overall analysis of the problem, the research split into three main components, course content and pedagogy, technology, and implementation, for the development of solutions.

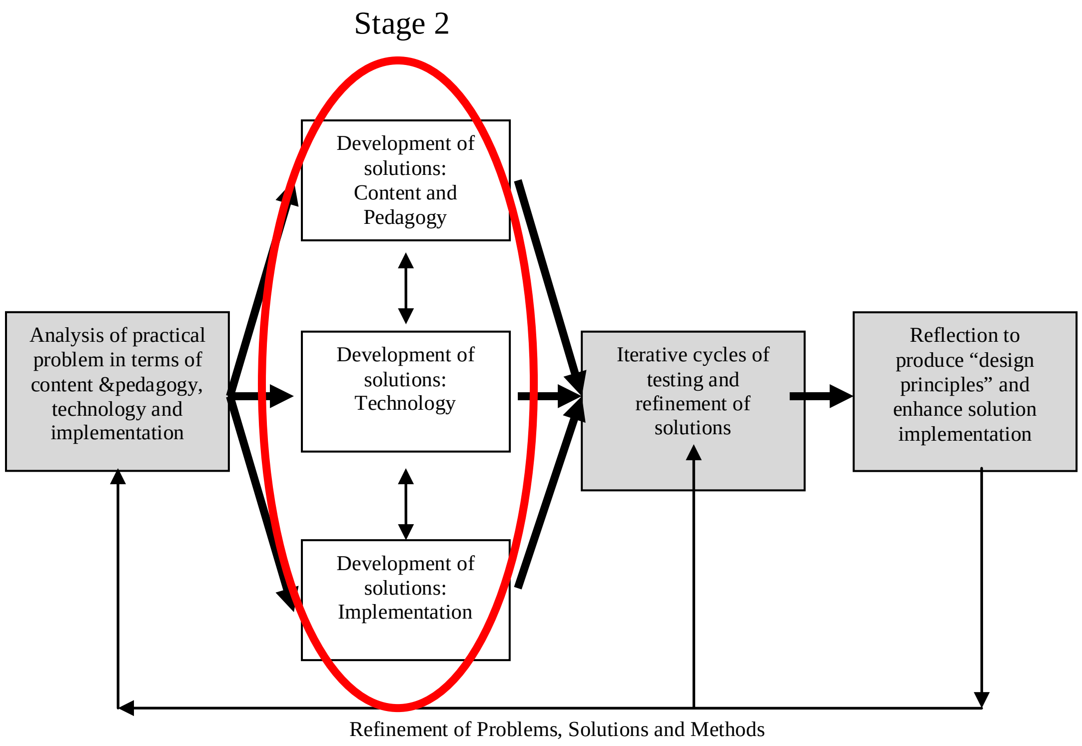


Figure 3-2 Components of the design-based research

3.2.2 Development teams

While each component of Stage 2 addressed complex problems, and solutions were developed independently by teams drawn from the stakeholders, the overall solution depended on the smooth integration of the individual solutions.

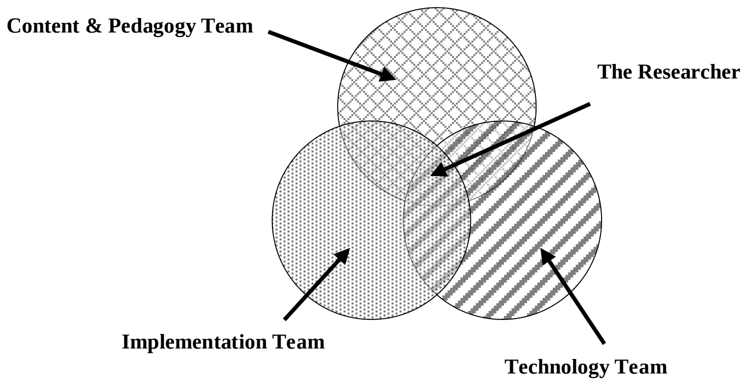


Figure 3-3 Teams for development of solutions

Development of each component's solutions required collaboration between researchers, practitioners and technologists. Overlap between the teams ensured that teams had insight into progress and possible problems during the development phase.

The researcher was a member of each team and had overall responsibility for the project. Details of the composition of the teams will be included in the discussions on the development of solutions for each component.

3.2.3 Stage 2: Development of solutions - content and pedagogy

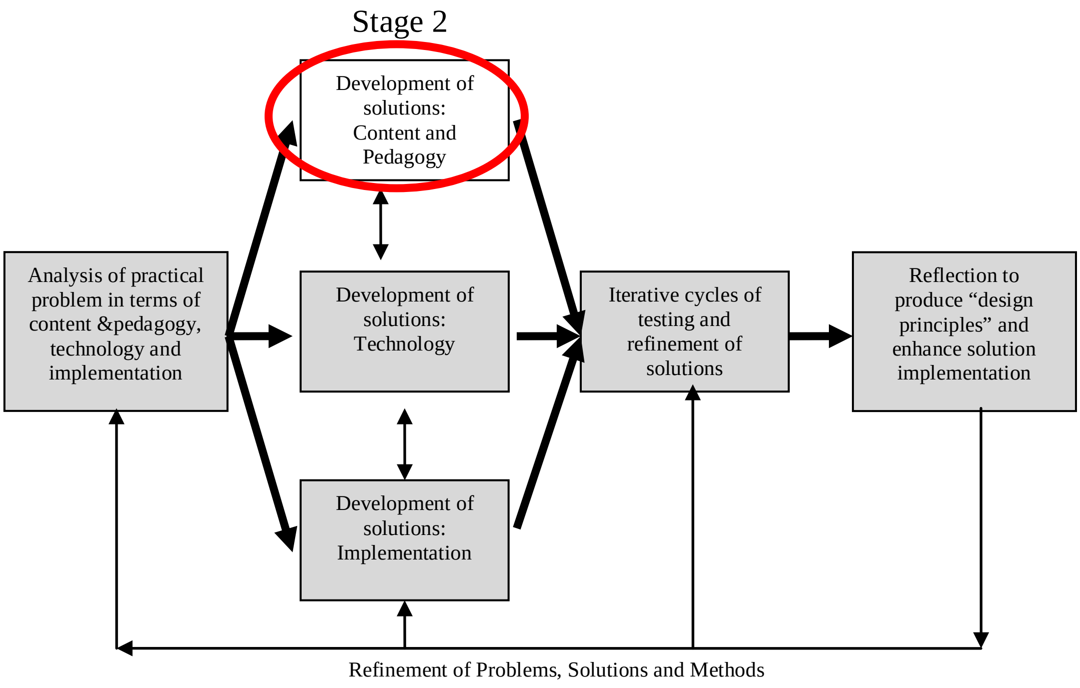


Figure 3-4 Stage 2 Content and pedagogy

3.2.3.1 Content and pedagogy overview

The function of the team responsible for this component was to write the course content using the guiding principles and selected lessons emanating from the analysis phase, Stage 1, of the design-based research. The team planned the flow of the course; the pedagogical framework to be employed; and the logical integration of the written, video and interactive course components.

3.2.3.2 Constraints

The main challenge facing the team developing the course content and pedagogy was the complexity and quantity of the material available for the course. Other constraints were time, both development time and length of course; the technology, this was the first course to be developed in the new LessonLab course software; the variety of implementation strategies planned; and the diversity of potential participants.

3.2.3.3 The team

The members of the team responsible for designing the course content and pedagogy were James Stigler Ph.D. (Professor, Department of Psychology, University of California (Los Angeles); CEO LessonLab, Inc., Santa Monica), James Hiebert Ph.D. (Robert J. Barkley Professor, University of Delaware), Diana Wearne Ph.D. (Professor Emerita in School of Education, University of Delaware), Carolyn Kieran Ph.D. (Professor, Mathematics Department, University of Quebec (Montreal)), Nanette Seago (Project Investigator, WestEd, US) and Gail Hood, the researcher, (Director, LessonLab, Inc., Santa Monica). All were all involved, to differing degrees, with the TIMSS video research, had expertise in mathematics' education and in teacher professional learning. Stigler and Hood were designers of the LessonLab course software and along with Seago had had extensive experience using video-cases online with LessonLab Viewer, the precursor to LessonLab Course, in teacher professional learning.

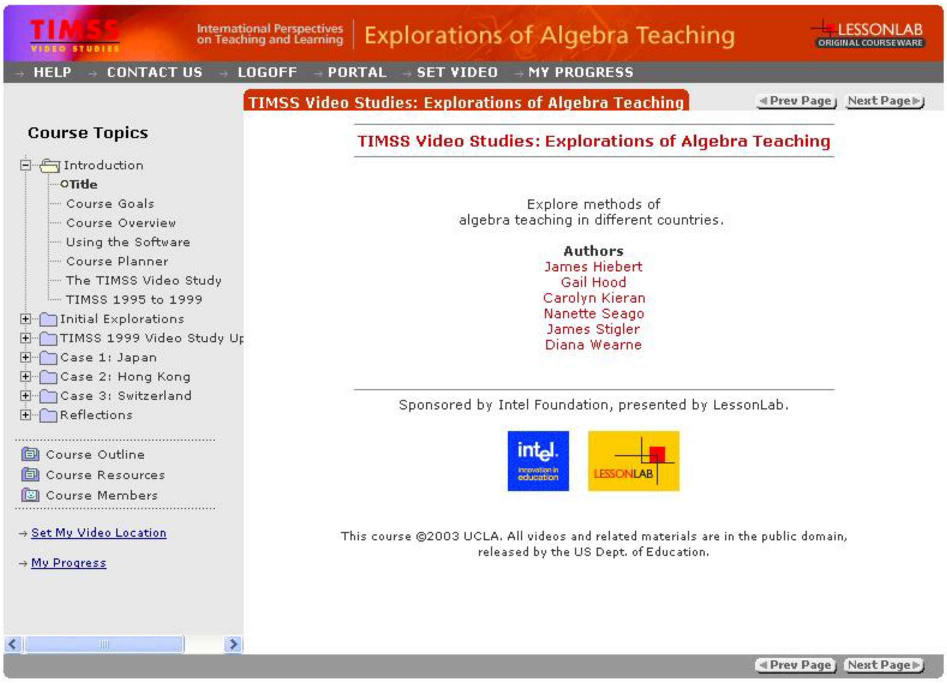


Figure 3-5 ***TIMSS Video Studies: Explorations of Algebra Teaching*** **course**

Figure 3-5 is a screen shot of the first page of the course showing the content team as the course authors.

3.2.3.4 The process

After the initial meeting of all stakeholders, the content and pedagogy team (3.2.3.3) assumed full responsibility for the course content. Tasks were allocated and strategies for sharing, discussing and editing submitted work and building the course were developed. In general, Hiebert, Kieran, Stigler and Wearne led the course content writing while Stigler and Hood took responsibility for building the online course, including the design of online tasks and forums, and writing technology support material within the course. Seago created the lesson graphs (see Figure 3-10).

As the team members were geographically spread, the written material was shared and reviewed by all team members via email and regular phone conferences. Writers edited content and submitted drafts ready for the online-course building stage.

During this stage, interactive tasks and forums were constructed to replace or enhance the written content, and resources such as the videotaped lessons, graphics files and URL links were created as the building blocks of the course. These were used with the draft text to create the course pages. The course building occurred as soon as the draft text was available and the development team regularly reviewed the online material.

3.2.3.5 Content design evaluation

Evaluation and testing of the solutions for content and pedagogy occurred regularly during the development stage before they were considered ready for the iterative cycles of testing and refinement, Stage 3.

At regular intervals during Stage 2, the online course was opened to stakeholders for feedback. Any suggestions from stakeholders were reviewed by the development team and, modifications made, where necessary, by the writers and/or builders.

When the draft course had been completed, outside content and pedagogical experts were asked to review it. Their comments and suggestions were discussed by the development team and fed back into the development cycle as appropriate.

3.2.3.6 The Content

The course software was structured around topics and it was expected that, in general, participants would complete the course linearly, as shown in Figure 3-6, from the *Introduction* through to *Case 3: Switzerland*. However each topic in this course was designed to be standalone and could be used in different ways to cater for a variety of implementation modes.

Figure 3-6 Explorations of Algebra Teaching topics Stage 2

The topics were designed to move participants through the process of first understanding the research methodology; to exploring some of the findings from the research; onto experiencing a process of lesson analysis using a variety of different videotaped classrooms; and finally, applying insights gained to their own teaching. As for many participants, this would be their first experience of online professional learning and in particular of sharing ideas online, the order and make-up of the topics were designed to scaffold this experience. For example, in the *Initial Explorations* topic, the online task simulated the process the researchers used, satisfying the authentic task component of the guiding principles; provided an opportunity for participants to view a variety of classrooms thus setting the scene for the more formal analyses of teaching in the cases that follow; and scaffolded the experience of sharing online as participants constructed, posted and read responses to the online interactive task.

By simulating the first-hand experience of the researchers, the course provided the basis for a deeper understanding of the research methodology and its findings. Three video-cases were included. Each case followed the same pattern, but, based on a different algebra lesson from a different country, each provided a new focus. The use of video moved participants from the familiar but provided a common experience that was conducive to the development of the skills necessary to analyze the content and pedagogy of the classroom.

3.2.3.6.1 **Introduction**

The topic *Introduction* was designed to introduce participants to the course, the software and to the TIMSS Video Studies research, the focus of the course. During the initial development stage the team agreed that the content of these pages would be developed during the testing cycles when the needs of participants could be better assessed. Initially the topic consisted of the course goals and an overview of the TIMSS Video Study.

3.2.3.6.2 **Initial Explorations**

The topic *Initial Explorations* was designed to give participants an insight into the work conducted by the TIMSS Video Studies researchers and to prepare them for the video cases that followed. For many participants this would be their first experience of watching and exploring teaching in other countries, or indeed their own.

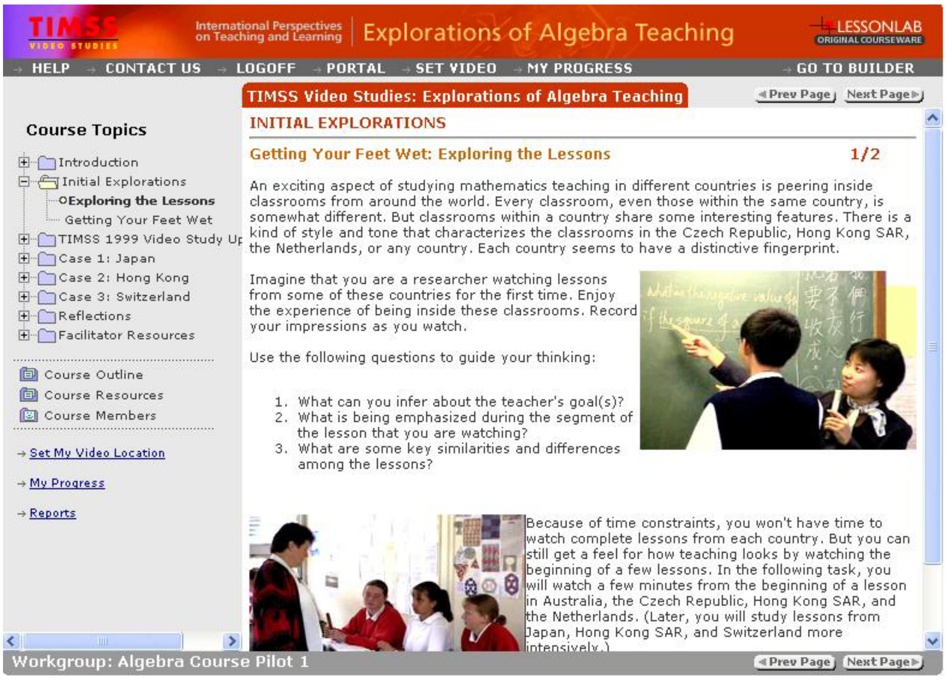


Figure 3-7 Initial Explorations 1/2

Watching videotapes of lessons, many times, was the starting point for the researchers and so too would be for the course participants. The initial viewing is full of distracters such as uniforms, language, and cultural differences. It was important to help viewers move beyond this point before they start the video-cases. Thus this topic scaffolded participants to better understand the methodology of the research as they explored some of the research findings; and, to have watched a variety of classrooms before undertaking deeper analyses of another three lessons. The task incorporated the guiding principle of learning about research by doing research.

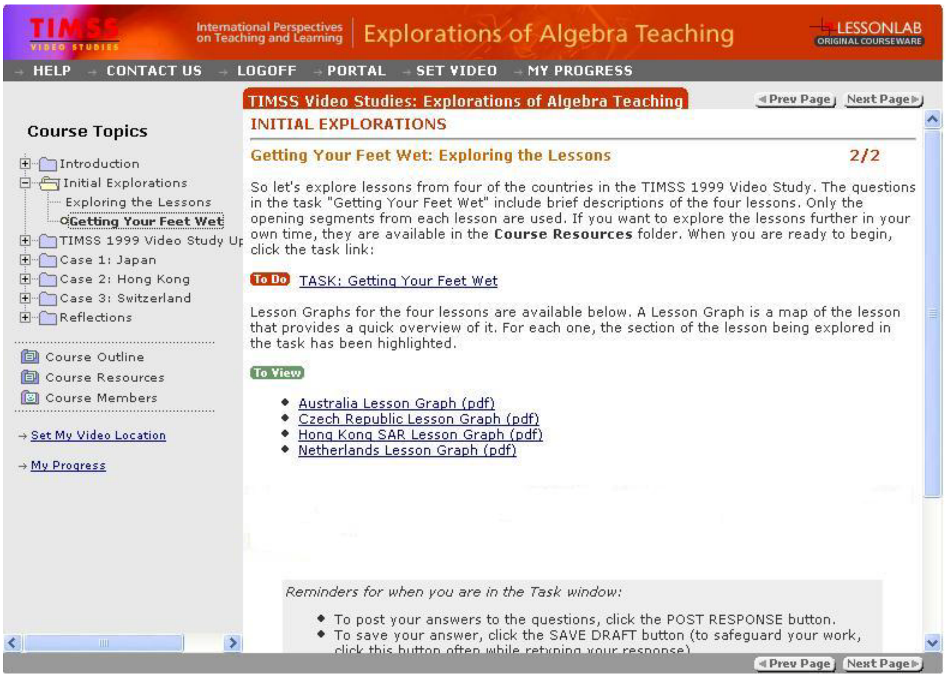


Figure 3-8 Initial Explorations 2/2

In the *Getting your feet wet* task, participants viewed the opening segments of a lesson from four different countries in the study - Australia, Czech Republic, Hong Kong SAR and the Netherlands.

Figure 3-9 Task: Getting your feet wet

A general description of each lesson was included at the start of each question within the task. The same questions were asked for each of the lessons: “What can you infer about the teacher's goal(s) by watching this segment? What is being emphasized during this segment of the lesson?” The focus of these questions was based on the guiding principle of developing lesson analysis skills, in this case, by asking teachers to question teaching goals. The final question asked participants to comment on similarities and differences they noticed in the segments.

The task interface provided access to the time-linked text (translated) of the video which also appear as subtitles as the video plays. Responses to the questions can include linked video-markers. Linked starting and finishing points for the segments to be watched were included in each question. Participants could see more of the lesson by accessing it in the *Course Resources* folder or by clicking the play button within the task viewer.

To give participants a quick overview of the whole lesson, one-page lesson graphs for each lesson were included on the course page.

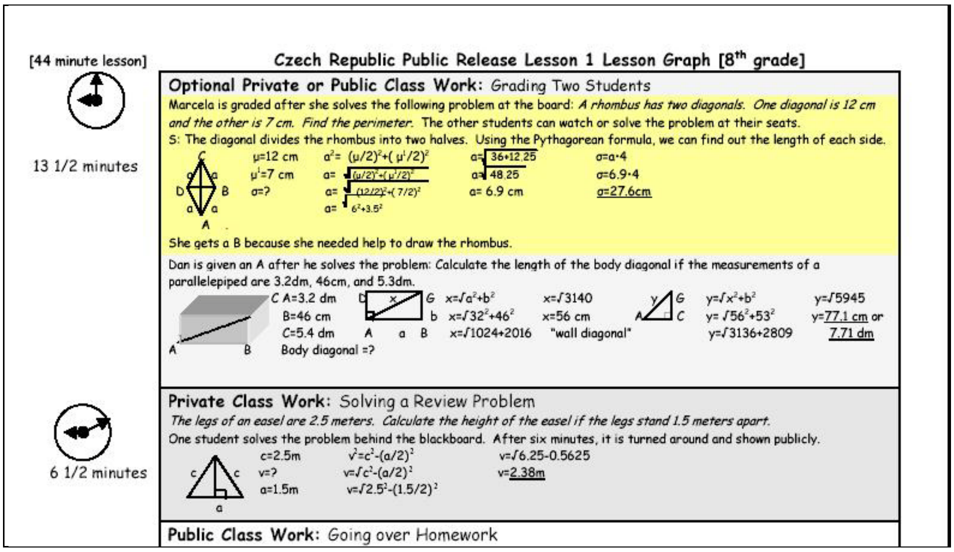


Figure 3-10 Segment of Lesson Graph

The *Getting your feet wet* task, centered on videotaped lessons from different countries, satisfied the authentic context and activity aspects of situated learning as discussed in 2.5.3.1.1 and 2.5.3.1.2. It also provided the opportunity for participants to expand their professional knowledge of teaching by becoming aware of a range of teaching strategies (see 2.5.3).

By the end of this topic it was expected that participants would have moved through Salmon's Stage 2, 'online socialization', into Stage 3, 'information exchange' where information is shared but individual differences may become more obvious (2.5.6). The diversity of the lessons in this task would be expected to facilitate such differences within the group.

3.2.3.6.3 **TIMSS 1999 Video Study Up Close**

In this topic, the methodology and some of the findings of the research study were presented. Links between sections of the course and the TIMSS research were made. For example, in the discussions on the research methods, links were made between the participants viewing of the video in the *Getting your feet wet* task and the first viewing by the researchers (see Figure 3-11 below).

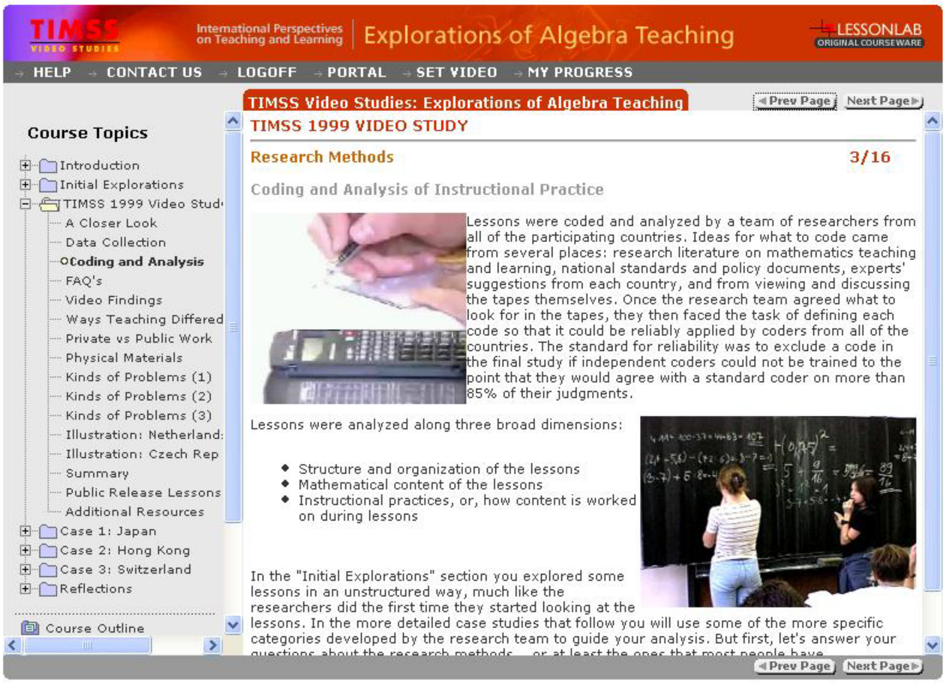


Figure 3-11 TIMSS 1999 Video Study Up Close page 3

Similarly, research findings for the use of physical materials (manipulatives) in mathematics classes were discussed after a link to the Australian lesson viewed in the *Getting your feet wet* task had been made (see Figure 3-12).

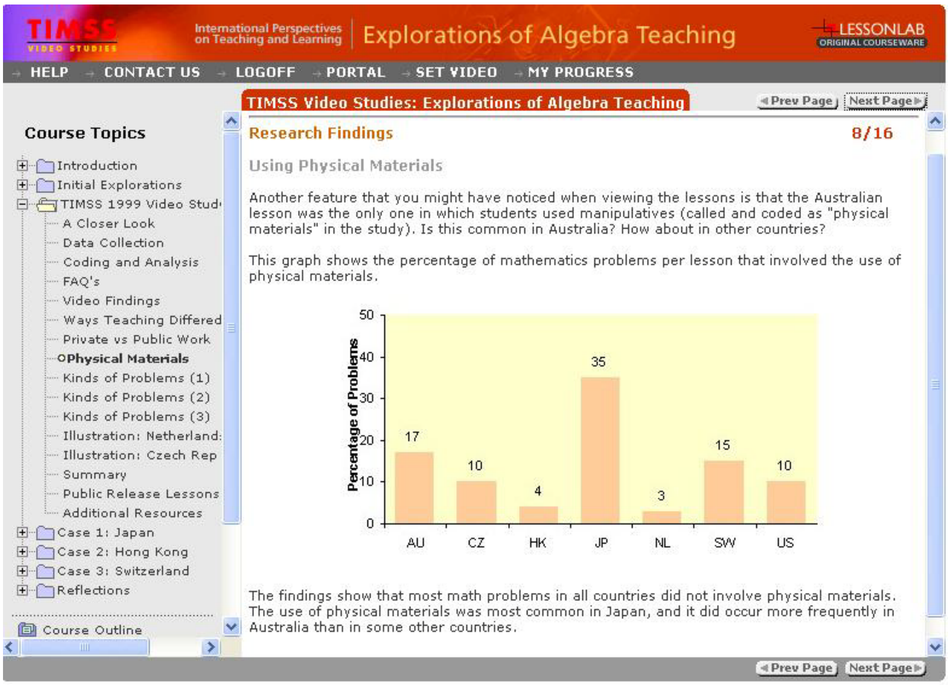


Figure 3-12 Research Findings: using physical materials

In general a brief explanation of a particular research finding was accompanied by a bar graph as in Figure 3-12. This visual representation of the data with the actual percentage included above each bar makes cross country comparisons easy and allows for more detailed examination where relevant.

The course included discussions on the research methodology from the data collection, including selection of classes and the videotaping, to the coding and analysis of the data. Commonly arising questions such as the affect the video cameras had on student behaviour were addressed in a frequently asked questions (FAQ) page. The benefits of studying teaching from different countries was explained as was the need to make decisions from reliably coded data from many lessons rather than from a single viewing (see Figure 3-13).

Research Findings 6/16

What Are Some Ways in Which Teaching Differed Across Countries?

By examining the teaching approaches used in different countries, it is possible to uncover features of teaching that might not have been considered, or even imagined, if the study had been restricted to one's own country. You probably noticed some of these features when viewing the beginnings of lessons in Australia, the Czech Republic, Hong Kong SAR, and the Netherlands. You will see more interesting features when you analyze additional lessons from Japan, Hong Kong SAR and Switzerland.

But how common are the features you noticed? Are the countries as different (or similar) as they seemed when watching a few minutes from a single lesson? Researchers try to provide answers to questions like this. The findings of the study allow you to learn how frequently particular events occurred across the full national sample of lessons, which will help you see the patterns that the researchers uncovered. Of course, not every feature of teaching can be coded reliably. But over 75 features were coded in the TIMSS 1999 Video Study and, although there is not time to present all the findings, a sample of them might help you check your impressions. If you are interested in seeing the codes that were employed by the researchers, a link to the TIMSS 1999 Video Study Math Coding document is provided in Additional Resources (last page of this topic).

Figure 3-13 How teaching differs across countries

The course only included a small number of the research findings but provided links to the full report at the US Department of Education and to other resources and sites with information on the TIMSS Video Studies and TIMSS.

The analysis of the problems in the mathematics classrooms was a major part of the findings and a focus of the course. These problems were classified as ‘Using procedures’, ‘Stating concepts’ or ‘Making connections’. Brief definitions and examples were provided for each. It was important that participants understood the researchers definition of ‘Making connections’ as this term is often used to imply a link to real world settings. In the research it refers to a connection between mathematical ideas (see Figure 3-14).

Research Findings 9/16

Presenting and Working Out Problems of Different Kinds (1)

One set of findings that might be especially important for understanding how teaching influences students' learning is the kind of math problems that students solve during lessons. At least 80 percent of lesson time in each country was spent solving problems, so it is reasonable to think that the kinds of problems students were solving would affect what they learned. The video clips that you watched did not show enough of the lesson to make predictions about these findings, but they will provide useful background information when you begin analyzing lessons in more detail.

The kind of math problems that are solved during a lesson can be evaluated at two points; when the problems are first presented and when they are worked out or discussed publicly with the class. Presented problems can be classified into three types based on the kind of work that students apparently are supposed to do when solving the problem:

- Using Procedures - apply or practice procedures that have been demonstrated or that students already know.(e.g., "Using the Pythagorean Theorem, find the missing side of the right triangle").
- Stating Concepts - state or identify a property or definition or term (e.g., "What is the slope of the line $3x + 2y = 6$").
- Making Connections - construct relationships between mathematical procedures and concepts and facts (e.g., "Graph the equations $y = 2x + 3$, $2y = x - 2$, and $y = -4x$, and examine the role played by the numbers in determining the position and slope of the associated lines").

Figure 3-14 Kinds of Problems (1)

The next table in the course (Figure 3-15) showed the percentage of problems in these categories by country. These are the problems as they are presented initially to the class.

It was noted that different high achieving countries have very different problem patterns.

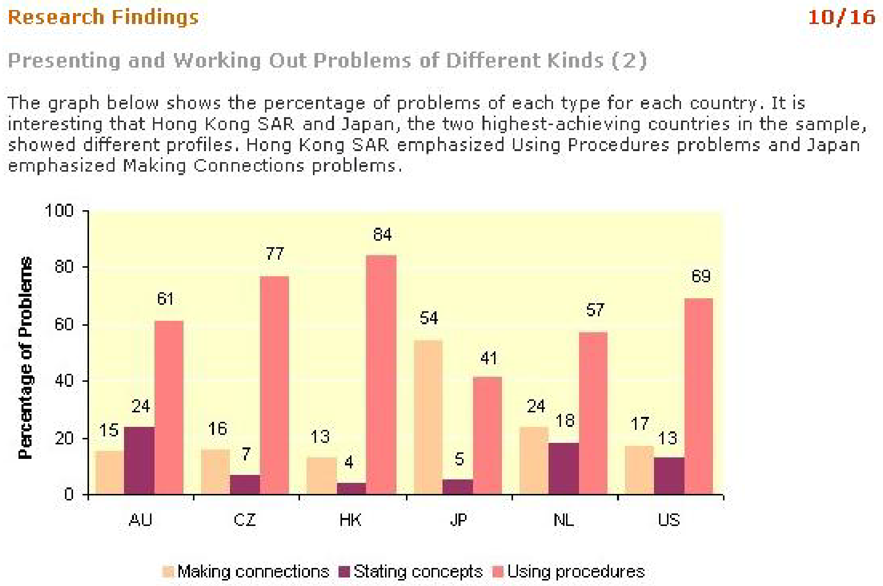
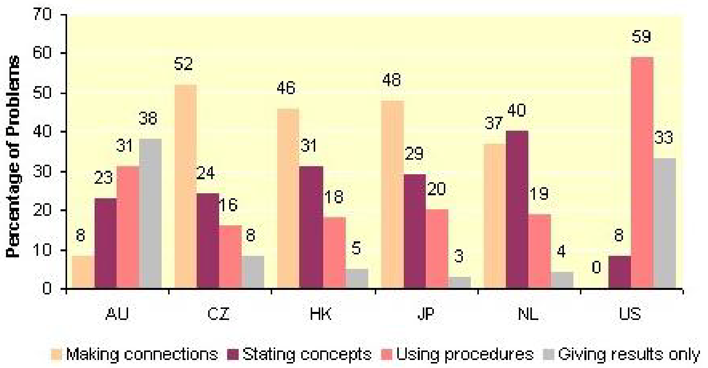


Figure 3-15 Kinds of Problems (2)

The *TIMSS Video Study* researchers studied the problems again when they were worked publicly in class. When the ‘Making connections’ problems were reclassified at this point, a very different picture emerged (Figure 3-16). In most cases fewer than half of the problems retained their original intent and in Australia and the US most problems became reclassified as ‘Using procedures’ or ‘Giving results only’ (a new category).

This graph shows how the Making Connections problems were classified when they were worked on publicly. A fourth category Giving Results Only was added because sometimes teachers reduced the public discussion of the problem to just giving the answer.



It is clear that teachers in all countries reduce a percentage of the problems from Making Connections to something else when discussing them publicly. But what is really striking about these results is that almost all Making Connections problems in the United States are reduced to lower-level problems when discussed with the class. In other words, public discussions about constructing relationships among mathematical procedures, concepts, and facts are extremely rare in the United States.

This result shows that simply presenting Making Connections problems to students might not be enough. Teachers also need to sustain the intent of these problems by working on them with the class so that students experience the mathematical processes of conjecturing, deducing, verifying, and so on.

Figure 3-16 Making Connections Problems

Inclusion of these two findings demonstrated the depth of the research and modelled the type of information that can be gained from lesson analyses.

3.2.3.6.4 **The Cases**

Three lessons, one each from Japan, Hong Kong and Switzerland, were chosen as the focus of three cases within the course. The cases covered the general areas of content and pedagogical content knowledge. Since the course was to be offered in a variety of ways to individuals and groups either facilitated or non-facilitated, it was decided to include expert viewpoints on the content and lessons within each case. These were not expected to distract from participants’ ideas and responses in the online tasks and forums.

Each case followed the same format: general information on the lesson and class; content exploration; lesson exploration; expert commentary on the content; lesson analysis; and expert viewpoints on the lesson. The material in the cases was informed by the guiding principles – increasing the teacher knowledge base by providing the opportunity to develop a deep understanding of content, and, supporting reflective thinking and construction of knowledge. With both content, and lesson analysis, the case employed a pattern of exploration followed by more directed investigation and/or expert information. Participants were thus scaffolded from their current level of understanding to a deeper analytical position.

3.2.3.6.4.1 Introduction to the lesson

The general information introduced the lesson, its focus, its place in the broader topic, its length and the makeup of the class. A comment was included to emphasize that the lesson was chosen to represent the data from the country (although as one of four lessons in the set, it was probably representative of a subset of typical features for that country).

3.2.3.6.4.2 Introduction to the problem

In this content exploration section participants, in line with the guiding principles, were first asked to solve and/or explore aspects of the problem being used in the lesson. In the Japanese lesson the problem given to the class was:

> It has been one month since Ichiro's mother entered the hospital. He has decided to give a prayer with his small brother at a local temple every morning so that she will be well soon. There are 18 ten-yen coins in Ichiro's wallet and just 22 five-yen coins in his younger brother's wallet. They decided to place one coin from each of them in the offertory box each morning and continue the prayer until either wallet becomes empty. One day they looked into their wallets and found the brother's amount was bigger than Ichiro's. How many days since they started prayer?

Participants were asked to solve the problem and to enter their solution (method and result) in the task interface. It was expected that a variety of methods would be used.

In the Hong Kong lesson, participants were asked to solve the two equations given to the class and to think about why the teacher used these particular equations (see Figure 3-17). This task opened the way to an exploration of the content and moved participants to think about how the content may be used by the teacher before they explored the lesson.

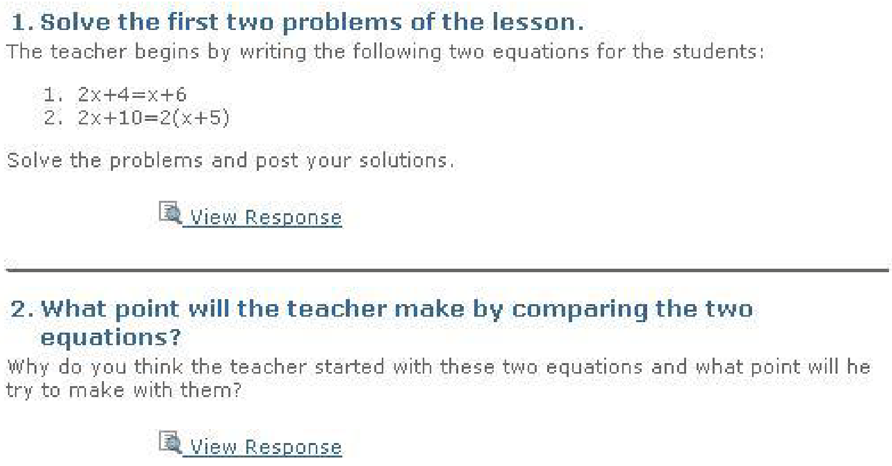


Figure 3-17 Task for Hong Kong Problem

In the Swiss lesson the emphasis was on the physical representation of variables in expressions rather than the solution of a particular problem. The task's main question, "Do you know of approaches that are effective for introducing students to variables? Describe them briefly." had a pedagogical content focus and linked to their own practice.

3.2.3.6.4.3 Exploration: Inside the classroom

The objective of exploration of the videotaped classrooms was to encourage participants to get an overall feel for the lesson and to form their own opinions before the analysis provided more of a focus. As in *Initial Explorations* (3.2.3.6.2), a lesson graph was provided as an aid to understanding the flow of the lesson.

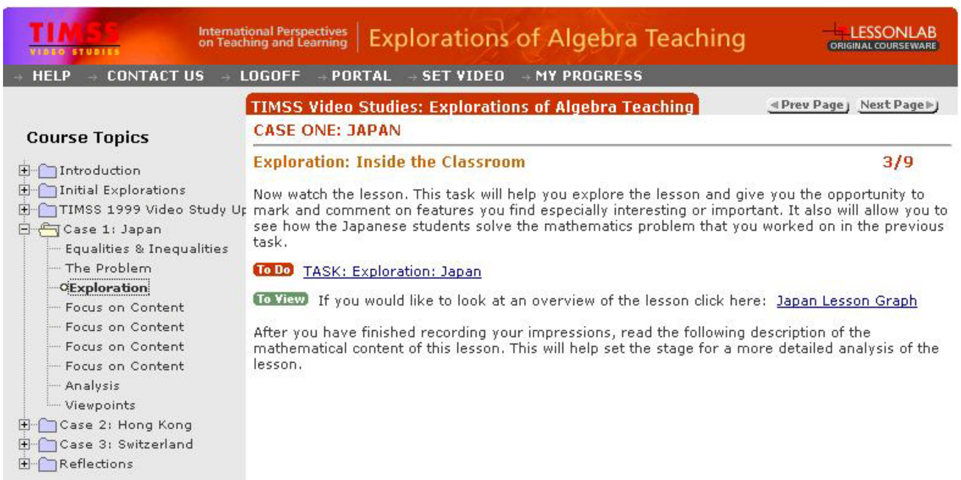


Figure 3-18 Exploration inside the classroom

Ideally the participants would be provided the opportunity to watch the whole lesson before submitting observations in the online task. However, the constraints of the course duration resulted, instead, in a guided exploration.

1. Explore the Japanese Lesson

You have already watched the beginning of the Japanese lesson in which the teacher presents and develops the problem. Now explore the rest of the lesson. Take your time, and use the links below as a way to focus your exploration. Think about the different segments of the lesson and how they are sequenced.

- The teacher starts by beginning the class and presenting the problem. (00:00:02-00:02:12 *TIMSS 1999 Video Study Mathematics - Japan Pu...)*
- The teacher then takes students through the problem in a thorough way. (00:02:12-00:05:00 *TIMSS 1999 Video Study Mathematics - Japan Pu...)*
- The teacher walks around to observe students as they work on the problem. This goes on for approximately 13 minutes. Here are a couple of clips taken from this period
  (00:08:53-00:09:42 *TIMSS 1999 Video Study Mathematics - Japan Pu...)*
  (00:17:38-00:18:25 *TIMSS 1999 Video Study Mathematics - Japan Pu...)* .
- The teacher reconvenes the class and calls up several students to share their solution methods. (00:18:34-00:31:19 *TIMSS 1999 Video Study Mathematics - Japan Pu...)*
- The teacher extends the last student's strategy by writing a chart on the board, asking students to fill it in, and summarizing the idea of inequality. (00:31:18-00:45:10 *TIMSS 1999 Video Study Mathematics - Japan Pu...)*
- The teacher presents a second problem, asks students to work on it, and then discusses the solution. (00:46:02-00:53:15 *TIMSS 1999 Video Study Mathematics - Japan Pu...)*

After you have explored the lesson, post a response to the following question:
What do you think was the main thing the teacher wanted students to learn from this lesson?

Figure 3-19 Q1 Task: Exploration Japan

The introduction to the task *Exploration Japan* (Figure 3-18), linked back to the solution of the problem the participants worked on in the *Introduction to the Problem* task. In question 1 as shown in Figure 3-19, main points in the lesson were described and pertinent sections were tagged for viewing. The question focused on what the teacher may have wanted students to learn. In question 2 participants were asked to reflect on the solutions they submitted comparing them with those presented by the students. Question 3 then provided a link between the research public release lessons and the participants own practice by asking what instructional features of the lesson may work for other lessons.

With the Hong Kong lesson, participants were first directed to focus on the organization of the class (Figure 3-20). One reason for this focus is that this lesson is very different from the Japan lesson but, based on the TIMSS results, both are ranked as high achieving countries. The second question asked participants to reflect how the teachers' discussion on the two equations compared with the predictions they made in the previous task on the lesson content (Figure 3-17). The final question, similar to that asked in the Japan exploration, asked what instructional features may work in other lessons, hence providing a link to practice.

1. Explore the Hong Kong Lesson

Take your time to go through the Hong Kong lesson. You can use the outline and links below to focus your exploration. Think about the different segments of the lesson and how they are sequenced.

- The teacher begins the lesson by presenting the problem (00:00:09-00:01:28 *TIMSS 1999 Video Study Mathematics - Hong Kon...*).
- The teacher then asks different students to solve each equation, in turn, and asks the class questions about the meaning of the solutions(00:01:28-00:09:07 *TIMSS 1999 Video Study Mathematics - Hong Kon...*).
- The teacher focuses on the "special" equation, asks students to check some additional solutions, and discusses their results (00:09:07-00:12:47 *TIMSS 1999 Video Study Mathematics - Hong Kon...*).
- The teacher examines the special nature of the equation to see why it has multiple solutions, labels it an "identity", and describes how one might prove it is an identity (00:12:51-00:19:24 *TIMSS 1999 Video Study Mathematics - Hong Kon...*).
- Students are asked to check whether several additional equations are identities (00:19:24-00:27:00 *TIMSS 1999 Video Study Mathematics - Hong Kon...*).
- The teacher summarizes the point of the lesson and assigns some practice problems (00:27:00-00:32:01 *TIMSS 1999 Video Study Mathematics - Hong Kon...*).

Figure 3-20 Task: Exploration Hong Kong

The Swiss lesson's exploration task had a similar structure with a focus on how the lesson was organised. The first question asked participants to mark and write about moments that interested them as they explored the lesson. The second question linked back to the task on the lesson problem asking them to compare their response to what they saw in the lesson. As with the other exploration tasks, question 3 asked participants about instructional features they thought would be transferable.

Presuming participants have worked linearly through the course, by the stage they are exploring the Swiss lesson they have completed two cases and should be more experienced at analyzing lessons having been exposed to more expert opinions and a variety of responses from their peers. This should be reflected in their responses to this task.

3.2.3.6.4.4 Focus on content

After the participants had had the opportunity to experience the lesson problem and explore the videotaped lesson, the course offered a comprehensive examination of the content. The aim was to provide a broad coverage of the lesson content, beyond a solution to the problem, without the scope of a full course on the topic. This satisfied the guiding principles of deepening participants' content knowledge and providing 'access to expert performances' (2.5.3.1) especially to totally online users.

For example, the students in the Japanese lesson present five solutions to the problem. The course participants, after submitting their solutions to the problem, have seen these solutions during the lesson exploration. The *Focus on Content* section then explained these and linked the different methods. Participants should see further links in the lesson analysis task that followed.

The content discussion in the Japan case is discussed below using segments from the four course pages. The link between equality and inequality is suggested at the start of the discussion (see Figure 3-21).

CASE ONE: JAPAN

Focus on Content: Equalities and Inequalities 4/9

The core problem in this Japanese lesson can be approached as either an equality or an inequality. Algebra problem solving often involves determing whether two quantities are equal or whether one quantity is greater than the other. When asked under what conditions one quantity would be greater than another, some find it easier to think about the two quantities as being equal before tackling the question of inequality.

Figure 3-21 Segment 1 Japan Focus on Content

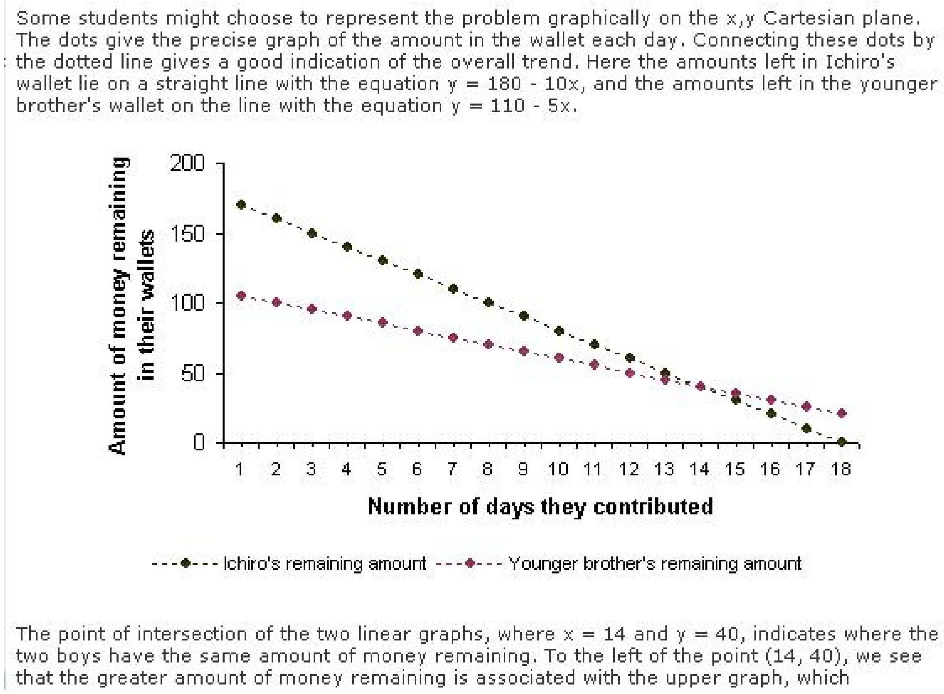
One of the simplest methods, a step up from trial and error, is the use of a table. The start of the table is shown below in Figure 3-22. In the course the whole table was included with a discussion about the solution based on the table.

Other students might use a table of values, and approach the problem by trying out several possible values for the number of days, at the same time keeping track of the total amount left in each boy's wallet:

No. of days	Amount left in Ichiro's wallet	Amount left in younger brother's wallet
1	180 – 10(1) = 170	110 – 5(1) = 105
2	180 – 10(2) = 160	110 – 5(2) = 100
3	180 – 10(3) = 150	110 – 5(3) = 95
…..		
11	180 - 10(11) = 70	110 - 5(11) = 55
12	180 - 10(12) = 60	110 - 5(12) = 50

Figure 3-22 Segment 2 Japan Focus on Content

The table values can be used to solve the problem graphically as shown in Figure 3-23. Dots were used to emphasize the actual amounts in the wallet, with the trends being shown by the dotted lines.


Some students might choose to represent the problem graphically on the x,y Cartesian plane. The dots give the precise graph of the amount in the wallet each day. Connecting these dots by the dotted line gives a good indication of the overall trend. Here the amounts left in Ichiro's wallet lie on a straight line with the equation y = 180 - 10x, and the amounts left in the younger brother's wallet on the line with the equation y = 110 - 5x.

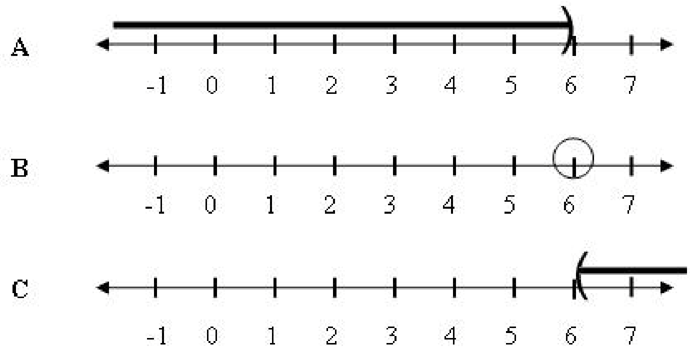
The point of intersection of the two linear graphs, where x = 14 and y = 40, indicates where the two boys have the same amount of money remaining. To the left of the point (14, 40), we see that the greater amount of money remaining is associated with the upper graph, which

Figure 3-23 Segment 3 Japan Focus on Content

A discussion (only partially shown) followed, explaining the link between the point of intersection of the lines and the amount of money each boy has and what the graph showed either side of this point.

This discussion was then taken to a theoretical level. The representation of an equation and associated inequalities in one variable were first shown on a number line (see Figure 3-24). This led to a discussion about linear equations in two variables and how inequalities are represented when graphed onto a Cartesian plane.

For example, take the solution to the equation $2x - 12 = 0$, which is represented on number line B of the figure below ($x = 6$). There are three implicit number-line regions created by the solution to this equality: the point associated with the number 6, the points for the numbers less than 6, and points for the numbers greater than 6. The numbers less than 6 (number line A of the figure below) are the solutions to the inequality $2x - 12 < 0$, whereas the numbers greater than 6 (number line C of the figure below) are the solutions to the inequality $2x - 12 > 0$.



Just as the solution to a linear equality in one variable divides the number line into three regions, something similar occurs on the plane with linear equations in two variables: $y = ax + b$ ($a \neq 0$). If the infinite number of solutions to this equation are represented on the Cartesian plane, the set of points (i.e., ordered pairs) forms a line $y = ax + b$. This line cuts the plane into three regions: the half-plane below the line, the line itself, and the half-plane above the line. The half-plane below contains all the ordered-pair points that satisfy the inequality $y < ax + b$ ($a \neq 0$), and the half-plane above the line contains all the ordered-pair points that satisfy the inequality $y > ax + b$ ($a \neq 0$). Just as a point on a line creates three regions of solutions for the linear equality/inequalities in one variable, so too does a line in the plane for the solutions to the

Figure 3-24 Segment 4 Japan Focus on Content

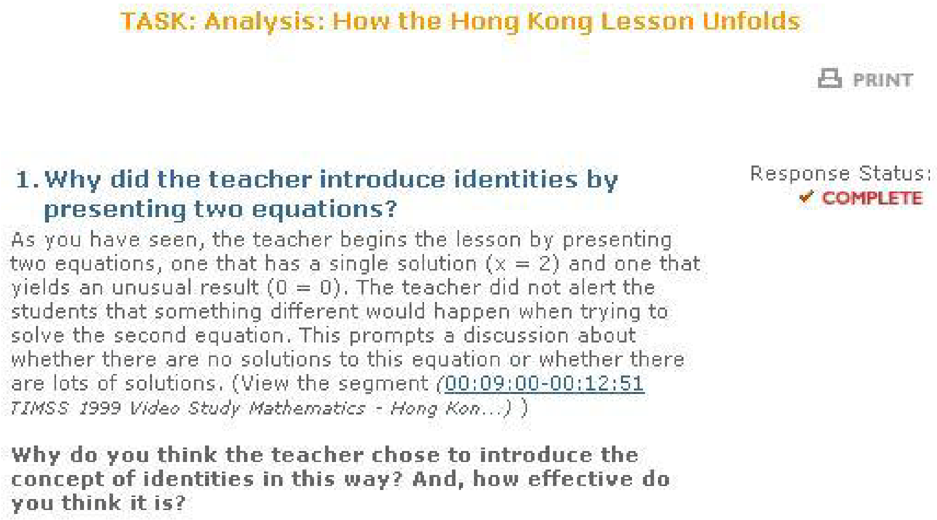
3.2.3.6.4.5 Analysis: How the lesson unfolds

Having explored the lesson content and the videotaped lesson, the next stage of the case was to provide participants with the opportunity to develop a deeper pedagogical understanding of the classroom. The analysis was guided by task questions that probed for understanding. As before, the scope was constrained by the length of the course.

In the Japan Case the focus of the lesson analysis was from where the students started working on the lesson problem. The first question asked participants: “What did the teacher do during private student work?” Supporting the big question is some suggestions on areas to concentrate on such as the notes the teacher was taking and the comments he made to students. Questions 2, 3 and 4 focused on the solution strategies used and presented by the students – the solutions themselves, the sequence of presentations and the connections made by the teacher. The next two questions looked at the follow up to the presentations by the teacher. In question 5 participants were asked about why the teacher had students complete the chart emanating from the last solution method – participants were asked to complete the chart themselves in order to fully understand the teacher’s method. A second problem was given in the lesson and participants were asked to comment on why and to contrast it with the first problem.

The last question moved beyond the lesson by asking: “Did the teacher engage the students in mathematical thinking?”

In question 1 of the analysis task for Hong Kong, the way the teacher introduced the concept of identities was analyzed. This linked back to the content work completed by the participants previously in this case.


TASK: Analysis: How the Hong Kong Lesson Unfolds

PRINT

1. Why did the teacher introduce identities by presenting two equations?

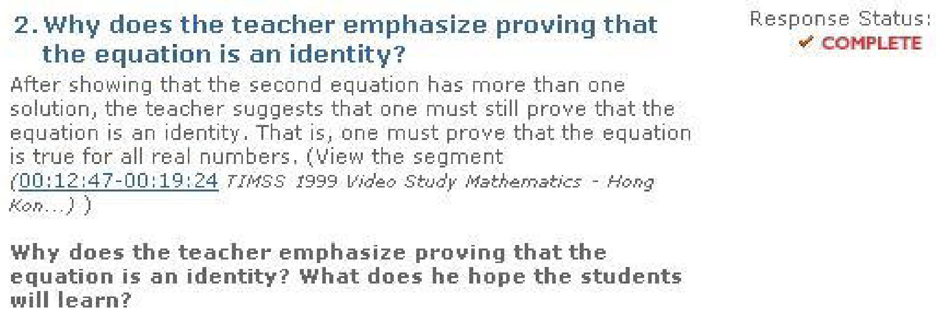
Response Status: ✔ COMPLETE

As you have seen, the teacher begins the lesson by presenting two equations, one that has a single solution (x = 2) and one that yields an unusual result (0 = 0). The teacher did not alert the students that something different would happen when trying to solve the second equation. This prompts a discussion about whether there are no solutions to this equation or whether there are lots of solutions. (View the segment *(00:09:00-00:12:51 TIMSS 1999 Video Study Mathematics - Hong Kon...)*)

Why do you think the teacher chose to introduce the concept of identities in this way? And, how effective do you think it is?

Figure 3-25 Hong Kong Analysis Q1

The use of proof in the mathematics classroom was addressed in question 2 (Figure 3-26). The US authors of the course were aware that this is not used often in American classrooms so saw this as an opportunity to present more formal mathematics to this audience, thus incorporating the guiding principle of increasing content knowledge. A third question linked back to practice: “Can some of the features of this lesson apply to your teaching of other mathematical topics? …”


2. Why does the teacher emphasize proving that the equation is an identity?

Response Status: ✔ COMPLETE

After showing that the second equation has more than one solution, the teacher suggests that one must still prove that the equation is an identity. That is, one must prove that the equation is true for all real numbers. (View the segment *(00:12:47-00:19:24 TIMSS 1999 Video Study Mathematics - Hong Kon...)*)

Why does the teacher emphasize proving that the equation is an identity? What does he hope the students will learn?

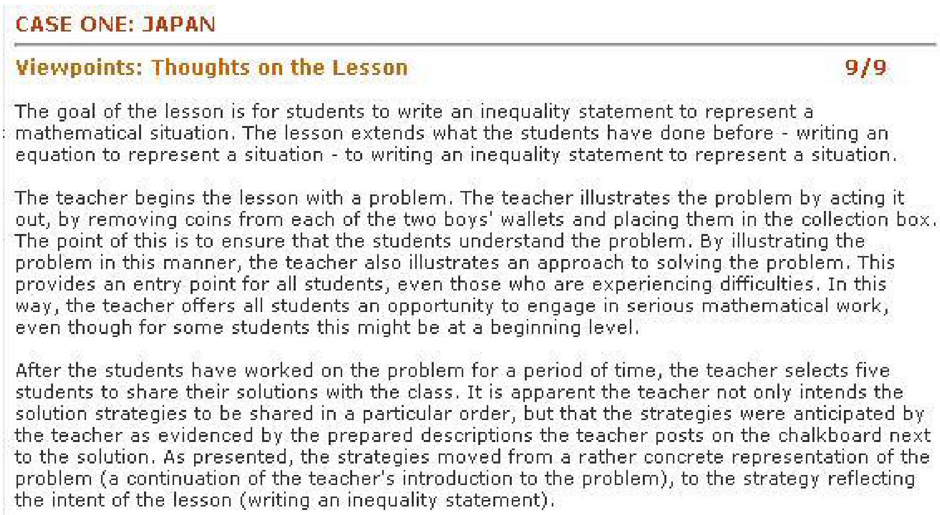
Figure 3-26 Hong Kong Analysis Q2

The *Focus on Content* section of this case included a discussion on identities in mathematics and their importance in mathematics in general. Here the discussion modeled the ‘Making connections’ category of the research finding ‘Kind of problem’ (Figure 3-15) while in the task question, emphasis was on how this could look in the classroom. The objectives here were to address the guiding principles of increasing content knowledge, increasing pedagogical content knowledge, linking to the research and scaffolding lesson analysis processes.

Question 1 in the Swiss lesson asked participants to model the procedure the students used in the lesson by illustrating an arithmetic equation with line segments. This idea was continued in question 2 where they were asked to describe two ways of using blue (value 5) and yellow strips (3) to represent the number 19. These concepts were linked together in question 3: “What features of the first two segments would help students understand the third segment (Introduction of Variable)? ...” Question 4 asked how the lesson could be extended to emphasize that the unknowns can be variables, not just particular unknowns. The last question addressed the bigger concept of how the lesson and teacher supported the students’ engagement in serious mathematical work.

3.2.3.6.4.6 Viewpoints: Thoughts on the Lesson

Each case ended with another expert opinion, this time presenting thoughts on the lesson.



CASE ONE: JAPAN

Viewpoints: Thoughts on the Lesson 9/9

The goal of the lesson is for students to write an inequality statement to represent a mathematical situation. The lesson extends what the students have done before - writing an equation to represent a situation - to writing an inequality statement to represent a situation.

The teacher begins the lesson with a problem. The teacher illustrates the problem by acting it out, by removing coins from each of the two boys' wallets and placing them in the collection box. The point of this is to ensure that the students understand the problem. By illustrating the problem in this manner, the teacher also illustrates an approach to solving the problem. This provides an entry point for all students, even those who are experiencing difficulties. In this way, the teacher offers all students an opportunity to engage in serious mathematical work, even though for some students this might be at a beginning level.

After the students have worked on the problem for a period of time, the teacher selects five students to share their solutions with the class. It is apparent the teacher not only intends the solution strategies to be shared in a particular order, but that the strategies were anticipated by the teacher as evidenced by the prepared descriptions the teacher posts on the chalkboard next to the solution. As presented, the strategies moved from a rather concrete representation of the problem (a continuation of the teacher's introduction to the problem), to the strategy reflecting the intent of the lesson (writing an inequality statement).

Figure 3-27 Japan Case Viewpoints

The discussion set the scene by restating the goals of the lesson and briefly addressing prior knowledge. The teacher's presentation of the problem was discussed along with the way it provided the opportunity for all students to engage in serious mathematical work during the lesson. The sharing of the solutions had already been a focus of the analysis task but the discussion reiterated this and made sure that participants thought again about the use of the chalkboard by the teacher to link ideas and show the progress of mathematical thinking in the different strategies used by the students.

The discussion continued and concluded with viewpoints on the way the teacher encouraged serious mathematical thinking.

In summary, the teacher encouraged serious mathematical work on inequalities through several key features of the lesson: (1) presenting a problem that could be approached at increasingly sophisticated levels, (2) asking students to share strategies at these increasingly sophisticated or abstract levels, placing them carefully on the chalkboard, and drawing connections between them to support students' movement from beginning approaches to more abstract approaches, and (3) clearly focusing on the intended outcome as the lesson neared its conclusion.

Figure 3-28 Japan Case Viewpoints cont.

Similar discussions were provided in the Hong Kong and Switzerland cases.

3.2.4 Stage 2: Development of solutions - technology

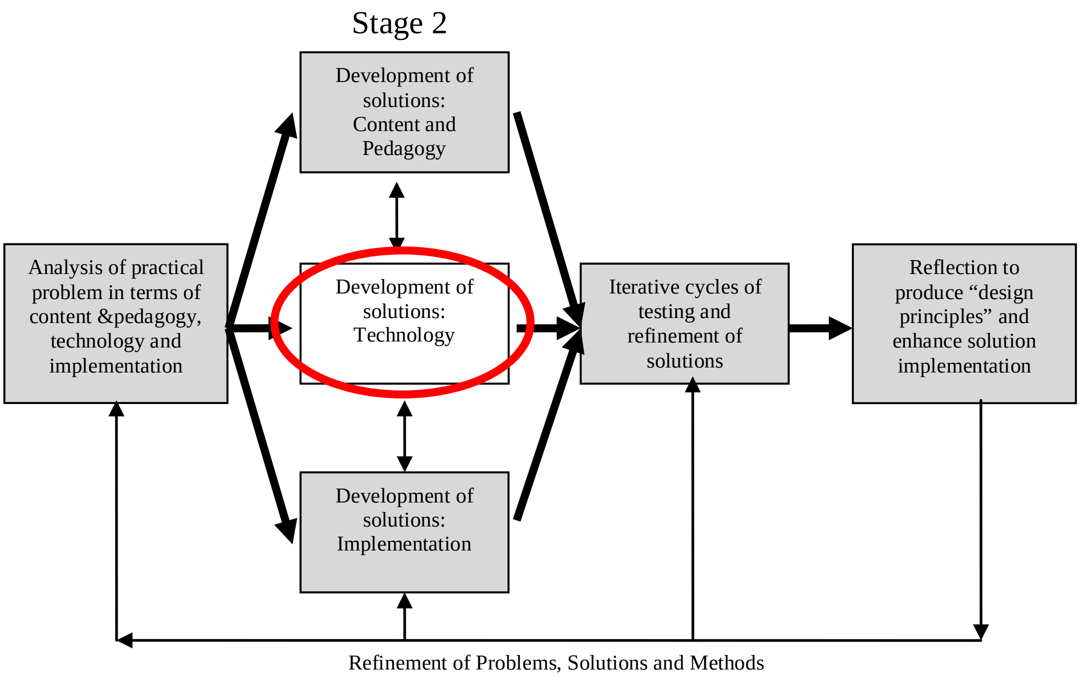


Figure 3-29 Stage 2 Technology

3.2.4.1 Technology overview

The team for this component was responsible for the development and maintenance of the online software to be used in the project; for the technology components of the support materials; for technical help and support of the implemented course; and for the development of an online ordering facility. Much of the software development had been completed before the design-based research started but refinements and some new features were added during the project. Processes were developed and put in place for technical support and the ordering system was developed from scratch.

The technology was central to the project and it would either support or hinder participants moving through the early stages of Salmon's model (2.5.6) from novice technology users to confident users, where the technology is just a tool that provides, through the course content, the means for them to construct knowledge.

3.2.4.2 Constraints

As with all software development there were budgetary and time constraints which sometimes required wish-lists being prioritized. The software incorporated third-party programs such as video-players and internet browsers, and was cross-platform resulting in some limitations when these different platforms and/or programs could not work together.

3.2.4.3 The Team

The team consisted of the designers of the original patented LessonLab software (Grudnitski et al., 2005), Grudnitski, Stigler, Sims, and Hood, and other members of the technology team at LessonLab. Stigler and Hood provided the link between the content and pedagogy, and technology teams.

3.2.4.4 The Technology

The online course was built in the Visibility™ Course software, a product developed at LessonLab in Santa Monica, US.

3.2.4.4.1 Background to the course software

When looking at the course software, it is necessary to look briefly at two programs developed previously - vPrism™, the program used for the video analysis in TIMSS Video Studies, and LessonLab Viewer™, the online lesson viewer developed at LessonLab.

The software, vPrism, had been designed specifically for video analysis in the TIMSS Video Studies. One of its features was the capacity for the user to mark and compile a set of video clips from full videos, which could then be used in professional settings. Stigler, the chief researcher on the TIMSS Video Studies and a vPrism developer, used selected video clips in his work at UCLA with pre-service teachers. It was during this time that he realized that much of the learning was in fact done by him in selecting the clips. His vision was to provide this opportunity to his students, and other teachers. That is, he wanted them to have the chance to view the complete lesson videotapes and select clips appropriate to the topic being studied. He also wanted them to be able to share and discuss these easily, preferably online.

This could not be done easily with vPrism as it could only be used standalone or on a local area network. There were also limitations as constantly changing specifications of computer operating programs and third party programs, such as Real Player, used by vPrism, resulted in development work being limited to the Apple Macintosh platform, rather than the cross-platform capabilities of earlier versions.

In mid-2000, technology development was at a point where the streaming of video over the internet had become viable. At this point, Stigler started working with a small team, including the researcher, to design software that would enable online sharing, discussing and analyzing of video. Towards the end of 2000, after the initial planning, programmers started working with the group. Early in 2001 the first components of the software were ready for testing. These components, known as LessonLab Builder and Viewer, consisted of an interface for storing and accessing digitized videotapes of lessons and their artifacts. The interactive components were tasks, for individual analysis and responses, and forums for group discussions. Links to the videos could be included by builders in the questions posed in tasks and forums, and by users in their responses and discussions. This aspect of the software was granted a patent in 2005 (Grudnitski et al., 2005).

3.2.4.4.1.1 LessonLab Viewer™ up-close

The first stage of the software development was to create a lesson viewing and building tool. LessonLab Viewer stored digitized video, time-coded lesson transcripts, lesson index, lesson artifacts such as lesson plans, student work and interviews with teachers, and text commentaries time-linked to the lesson.

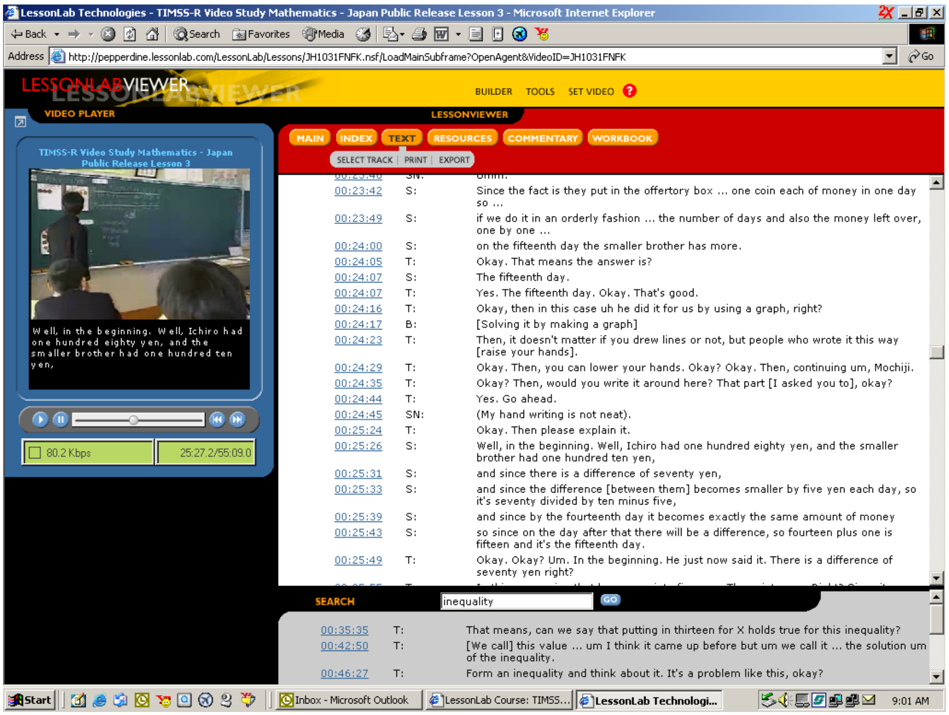


Figure 3-30 LessonLab Viewer™ Interface

The interactive components, tasks and forums, enabled users to answer questions and take part in online threaded discussions. Questions, responses and discussions could be easily linked to the videos by time-codes embedded by builders and users. Completed responses to tasks could be viewed by other users once they had completed that task.

Figure 3-31 LessonLab Viewer™ Task and Forum Interfaces

It was the task and forum features that provided the means for online collaborative construction of knowledge, characteristic of situated learning and one of the project's guiding principles (2.5.3.1.1). Further, sharing responses to the task questions and participating in threaded online forum discussions encouraged the multiple perspectives and reflections aspects of situated learning. The forum interface enabled facilitators to add overall comments and be tagged within discussion threads thus providing the means to, say, scaffold or encourage articulation within the discussion.

LessonLab Builder had a similar interface to LessonLab Viewer except for header colour schemes. The advantage for builders was that they saw the finished product as they built. Minimal training was needed to build in the software and many lesson or course authors built their own products.

Before a video could be used in the software, it had to be digitized and loaded to a central server. Video was normally provided in two compression rates. A lower rate was available globally for streaming over the internet while a higher compression rate, and hence better quality video, could be accessed locally from a disk. In both cases the user needed to be connected to the internet as all interfaces, time-links, transcripts, online tasks and forums and other resources were stored in the central server and provided via the internet.

3.2.4.4.1.2 Use of LessonLab Builder and Viewer

The first lessons were built in the software from April 2001 and used with mathematics teacher groups across California that summer and with English teachers at Pepperdine University the following semester. This period, outside of the scope of this research but vital to its feasibility, was one of extensive development of the software, support materials and implementations across a variety of settings. Challenges included cross-platform requirements of the software including the host browsers and video players (Internet Explorer for PCs, Netscape Navigator for Macs and Real player for the videos); storage of the vast quantities of data including the digitized videos; the speed and access of networks; registration onto the software; distribution of materials such as content keys for registration, disks with local video and user documentation; and the training and support of local faculty who were using the program in their teaching. As the clients using the software, built the lessons, tasks and forums directly themselves, they had usually developed enough expertise to confidently implement the programs with their groups after initial support from LessonLab personnel.

The early implementations were an opportunity for the technology team to evaluate all aspects of usage from gaining access to the software, testing the configuration of computers to see they had the necessary third-party software, and adequate access to the internet without, for example, blocks such as firewalls, as well as the ongoing use of the software itself. Refinements resulting from this period included providing the browser and video player software on the disk with the local video, developing help pages and help-desk protocols, making registration more straightforward by removing unnecessary data fields and establishing minimum requirements and protocols for testing computer labs.

The TIMSS Public Release Lessons were released in an offline version of Lesson Viewer that did not include the task and forum functions.

3.2.4.4.2 Course Builder and Viewer

Lessons, tasks and forums became the building blocks of the course software. Builders used these and other components, such as on online lesson planning tool, URL links and graphics files, as resources in their course. Resources were constructed and stored in a dedicated area and were then available to builders to use in course pages.

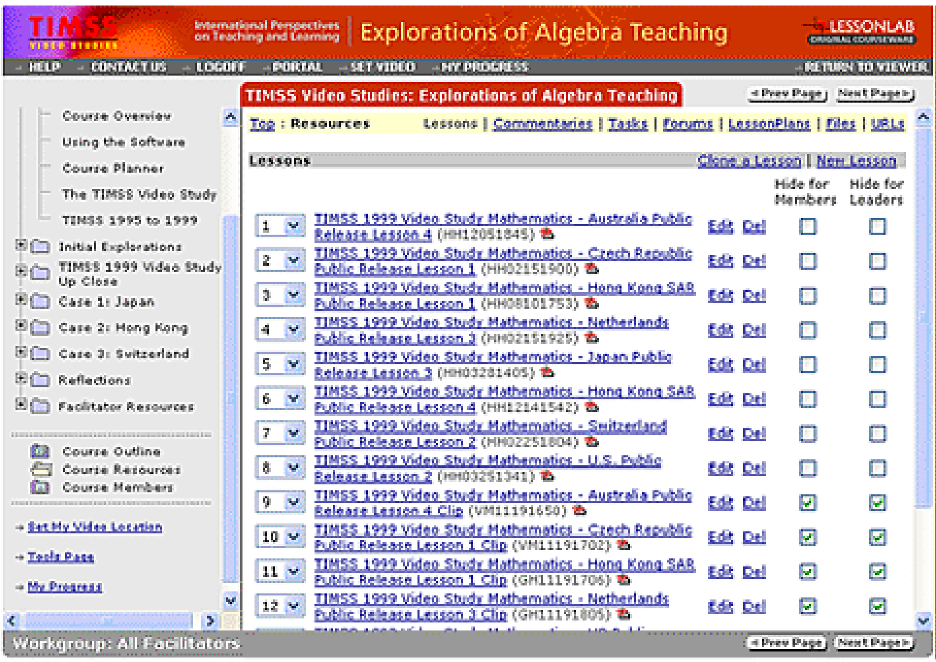


Figure 3-32 LessonLab Course Builder Resources

Similar to LessonLab Viewer and Builder, Course Viewer and Builder shared the same interface with minor differences so a builder could always see the look of the final product. Course topics, pages and resources could be made available to users and/or leaders (facilitators) when the builder was ready. This enabled the use of part of a course while further sections were being built. It also provided a way for information or resources to be available to facilitators only. This feature was very important in the design of the TIMSS course facilitator training and support materials.

Courses were designed around topics that have pages embedded in them. In the design stage of the course software, this was the format that made most sense to course builders/designers and end-users and enabled these parties to grasp the navigation quickly. The topics appeared on the left-side of the course screen in a format similar to listed files and emails on many computers. The expanding and contracting of topics is familiar to most computer users. When a topic icon was clicked it automatically expanded as the currently opened topic closed. Pages within the topic could be accessed by clicking on its name in the expanded topic view. Navigation between pages was possible using the 'Next Page' and 'Prev Page' buttons at the top and bottom of the interface.

Under the course topic map there were links to the 'Course Outline', 'Course Resources' and 'Course Members'. 'Course Outline' provided a detailed linked-mapping of the course and the means to view, save or print the course pages, without the tasks and forums. Users could therefore read or refer to course text without the computer. Users could access any resources that were available to them from the 'Course Resource' area. In the TIMSS Algebra course, for example, they could access the full lessons, including all artifacts, used in the course. From the resource area, these appeared in the LessonLab Viewer interface whereas within the course pages, they appeared only in the Real Player interface either standalone or embedded in tasks or forums. 'Course Members' showed all participants and facilitators within their workgroup. From here, they could email the group or group members.

The remaining links in this area provided the means to change the video location (global or local) and see progress made through the course's tasks and forums.

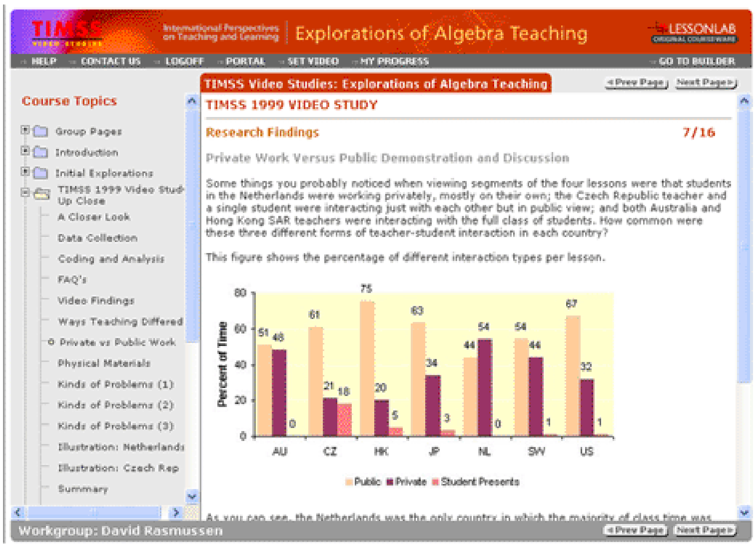


Figure 3-33 LessonLab Course Interface

3.2.4.4.3 Online ordering technology

An online ordering system was developed at LessonLab for individuals and groups to order the course and pay the materials fee. The system automatically generated a receipt and a content key to be used during the registration process and alerted administrative staff that a materials package needed to be sent. The content key assigned an individual to their choice of a facilitated or non-facilitated group and, for a group order prompted the creation of a new workgroup and assigned the individuals to that workgroup.

While the online ordering facility was an important part of the development, further details will not be included as it is not considered part of the solution to the research problem. However, it is mentioned because it was tested during one of the testing and refinement cycles and caused unexpected problems that affected the number of active participants in that cycle (see 4.6.2.1). Changes were made to the distribution of materials process as a result. This will be discussed further in the next chapter.

3.2.4.4.4 Support materials

The technology group had responsibility for creating a CD-ROM that contained the higher quality video that could be used in place of the streaming video, and links or copies of the third-party software required to run the course software. They wrote the technical details for the user guides and provided online and help-desk support for users.

The support of participants was essential as it was expected that online professional learning would be a new experience for many course participants. It was planned that the course would be made available to individuals for a nominal cost to cover materials. Information technology usage was limited among teachers in the US at that time and it was expected that there would be many first-time users with little support to help configure their computers and gain access to the internet. The testing and refinement cycles of this component were essential to ensure participants could move successfully through Salmon's first stage of 'access and motivation' (2.5.6).

3.2.5 Stage 2: Development of solutions - implementation

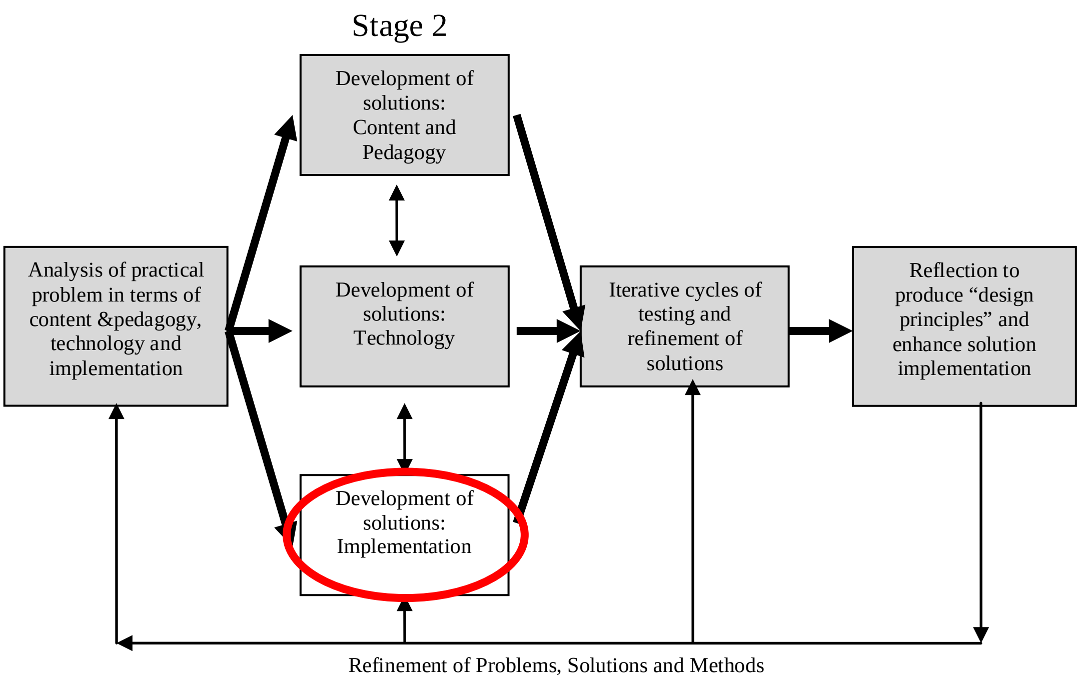


Figure 3-34 Stage 2 Implementation

3.2.5.1 Implementation overview

It was agreed that the course would be offered flexibly, both online or blended (online and face-to-face), to groups and individuals wanting to learn about the TIMSS Video Studies. Individuals could order and enroll any time online and could elect to join a facilitated or non-facilitated online workgroup. Groups, usually from schools or districts, would enroll together and would be facilitated with a delivery mode to suit the group. The implementation group had overall responsibility for the design of flexible delivery models, testing, facilitator training, and text support materials.

3.2.5.2 Constraints

As with the other components the implementation group had time constraints. The course needed to be ready for launching the same week the TIMSS 1999 Video Study

(Mathematics) report (Hiebert et al., 2003) was released by NCES (U.S. Department of Education, National Center for Education Statistics). There was no exact date set for this, but it was expected to be late 2002 or early 2003. This constraint limited development and the cycles of testing, evaluating and refinement to a period of approximately four months from the initial week-long joint planning meeting in August, 2002.

3.2.5.3 The Team

The team members were drawn from LessonLab, Intel and the Institute of Computer Technology (ICT) with Seago and Hood providing the link between the implementation and content and pedagogy teams, and Hood the link to the technology team. It was planned that ICT, through Intel, would provide the facilitation for the facilitated workgroups formed for individual participants.

3.2.5.4 The Implementation

Responsibilities of the implementation group included designing the different implementations; designing the support text materials (user guides) and consent forms; and designing and conducting the facilitator training. The group conducted the testing cycles of the design-based research model and had responsibility for the course once it was implemented.

3.2.5.4.1 Planning the testing

Two cycles covering three implementation methods were originally planned for Stage 3. These covered a range of delivery options – the first was totally face-to-face with optional online exploration between sessions; the second had face-to-face sessions to start and finish, with online work between; and the third was totally online and non-facilitated. A third cycle was added after a delay in the release of the TIMSS 1999 Video Study (Mathematics) findings and extra funding was provided by Intel. It was totally online with facilitation and tested the online ordering system and administration process for distributing materials.

It was expected that by using such a range of delivery options, each of the three components, content and pedagogy, technology and implementation, would be thoroughly tested by a wide variety of users in a variety of settings. It was also expected that the first cycle would be the most critical, hence the face-to-face delivery mode. Outcomes from the testing will be discussed in Chapter 4.

The group planned the testing, sourced suitable locations (external to LessonLab) and participants, conducted the testing and reported back to the larger group.

3.2.5.4.2 **Course guide**

The implementation group developed the users' course guide. It was to cover technical and content segments such as system requirements for using the software, instructions on getting started, the course outline, guides to help participants move through the course and work areas for the tasks. Development, testing and refinement occurred during the iterative cycles of Stage 3 of the design process.

3.2.5.4.3 **Consent forms**

All pilot participants were required to complete and sign consent forms agreeing to the face-to-face sessions being videotaped and to enable all observations, evaluations and online responses to tasks and forums being used for research purposes (see Appendices 3.1 and 3.2). The consent forms were written collaboratively by LessonLab, Intel and UCLA's legal teams. The forms are stored at LessonLab Research Institute, Santa Monica, California, US (http://www.llri.org/). Participants were also required to sign confidentiality forms, as the US Government had not released the TIMSS Video Study Report.

3.2.5.4.4 **Facilitation**

After the course was published, it was initially delivered only online with or without facilitation. Individuals were assigned to groups within the software. The facilitation for the first groups was provided by a mathematics educator through the Institute of Computer Technology (ICT) and funded by Intel. The facilitator received training from LessonLab on using the technology and, after completing the online course, was given more in-depth insights into the research and the course and its facilitation through talking with course developers and participating as an observer during the early testing cycles and working as an online facilitator during later testing.

After completing the course, individuals with a background in teacher professional learning in mathematics, could apply to train as facilitators. On successfully completing the training, the facilitators could enroll a group of participants to take the course. Delivery modes were more flexible for small groups, with facilitators given the training and resources to design their own implementations by blending online and face-to-face segments.

The training and materials, online and offline, were designed by the implementation team throughout the course testing and refinement cycles, Stage 3 of the design-based research. They will be discussed as appropriate in the next chapter although the actual training sessions for facilitators are not part of this research.

3.3 Summary of Stage 2 of the design-based research

At the end of this stage of the design-based research, the three development components had been integrated into an initial solution to the overriding problem of disseminating the outcomes of educational research to inform teachers' practice. The first version of the online course had been designed and built in the Visibility Course software and then tested in-house. CDs containing the higher quality videos and start-up software were ready for distribution. Consent forms and basic course notes were ready. Participants for the first cycle of testing had been identified and meeting times and places set. Presenters, observers, support staff and videographers were identified and their roles defined. All was ready for the next stage of the research - cycles of testing and refinement.

Chapter 4 Design-Based Research Stage 3

4.1 Introduction

This chapter will examine the iterative cycles of testing and refining that followed the design of the initial solutions to the main question of this research, *What are the design principles for developing online professional learning to disseminate the outcomes of educational research that will inform teachers' practice?* This is the third stage of the design-based research process.

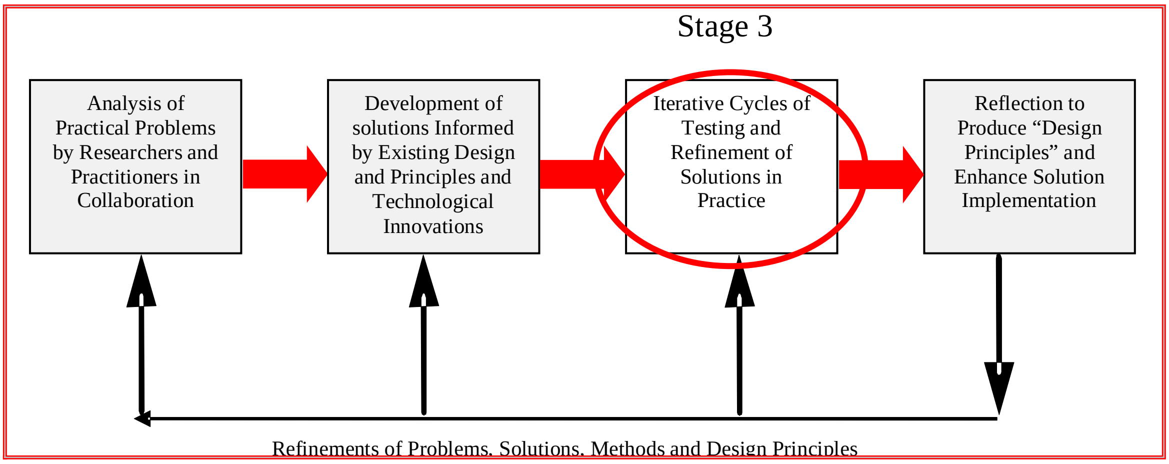


Figure 4-1 Design-based research Stage 3 (Reeves 2006)

The Implementation Planning group as described in Chapter 3 (3.2.5.3) had responsibility for conducting this stage of the process but the outcome relied on, and had implications for all groups, content and pedagogy (3.2.3.3), technology (3.2.4.3) and implementation (3.2.5.3).

This chapter will start with a general discussion on the process of collecting and analyzing the data for this stage. Next it will examine each cycle of testing - the process, the analysis of the collected data, and the resulting refinements made for that cycle. The chapter will conclude with a reflection of this stage, in preparation for Chapter 5 where the aggregated data from all cycles will be analyzed in terms of the design principles that guided the development of the solutions during Stage 2 of the design-based research.

4.2 The data of Stage 3

During Stage 2 of the design-based research process, the implementation group designed the evaluation tools for Stage 3. These tools were designed to collect both qualitative and quantitative data. Using the following definition developed by Plano Clark and Creswell (2008) after an examination of current literature, this component of the research could hence be described as aligning with mixed methods.

> A *mixed methods study* involves the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research. (Plano-Clark & Creswell, 2008, p.165)

An overview of the source of each data type for Stage 3 will follow along with a general discussion on analyzing the data sets – methods, levels and challenges.

4.2.1 Qualitative data

Qualitative data during this stage were collected from a variety of sources including observations, focus groups, videotapes, documents, questionnaires and online responses. Observations were sourced directly from observers at the face-to-face sessions and indirectly during the periods participants worked individually online. When face-to-face meetings were possible, the pilots finished with focus group meetings where participants had the opportunity to reflect on the whole experience including course content and the overall online experience. This occurred in three of the four pilots. All face-to-face sessions were videotaped providing another source for clarifying observers' notes and examining particular points at a deeper level after the event.

Participants at the pilots were encouraged to use journals to write down thoughts, observations and working notes as they progressed through the course. These were collected for use in the evaluation process. Individual questionnaires used before and after each testing phase, collected both quantitative and qualitative data. In some questions the qualitative data were qualifiers attached to a quantitative question such as 'Did you learn anything new about mathematics?' (Yes/No) with opportunities for comments drawing responses such as 'Algebra from years passed' and 'The connections of concepts…'. In other cases the question called only for a qualitative response such as 'How might this Course assist you in your teaching practice?' The complete questionnaires are included in the Appendix (see Appendices 4.1, 4.2 and 4.3).

A valuable and very extensive source of data was provided by the online course itself. Interactive tasks and forums are embedded throughout the course and responses to these were collected for analysis. An initial examination of this qualitative data provided an overview of the effectiveness of the task questions or forum topics and was used to make decisions on refinements during the cycles of testing and refinement. At the development stage, effectiveness of the interactive components was measured on different levels including the number of questions answered, and the quality of the answers such as evidence of deeper thinking, links to the video and links to participants own experience. A more in-depth analysis of the responses was made after Stage 3 to formulate the design principles evolving from Stage 4 of this design-based research.

4.2.2 Quantitative data

As mentioned above, individual questionnaires were given to participants before and after each testing cycle. Data collected covered demographics of the participants and their experience taking the course. Many of the question responses were quantitative including interval data, such as years teaching and hours spent on the course; categorical (nominal) data such as the Yes/No question mentioned above; and ordinal data derived from Likert scales that rated, for example, the interest and usefulness of each section of the course from ‘5=Extremely’ to ‘1=Not at all’.

The use of quantitative data in the evaluations provided researchers with a quick overview of the participants’ experiences before and during the pilots. Prior experiences included levels of mathematics studied and taught and participants’ computer usage and access. Both of these variables could influence the course experience as the content focuses on mathematics education research, learning and teaching and the delivery is via the internet using specific software that, in some cases, required third-party software to be installed by the participant. Post-course questionnaires collected basic information such as the time taken to complete the work and the ease of using the software.

Quantitative data was also collected as participants worked through the course. For example, in the face-to-face sessions, observers measured the time it took different participants to complete the online tasks. When the work was completed remotely online, progress through the course’s tasks and forums could be tracked using the report feature of the software. This data was compared with data collected from the participants' questionnaires.

The qualitative responses to tasks and forums mentioned above (4.2.1), was quantified by coding it using variables such as mathematical content knowledge, pedagogical content knowledge and links to practice. This enhanced the process of looking for patterns and evidence in the data to support the refinements made through Stage 3 cycles and to produce the design principles informing the design-based research. Details of the coding appear below in 4.3.3.1.

4.2.3 Validity of the research

The use of multiple sources of data provided different perspectives from which to find evidence to support both the refinements made during the testing cycle and the final design principles emanating from the research. This process of using multiple data sources, or triangulation, facilitates the development of a coherent understanding of the research. (Creswell, 2007; Kervin, Vialle, Herrington, & Oakley, 2006; Merriam, 1998; Miles & Huberman, 1994; Plano-Clark & Creswell, 2008; Yin, 1994)

Triangulation is one of the six strategies Merriam (p.204) lists as basic to maximize the 'internal validity' of qualitative research, that is, how research findings match reality The others are member checks, that is, checking the plausibility of results with participants; long-term observation or repeated observations; peer examination through ongoing reviews of findings by peers; participatory or collaborative modes of research by involving participants in all phases of the research; and clarifying researchers' biases. The validity and reliability of any research relies on the ethical and rigorous approach of the researchers. In experimental designs this is accounted for before the research begins but in qualitative research it is derived from "…the researcher's presence, the nature of the interaction between the researcher and the participants, the triangulation of data, the interpretation of perceptions, and rich, thick description" (Merriam, 1998, p.151).

Creswell (2007), while recognizing that the validation strategies used depends on the research being conducted, emphasizes that all such research needs accepted strategies to assess the 'accuracy' of the findings. He identifies eight strategies, adding two to

Merriam's list: prolonged engagement and persistent observations in the field; triangulation; peer review for an external check; negative case analysis where the initial hypothesis is refined as the inquiry advances; clarifying researcher bias; member checking; rich thick description to facilitate transferability; and external audits. Creswell's recommendation is that at least two of the strategies should be used in any qualitative research (Creswell, 2007, p.209).

In the design-based research of this thesis, prolonged engagement and persistent observations in the field, triangulation, peer review for an external check, clarifying research bias, thick rich description to facilitate transferability and external audits were strategies employed at different points during the design, implementation and analyses stages.

4.2.4 Data analysis in Stage 3

As time between the testing and refinement cycles was limited, descriptive statistics from the quantitative data provided a basic view of fundamentals such as the time required to complete the course, the ease of accessing and using the software, and the level of satisfaction with different sections of the course. The qualitative data provided a more expansive picture of the details behind and beyond the quantitative data. Both types of data were used to make decisions about refinements during each cycle and the aggregated data from all cycles were used as evidence in producing the design principles of Stage 4 of the design-based research.

4.2.4.1 Qualitative data analysis

The quantity and complexity of data collected through the research process can be overwhelming and strategies are needed for the analyses stages. With quantitative data, the use of descriptive statistics such as means and graphs of the data can provide a quick insight into particular aspects of the research. Where relevant, statistical tests within or between sets of data can provide another level of analysis. With qualitative data, although the statistical methods appropriate for quantitative data cannot be applied, systematic methods guided by the researchers' intuition and understanding of the context of research, need to be used for valid conclusions to be drawn.

The process of analyzing qualitative data proceeds in a non-linear fashion throughout the entire research period. For example, when deciding what data will be collected, an analysis has been made about what data is needed to show that the objectives of the research can be verified as having been met. In design-based research, design principles are identified in the first stage of the cycle to guide the development of the solution to the practical problem in Stage 2. During the testing cycles of Stage 3, the data collected must be able to indicate whether or not these design-principles are appropriate, clarify strengths within the solution and identify any problems to be solved in the subsequent refinements. At the end of the cycles, analyses of all data, may verify some design principles, suggest modifications to others and indicate others that may be appropriate.

A basic system for analyzing qualitative data, drawn from the literature, suggests that it first be prepared, organized and reduced into manageable chunks, presented or displayed in formats such as matrices, graphs or networks, ready for drawing conclusions and verification. As mentioned above, these steps are non-linear and 'interwoven before, during, and after data collection in parallel form' (Miles & Huberman, 1994 ,p.11). Creswell represents the data analysis process as a spiral with the researcher moving in analytical circles from the data management stage, through an organizational stage onto a sense making stage ready for classification, coding and interpretation (Creswell, 2007, p.151). Kervin, Vialle, Herrington and Okely (2006) also represent the analysis process as a spiral, based on Creswell's work. Their diagram, shown below, emphasizes the recursive nature of analysis.

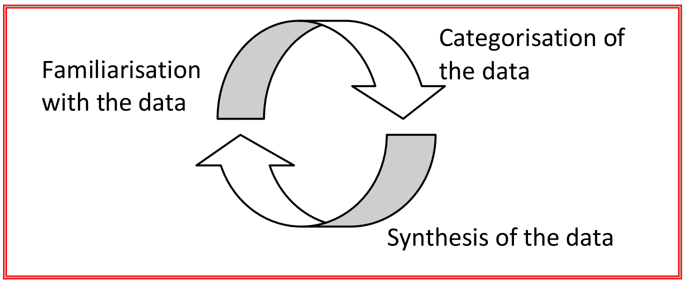


Figure 4-2 The data analysis spiral (Kervin et al., 2006 p,140)

For the sense-making stage of the data analysis process, a constant comparative method was used. The overall aim of this method is to identify patterns within the data by grouping together segments or events that can be linked through common characteristics. This grouping leads to identifying categories and/or sub-categories that form the basis for further analyses of the data (Merriam, 1998). In this research, the categories were also strongly influenced by the guiding principles used in Stage 2 and the technology used.

This data analysis system was followed throughout the testing periods of Stage 3 of this research. As will be discussed below, as the pilots within each cycle were being conducted, data were being collected and initial analyses conducted at each point in the process.

As a result of this, some refinements were made immediately if they were pertinent and did not affect the planned testing. For example, if a bug in the software was causing problems for the participants it was fixed, or, if progress was too slow in one section because of the number of questions posed in a task and there was a risk of major sections of the course not being tested, then participants would be moved on to the next section and encouraged to return to the uncompleted work outside of the set time.

Generally, however, most refinements came at the end of each cycle after the group had a chance to analyse data for that cycle in greater depth. After the final cycle, the data was aggregated and analysed for evidence to support the design principles and to see if there were any unexpected findings.

4.3 Cycles of testing

Three major cycles of testing and refinement were conducted prior to the online course being made available to the general public (see Figure 4-3). The most visible refinements were in the content area, but there were modifications made to the technology and the implementation plans as a result of the testing. Some refinements were made after the general release of the course and these will be discussed at the end of this chapter.

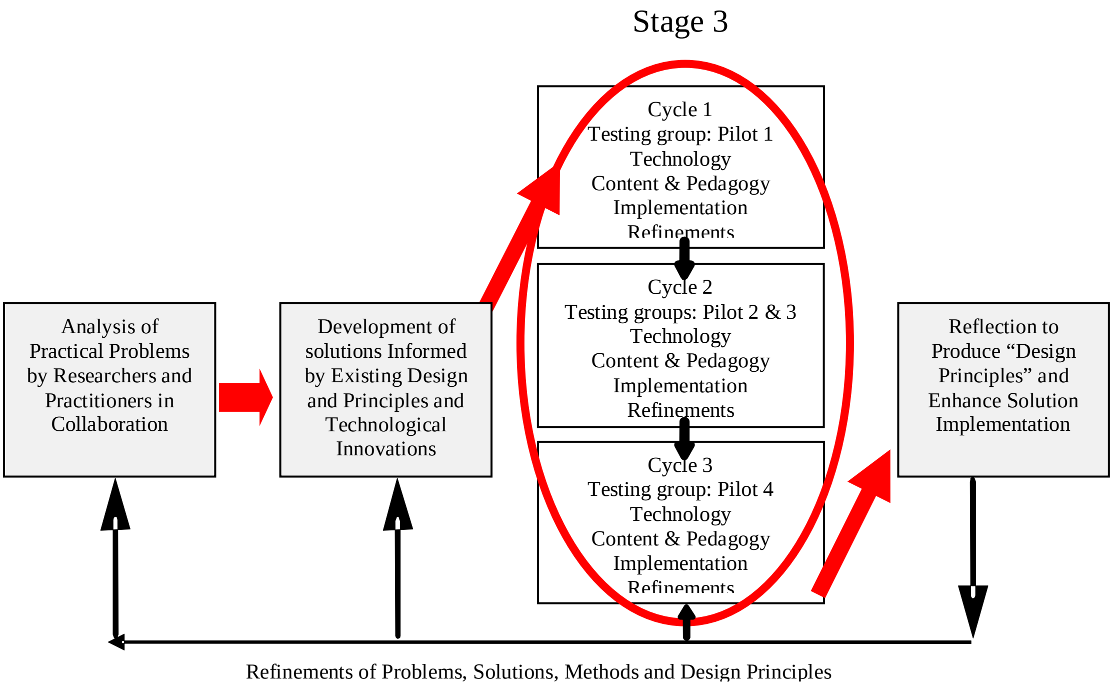


Figure 4-3 Cycles of Stage 3

The discussion below will start with an overview of the pilots of the cycles, the data collected, and processes used before moving into a more detailed analysis. Refinements emanating from the iterative cycles of Stage 3 will be discussed in terms of each cycle of testing, the data collected and analyzed, and the resulting changes.

4.3.1 Pilots

Four pilots were conducted during the three cycles of testing. These covered the range of delivery options – the first was totally face-to-face with online exploration between sessions; the second had face-to-face sessions to start and finish, with online work between; the third, conducted in parallel with the second pilot during Cycle 2, was totally online and non-facilitated; and the fourth was totally online with facilitation.

Table 4-1 Pilot Overview

	Pilot 1	Pilot 2	Pilot 3	Pilot 4
Number of participants	11	10	10	34
Face-to-face meetings/course (hours)	3 + 3 + 2	2 + 1	0	0
Individual online work (hours)	2	7	10	10
Online facilitation (Yes/No)	Yes	Yes	No	Yes
Registration (f2f guidance or remote)	F2F	F2F	Remote	Remote
Order course online	No	No	No	Yes
Course materials (Guide and CD)	Yes	Yes	Yes	Yes
Video consent forms	Yes	Yes	Yes	No
TIMSS confidentiality forms	Yes	Yes	Yes	Yes
Research consent forms	Yes	Yes	Yes	Yes
Questionnaire 1 - Demographics	Yes	Yes	Yes	Yes
Questionnaire 2 – Post course	Yes	Yes	Yes	Yes
Questionnaire 3 – online experience	Yes	Yes	Yes	Yes
F2F debrief/ feedback session (hours)	1	1	2	0
Journals collected	Yes	Yes	Yes	No
Session videotaped	Yes	Yes	Yes	No
Pre and Post online testing	No	No	No	Yes
Phone & online tech support	Yes	Yes	Yes	Yes
Participant stipend	$300+IDC	IDC	IDC	$80

(IDC=Intel Digital Camera)

Table 4-1 gives an overview of the four pilots showing their formats including the hours of face-to-face and online work, the support provided, and the sources of data collection for each. Note that all participants received a stipend for participating in the pilots. As this is the norm in the US, it was not expected to influence the research outcomes.

Originally only two cycles of three pilots were planned, each with 10 participants, to test different modes of implementation. As each of these involved face-to-face meetings, participants needed to be in close geographical contact and so participants were recruited from schools in the Riverside and Lake Elsinore areas of California.

A delay in the release of the TIMSS Video Study Report provided the time to conduct a third cycle with a fourth group (Pilot 4) using extra funding from Intel. This was an opportunity to test the course in online delivery with facilitation. Since the delivery mode for this cycle was totally online, geographical location was irrelevant and so participants were accepted from throughout the US.

4.3.1.1 Pilot 1 overview

Pilot 1 was conducted in early November, 2002. There were two 3-hour meetings with a facilitator, a week for online individual work (approximately 2 hours of work expected) and a final 3-hour meeting to finish the coursework and conduct a one-hour debriefing with the participants.

The face-to-face meetings were held in a school computer laboratory that incorporated a large non-computer area. Participants in this group were guided through the registration process to use the software in their first face-to-face meeting. The computers in the laboratory had been configured by the technical staff from LessonLab before the first meeting. Participants were required to access the course from their home or school computers individually to complete online work between the face-to-face sessions.

4.3.1.2 Pilot 2 overview

Pilot 2 was conducted in December 2002. It consisted of a two-hour introductory meeting, approximately 7 hours of independent on-line coursework with a facilitator, and a final two-hour summary and evaluation meeting. As with Pilot 1, participants in this group registered to use the software in the first face-to-face session. They were required to access the course individually for seven hours of online work between the face-to-face meetings.

4.3.1.3 Pilot 3 overview

Pilot 3 was conducted in December 2002, at the same time as Pilot 2. It was exclusively online with participants working individually without facilitation. They received the course CD-ROM by mail and were required to register individually and remotely onto the software with phone and online tech support available. Participants attended a two-hour meeting after the course to give feedback.

4.3.1.4 Pilot 4 overview

Pilot 4 was conducted in February 2003 and was totally online with a facilitator guiding the experience. This pilot also tested the online database for ordering the course and the process for materials distribution, both developed at LessonLab. After ordering the course individually online, participants were sent course materials and a unique content key that provided access to the LessonLab portal and assigned them to a workgroup.

4.3.2 Data from the cycles of testing

Table 4-2 below summarises the data collected from each pilot during the three cycles of testing – the methods used; what was collected for each method; and the type of information produced, how it was used and how it linked to the other methods. Each method includes a code used in the analyses (see 4.3.2.1).

Table 4-2 Data from the cycles of testing

Method	What	Information & Usage
Questionnaire 1 (Q1)	Demographics	Background information on teaching and subject qualifications and experience, and computer usage. Cross-referenced with data collected in other questionnaires and from online responses and experiences. Collected in Pilots 1, 2, 3, 4.
Questionnaire 2 (Q2)	Post course	Feedback on the online course including time taken, interest and usefulness of course topics and the interactive tasks and forums. Used after each pilot for quick analysis of participants' reaction to the course and for triangulation of data collected by observers and at final debrief. After all pilots, enabled comparisons between group responses. Collected in Pilots 1, 2, 3, 4.
Questionnaire 3 (Q3)	Online experience	Feedback on the technology especially use outside of the f2f sessions. Triangulated with tracked technical help provided and with f2f videos and observations. Collected in Pilots 1, 2, 3, 4.
Videotape (V)	Face-to-face (F2F) sessions	All videotapes transcribed after the pilots and coded for evidence of understanding, misunderstanding and other f2f events that resulted in course refinements. Triangulated with data from observers, participant feedback and online responses. Collected in Pilots 1, 2.
Videotape (V)	F2F debrief or feedback session	Facilitators used guiding questions to elicit detailed feedback from participants on their experiences with the course, the software and the internet. Triangulated with the written questionnaires 1 and 2. Collected in Pilots 1, 2, 3
Observations (O)	F2F sessions	Observers' notes and recollections were discussed with the facilitators after each f2f session to provide immediate feedback through peer review. Any modifications for the next session were discussed and planned during this time. The notes were analysed further after the pilots. Collected in Pilots 1, 2, 3.

Method	What	Information & Usage
Online responses (T) & (F)	Course tasks & forums	Participants completed the courses' online tasks either in the laboratory during the f2f sessions or remotely in their own time. The completion rate and the responses provided a rich source of data for analysis after the pilot to see the depth of understanding and whether or not this changed as they completed more of the course. Codes were developed to capture the essence of the responses particularly as they related to the design principles used to guide the development of the solution. They also provided a glimpse of participants' preconceptions and reactions to the public-release lessons used in the course. The responses were triangulated with the videotaped data and the written questionnaires. Collected in Pilots 1, 2, 3, 4.
Incidental notes & feedback (J)	Participants' journals	Participants shared the journals they used during the pilot for both working out mathematics' problems from the course and reflecting on the f2f sessions and course. Collected in Pilots 1, 2, 3.
Technical tracking and Help (H)	Email and phone log	The Help desk kept a track of all calls, emails and responses during the pilot. These, questionnaire 2 and the debriefing video provided a picture of the online experience and technology challenges. The technology team used the data to redevelop support materials and responses. Collected in Pilots 1, 2, 3, 4.
Incidental (E)	Emails between team members	Emails provided a further source of qualitative data for the three areas of content and pedagogy, technology and implementation from each of the stakeholders. Collected in Pilots 1, 2, 3, 4.

4.3.2.1 Referencing the data

The initials after each method type in Table 4-2 will be used within the discussions on the cycles to indicate the source of the data. P.n.x will be added to specify the pilot (n) and the participant (x) where relevant. M will be used in place of x to indicate the facilitator or moderator. Data from questionnaires will be referenced as Qn.q where n is the questionnaire number (1 – 3) and q represents the question within that questionnaire. So Q1.2.P.3 would be a reference to question 2 from the first questionnaire, demographics, for Pilot 3. For videotaped sessions (V) a number will be added to denote the session. So V.3.P.1.M indicates the reference is from Videotaped face-to-face session 3 of Pilot 1 and is a quote from the Facilitator. O.3.P.2 would indicate source is an observer from session 3 of Pilot 2. Note within the transcripts M denotes a facilitator and T a teacher participant. TN denotes when a new T starts talking and the following Ts relate to this teacher until the next TN appears.

For online activities, the task (T) or forum (F) will be denoted by a code and number to indicate the particular activity and the question. Task codes will relate to the topic so IE: Initial Explorations; JP: Case 1: Japan; HK: Case 2: Hong Kong; SW: Case 3 Switzerland; and R: Reflections. In each case there are three tasks I: Introduction to the problem; E: Exploration; and A: Analysis. So T.JP.E.3.P.4.6 after a quote indicates the source as being an online Task from Case 1 Japan, the task is Exploration question 3, and is from Pilot 4, participant 6. The code J will be added to the above if the entry is taken from the participant's journal.

Note that any quotes attributed to participants or team members are used literally without any editing on the part of the researcher.

4.3.3 The review process

As mentioned previously (4.2.4.1), a review occurred immediately after each pilot face-to-face session to share observations and react to any critical occurrences before the next session. This ensured that the pilots ran as smoothly as possible without the participants being inconvenienced.

During this time refinements such as changing task questions, were identified to be implemented after the pilot before the next cycle of testing. At the end of the cycles all sources of data were examined more closely to identify other possible refinements and to measure the effectiveness of the guiding principles.

4.3.3.1 Task and forum data

Participant responses to the interactive components of the course, the tasks and forums, were analyzed further by the researcher at the end of the cycles. Coding was conducted on many dimensions including mathematical content, pedagogical content knowledge, student thinking, link or transfer to practice, link to research, and video evidence. Each of these dimensions had sub-codes. The full list of dimensions is included in Appendix 4.11.

All responses were independently double-coded by the researcher and a colleague who had worked as a researcher on the TIMSS Video Study and as a (trained) facilitator on the TIMSS Video Studies: Explorations of Algebra Teaching course. Both coders then discussed the codes until a consensus was reached. The number of disagreements in the initial codes was noted so that reliability could be calculated. Codes were modified throughout the process to cater for unexpected or unforeseen points within the responses. Where necessary, previous responses were re-coded with the amended codes. These codes provided a means to compare aspects of individual responses within tasks; responses by an individual between a number of tasks; and responses between different pilot groups.

4.3.4 Facilitation and support

Face-to-face meetings in Pilots 1 and 2 were conducted by a LessonLab consultant experienced in the use of video-case studies in teacher professional learning and an extensive user of LessonLab online software. The facilitator was also a member of the content and pedagogy, and implementation teams during Stage 2 of the research process.

The online facilitator for Pilot 4 was an experienced mathematics educator employed by ICT specifically to facilitate the TIMSS Video Studies course (see 3.2.5.3). The facilitator attended Pilots 1 and 2 as an observer and also received training in the use of the software and more information on the TIMSS Video Study research at LessonLab before Pilot 4.

The researcher assisted the facilitator at the face-to-face meetings and conducted the technology components of the sessions when participants worked online. The Information Technology team at LessonLab provided further support with the software and registration as necessary. The LessonLab Help desk answered online and phone enquiries throughout each pilot and kept a log of all communications.

4.3.5 Materials

The Implementation team had responsibility for developing User guides to support participants when they registered onto the LessonLab site and then on the use of the course software. The development and testing of the guides were part of the design based research Stage 3 cycles and will be discussed in the implementation component of each cycle below.

Each participant received a CD-ROM containing the higher quality video and the third-party software required to run the course software (see 3.2.4.4.4).

4.4 Cycle 1

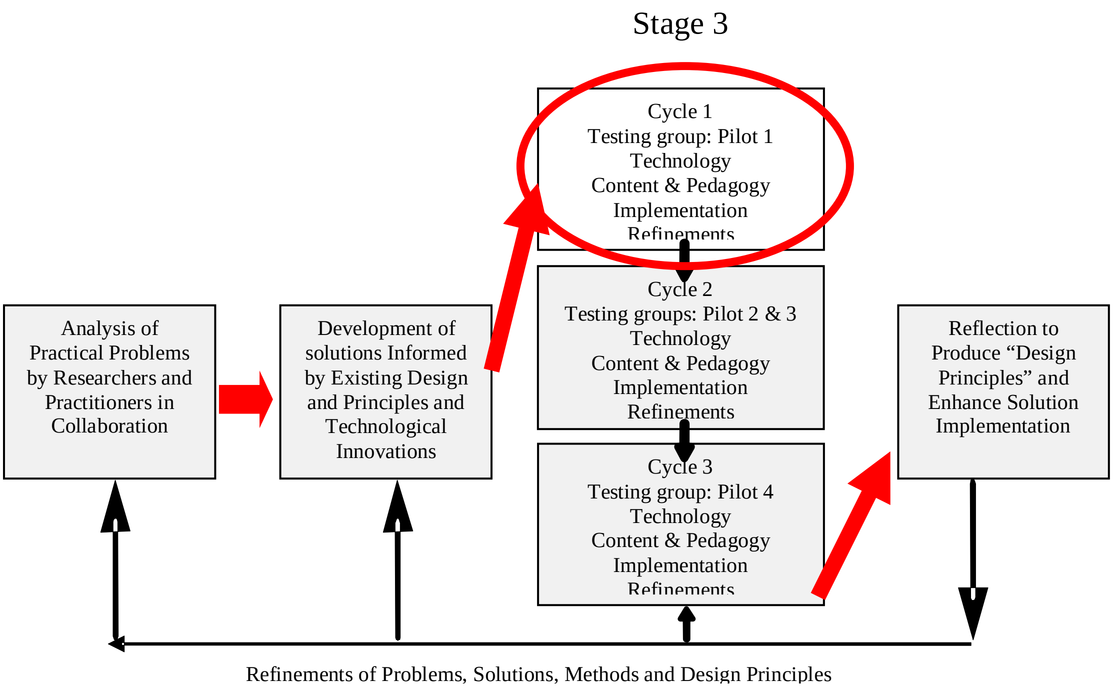


Figure 4-4 Cycle 1 of Stage 3

The first cycle of Stage 3 used the first iteration of the course directly from Stage 2. The course outline at this point is shown below. There were six main topics including three cases. Since each case followed the same pattern, only details of the first case, Japan, is shown. At this point there were ten online tasks (three in each case) and no forums.

- Introduction
- Initial Explorations
    - Getting your feet wet (Task)
- TIMSS 1999 Video Study Up Close
- Case 1: Japan
    - Content
        - Introduction to the problem: Japan (Task)
    - Exploration
        - Exploration: Japan (Task)
    - Focus on content
    - Analysis
        - Analysis: How the Japanese lesson unfolds (Task)
    - Viewpoints on the lesson
- Case 2: Hong Kong
- Case 3: Switzerland

As was discussed in 4.3.1 above, a range of online and blended delivery formats were used throughout the cycles to test the guiding principle of flexibility of delivery. It was expected by all design groups that the first cycle would produce the greatest number of refinements to the initial solution from Stage 2. For this reason, it was planned that the delivery option with the most face-to-face sessions would be used for Cycle 1.

Face-to-face sessions were videotaped and observers from each stakeholder were present at each meeting. Other members of the content and pedagogy, and technology teams, who were not at the face-to-face sessions, could observe the pilot indirectly by viewing participants' responses to the online tasks. Members from the technology team were on standby at LessonLab during the face-to-face sessions to solve any technical problems that arose.

As mentioned above, Cycle 1 was designed to be delivered mainly face-to-face and so online forums were not included at this point, rather discussions were planned to be conducted by the session facilitator. A major task of the content team was to observe these discussions and use information gleaned to formulate online forums for Cycle 2.

After each face-to-face session, the facilitators and observers met to evaluate the session and make modifications, if necessary, to the plan for the next session. They also met, either face-to-face or through teleconferencing, with other members of the Stage 2 teams to report back, answer questions and discuss any issues and/or modifications.

4.4.1 Participants' backgrounds

Cycle 1 started with a face-to-face session from 4 p.m. until 7 p.m. for the group of eleven participants, known as Pilot 1. During the first half hour participants read and signed the video and research consent forms and the confidentiality statements (see 3.2.5.4.3). They also completed the first questionnaire, demographics.

The demographics data showed that of the eleven participants (six females, five males) starting the pilot all were credentialed teachers, experienced in teaching mathematics at different levels and with different mathematics' qualifications (Q1.P.1). All participants were teaching mathematics at the time of the pilot.

Table 4-3 Mathematics teaching experience

8. Not counting this year, what is your mathematics teaching experience?											
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Elementary	4	2				30		25		4	1
Middle	1	1		10		6			2	1	
High			7		4		27		1		
College									2		
Total	5	3	7	10	4	36	27	25	5	5	1

As can be seen in Table 4-3, number of years teaching mathematics ranged from 36 years to 1 year with the majority, 8 teachers, having taught for 10 or fewer years. This teaching experience ranged over all levels with four at high school, six at middle school and six at elementary, with some overlap (Q1.8.P.1). Thus all participants were familiar, to varying degrees, with mathematics' classrooms and could draw on their own experiences as they watched the videotaped lessons and reflected on the mathematics and pedagogy of each.

Although not all participants provided the information about the highest level of mathematics studied, Table 4-4 shows that all respondents had studied some mathematics at tertiary level (college or graduate) (Q1.9.P.1). Looking further at the major and minor subjects studied at tertiary level, Table 4-5, six participants listed subjects with a strong mathematical base (shaded cells) including participants 3 and 5 who did not respond to the previous question (Q1.10.P.1). Since the TIMSS public-release lessons are year 8 level, it was expected that the mathematics in the lessons would be within participants' level of understanding given their qualifications and experience.

Table 4-4 Level of mathematics studied

9. What was the highest level of math you studied in:											
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
High	G	G		Pre-C			G&T		A2		
College	C	A		DE			C		S	S	C
Graduate	T			CT					S&T		
A: Algebra C: Calculus CT: Computer Technology DE: Differential Equations G: Geometry S: Statistics T: Trigonometry											

Table 4-5 Subjects studied at tertiary level

10. What was your:											
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
College major	LS	P	M	M	P&S	EE	M	E	Bu	HS	PE
College minor		B	S		E	A	Bi&ES	En	M		M
Grad school major	BE	E	M	ET		E&P	Bi	R	Bu	EA	
Grad school minor							E		M		
A: Art B: Bible BE: Bilingual Edn Bi: Biology Bu: Business E: Education EA: Edn Admin EE: Elementary Edn ES: Secondary Edn En: English ET: Edn Technology HS: Health Science LS: Liberal Studies M:Math PE: Physical Edn P: Psychology R: Reading S: Science So: Sociology											

Table 4-6 and Table 4-7 show that all participants were regular computer users at school and, most, also at home. Connection speeds to the internet varied both at school and at home but all did have access (Q1.3.P.1). All participants had access to PCs at school, while, at home, ten had PCs and one a Mac (Q1.4.P.1). This information was important as it indicated the level of support that may be required and also reinforced the need for video to be accessed locally from the CD-ROM provided (internet connection was required regardless).

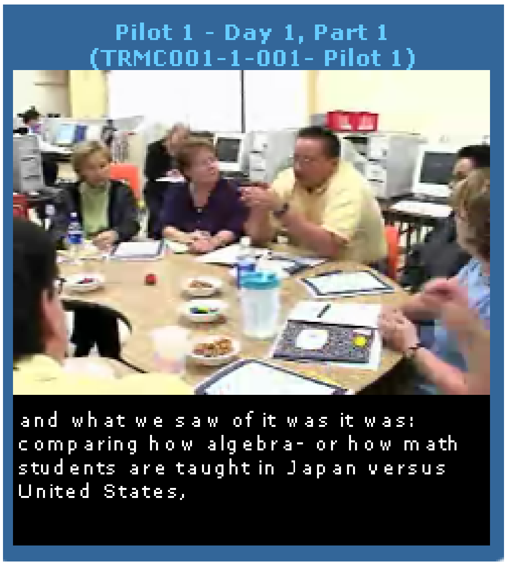
Table 4-6 Computer usage frequency

Computer usage	School	Home
Rarely		2
Once a week	1	
Every other day		2
Once a day		4
More than once a day	10	3
Total	11	11

Table 4-7 Type of internet connection

Internet connection	School	Home
DSL/Cable Modem	2	6
Dial-up	2	4
Ethernet	4	
Not sure	2	1
Don’t have internet access		
Total	10	11

In the opening session, after the objectives of the pilot had been explained and the attendees introduced themselves to the group, the facilitator led a discussion on the research asking participants about their knowledge of the previous (1995) TIMSS Video Study. Over half of the eleven participants mentioned seeing public-release lessons from the first study and reading *The Teaching Gap*, a reflection on the conclusions of the study (Stigler & Hiebert, 1999) (O.1.P.1).



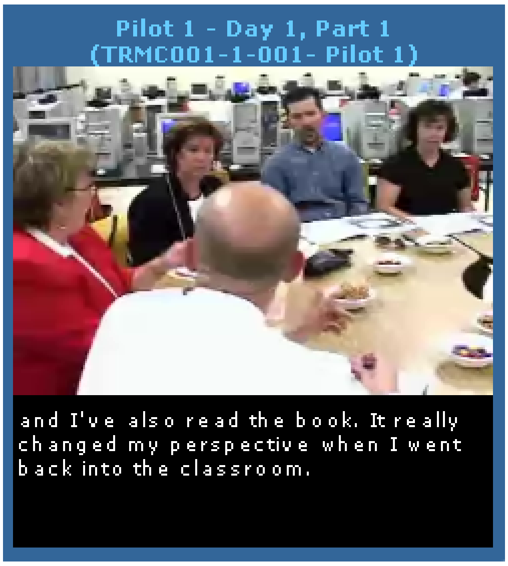


Figure 4-5 Participants discuss 1995 TIMSS Video Study and the Teaching Gap

One participant (see Figure 4-5) talked about the influence the experience had on his teaching and was excited to attend the pilot to see more lessons (V.1.P.1).

4.4.2 Technology

As this was the first implementation of the LessonLab course software, the testing cycle was very important for the technology team to see how the hardware and software worked both in the laboratories in the face-to-face sessions, and remotely as participants accessed the course between sessions. In the discussion below, problems and their solutions or refinements are discussed along with aspects of the technology that worked well.

4.4.2.1 School computer laboratories and software

The first technology problem was the absence of the Adobe Acrobat Reader program on the computers in the computer laboratory and the difficulty of having any software, even a freely available one, downloaded onto school computers. The program was needed to display the lesson graphs, a one-page overview of the lesson, included to enhance the participants' first online task *Getting your feet wet*. The technology group had sent a checklist for the computer lab to the school before the event but when the implementation group arrived they discovered it was not on the computers, and could not be loaded on the day even by the school's lab manager.

4.4.2.1.1 **Refinements**

The process of preparing and checking computer laboratories needed to be reassessed. The disks with the higher quality video given to all participants needed to contain as many of the third-party programs as was possible. This would be useful for computer laboratory managers and would also provide the participants with the third-party software required to access the program from their home computers.

Apart from solving the software problem, it was necessary to cater for situations where unexpected problems still occurred. One way was via the text support materials. As noted by one of the observers "Lesson graph should be in user guide, along with larger pictures of equations being worked. In facilitated course, remind teacher to have lesson graph available…" (O.1.P.1)

4.4.2.2 Accessing the software

The LessonLab software was on a secure site that required users to be registered and assigned, via a content key, into a specific group. Registration onto the LessonLab portal during Pilot 1 was very smooth apart from one or two people forgetting their passwords in the few minutes it took from registering to logging back onto the site. One observer suggested "In user guide, provide space to write password" (O.1.P.1). Changing from streaming video to the better quality one on the CD-ROM was also easy. No refinements were considered to be necessary at this stage.

4.4.2.3 Video Clips Task 1 online

After accessing the course, the first online activity for participants was to complete the online task *Getting your feet wet*. The task consists of five questions, four requiring participants to watch and comment on the first five to ten minutes of four lessons, one each from Australia, Czech Republic, Hong Kong SAR and the Netherlands, and the last question comparing the lessons.

When this course was being developed, LessonLab's policy was to include whole lessons whenever video was used in courses. If only a section was to be viewed, the start and end points were specified by time-markers coded into the task question. The participant would click the link to view the segment as is shown in the segment of question 1 of the *Getting your feet wet* task below.

> Explore the first part of this Australian lesson. ***Click the link to start the video:*** (<u>00:00:00-00:05:24</u> TIMSS 1999 Video Study Mathematics - Australi...) (T.IE.5)

However, once the video clip started playing, it would only stop at the designated spot if the user did not press any controls on the video player. If the user clicked, for example, rewind or pause and play, the original stopping point was lost and the video would keep on playing until it finished or the video player pause or stop button was clicked. Likewise, if a linked time from the lesson transcript was clicked, it would override the clip time.

In the first pilot, approximately an hour had been set aside for participants to complete the first four questions in the *Getting your feet work* task, with the fifth question on the similarities and differences between the lessons, planned as a group discussion. So on average that was fifteen minutes to watch the video clip and write a short response to the question for each lesson:

> What can you infer about the teacher's goal(s) by watching this segment? What is being emphasized during this segment of the lesson? (T.IE.1-4)

The observers kept track of the time taken by participants to finish each question while the facilitators answered questions asked by individual participants. Participants were not prompted to finish questions at a particular time. It was during this period that the problem with the time-link controlled clips became obvious. Notes from the observer shows that the first participant to finish question one, the Australian lesson, took 14 minutes while the last one to finish took 40-45 minutes "because they viewed past the 7 minute segment" (O.1.P.1). The average time for the group was 30 minutes. The second observer noted that 28 minutes after they had started, eight of the participants were still working on question one.

From the transcript of the video of the session, the confusion over the clip times can be seen at several points. Note that work on this task started about 10 minutes before the time shown in the transcript excerpts below, so 00:21;19:27 corresponds to about 31 minutes of working time.

```
00:21:19:27  T     I'm going to click on here until thirty-
one.
00:21:21:07  TN    Thirty-one.
```

```
00:21:22:00 M2    You don't have to even- Look, this little
segment...
00:21:24:10 TN    Oh.  Oh.  We weren't supposed to hear the
whole thing?
00:21:28:09 M2    No
00:21:29:01 T     Oh, because we've been all sitting here
listening to this whole thing.  See?  Thirty.
00:21:32:10 M2    Oh, well that's good to know. (V.1.P.1)
```

About two minutes later a different group of participants have a similar discussion with the moderators.

```
00:23:12:23 TN    I watched all of it.
00:23:14:02 M     Oh, you're only supposed to- the- the six.
00:23:15:02 TN    Alrighty.
...
00:23:19:11 TN    I was really getting into this one.
00:23:20:17 M2    You did.  I was impressed.
```

Back at the central table for the discussion about the lessons, the participants commented on watching more than the specified amount and their first reaction to the lesson.

```
00:58:58:25 TN    I watched a little bit too much of the
first one.
...
00:59:02:12 TN    I didn't realize we were only supposed to
watch-
00:59:03:00 TN    You didn't tell us six minutes.
00:59:08:15 TN    I was sitting there watching, going, "Does
my classroom look like this?  I hope my classroom doesn't
look like this."
...
00:59:17:19 TN    I was about 25 minutes into it.  I'm going,
"hey, this is not bad."  (inaudible) minutes.  Gee!
00:59:26:12 M     I don't think you were alone. (V.1.P.1)
```

Looking at the online responses from the participants to the Australian lesson also shows evidence of participants watching beyond the designated time. Video time markers could be embedded into responses to support comments. Six participants, P1.1, P1.4, P1.6, P1.7, P1.8, and P1.9, used this feature and all times used were beyond the 00:05:24 point where the video should have stopped, the times ranged from 00:09:04 to 00:28:21. Three other participants did not use the time markers but their answers indicate they have viewed beyond the set clip. Two for example, P1.5 and P1.9, talk about the teacher using money and this is first mentioned in the lesson video at 00:09:56 while another, P1.11, talks about the writing of ratios and “…the constant concept clarification with numerous activities…” and “…always starting from small numbers for the concept development and transferring the concept to larger numbers”. This all happens beyond the set video clip.

Once participants became aware of the problem of unwittingly playing beyond the designated clip, they generally avoided this problem with the other three segments they watched from the Czech Republic, Hong Kong and the Netherlands. Responses to these questions tended to be shorter. Four participants did not finish all five questions. Participants 7 and 10 finished questions 1 to 4, participant 3 finished 1 and 2 and participant 4 finished 1 and 3.

4.4.2.3.1 **Refinements – video clips**

As the time limitations to complete the course were critical, and since this task was aimed at preparing participants for the discussion on the TIMSS Video Study findings and for the more in-depth video cases that followed, the decision was made to replace the time-links with video clips in this task. The complete lessons, with the artifacts and commentaries were available to participants in the course resource centre if they wish to explore them further.

4.4.2.4 Saving responses

An ongoing challenge with the software since it was first developed was having users understand the stages of saving responses in the task interface. The first stage was to save the response as a draft after which the response could be changed and resaved as often as required. At this level the user’s response is not visible to any one else in the group, nor can the user see other responses. When the response was saved as final, the second stage, the user could not make further changes, the response is opened to other users in the group and the user could read all responses in the group that had also been saved as final. Each question in the task had to be saved, as draft or final, before the next question was started. The double saving process was designed to facilitate the use of the software in formal assessment settings and to encourage users to enter their own thoughts before reading others. The concept of saving took more individual explaining than was expected.

About ten minutes after the participants started answering questions in the *Getting your feet wet* task, the facilitator gave the first reminder to a participant to save the response.

After a few minutes another participant (T) had the following conversation with the facilitator (M).

```
00:03:14:21 T     I'm saving as complete.
00:03:15:28 M     Mm-hm.
00:03:16:18 T     Um, we write an answer, there's a
possibility to come back and change that answer at another
time?  If I don't click this option?
00:03:24:17 T     Is that what this is telling me? (V.1.P.1)
```

The confusion between the different saving options was not confined to the participants as is shown in the following excerpt, where two facilitators (M and M2) had a discussion with the teachers.

```
00:03:49:24 T     I'm a little unsure as to my answer.
00:03:52:11 T     I mean, so if there's a possibility that I
could come back at a later time and change it.
00:03:55:07 M     They want to save as complete-
...
00:03:57:12 M     but they might later on want to go back and
add to it, revise it.
...
00:04:00:13 M     They can't?
00:04:02:10 M2    No.  They can only do that when it's "save
as draft." (V.1.P.1)
```

Ten minutes later, a different participant:

```
00:13:48:17 T     Oh, okay.  Save?
00:13:50:10 M     Save as draft.  Okay.
00:13:53:06 M     Alright.  If you want to save it as
complete, you can.  And then it's- then it's a- a completed
statement that you want to keep in there.
00:13:59:01 T     Okay.
00:14:00:00 M     Or you can keep it as draft and go on.
It's up to you.  Once it's final, then it's final in the
thing.(V.1.P.1)
```

And then the problem of not saving:

```
00:18:37:26 M     Are you finished?
00:18:39:22 TN    No!  What happened?
00:18:43:21 T     What happened?
00:18:44:28 T     I paused it.  Watch.
00:18:46:27 M2    Oh my gosh.
00:18:49:10 T     What happened?
00:18:50:06 M2    I don't know.
00:18:51:00 T     All my typing's gone.
00:18:54:12 T     I just paused it and got water, came back
and it was gone. (V.1.P.1)
```

Another participant:

```
00:24:04:23 TN     Okay.  How do I save it? (V.1.P.1)
```

and another:

```
00:57:09:00 T     What does "save as complete" mean?
(V.1.P.1)
```

Although the process for saving responses was written on the course page that contained the link to open the task window, and the button for saving as draft was below the response input box, too many participants seemed to experience problems with this. It is interesting that this aspect became obvious from watching the video of the session but was not generally noted by the observers. One made no mention while the second observer wrote as a suggestion “Tell teachers to ‘save as draft’ every 5-10 minutes or so, and remind them once or twice initially.” (O.1.P.1). While this suggestion may have worked for face-to-face sessions, it was not a solution for totally online implementations.

4.4.2.4.1 **Refinements – saving responses**

The immediate reaction to the problem of saving work was addressed by the researcher producing a printed document on technical issues for the following day’s face-to-face session. This reinforced the logging on process, the method for accessing local video and the saving of responses. The participants were to use the software at home between the second and third face-to-face sessions and so discussion of the document at the session was also an opportunity to make sure they were prepared for this.

Another solution was developed and implemented after all cycles and will be discussed at that point.

4.4.2.5 Summary of technology Cycle 1

Participants were given two questionnaires at the end of the pilot. Questionnaire 2 (Q2) consisted of 16 questions asking about the course and experience in general. Most questions required a numeric or categorical response with the opportunity for additional comments. Questionnaire 3 (Q3) concentrated on the technical aspects of the implementation and the non-scheduled time spent on the course. It consisted of four questions, each with a numeric or categorical, and optional response section, and an area for additional comments.

Responses for the first two questions from Questionnaire 2 and the second question from Questionnaire 3 are shown in Table 4-8 below.

Table 4-8 Summary data Questionnaires 2.1, 2.2 & 3.2

How did you find using the LessonLab software…	Very difficult	Little difficult	Okay	Quite easy	Very easy
"… the first time" (Q2.1)	2	2	2	3	2
"… after using it a few times"(Q2.2)	0	2	0	3	5
Using the LessonLab software by yourself was (Q3.2)	3	1	2	3	1

From Questionnaire 2, participants were evenly spread from *very difficult* to *very easy* the first time they used the software. After extended use, 80% were in the two top intervals, *quite easy* or *very easy* with half the group in the top rating. Two participants (20%) still had some difficulties. Only three comments were written for these questions, only two were relevant "At times I was unsure as to what section to do next" (Q2.1.P.1.3) and "Some problems with saving file" (Q2.1.P.1.5).

Question 2 from Questionnaire 3 reflects the experience of participants setting up and accessing the software remotely by themselves. Seven participants added comments to the question, five indicating problems. Four of the problems involved video – two caused during the installation of the software Real Player® onto computers - one ongoing due to the network provider (Q3.2.P.1.2) (a problem evident with later users) and the other solved by a colleague (Q3.2.P.1.4), while the other two had ongoing problems playing the video (Q3.2.P.1.6&9). The other problem was with the Java script and was solved by the participant holding down the control button when pressing the mouse (Q3.2.P.1.5). One participant found the colour of the NEXT button too light (Q3.2.P.1.8). The other comment was from a participant who helped others solve problems getting online and found that the email function in the software was very useful for this purpose (Q3.2.P.1.3).

Related to the remote access of the software was the help participants required, question 3 of Questionnaire 3. Table 4-9 indicates that 7 of the 10 respondents in Pilot 1 did require some help.

Table 4-9 Questionnaire 3.3

Did you require help using the LessonLab software outside of the pilot sessions. (Q3.3)	Yes	No	Other
	5	3	2

Only three participants added comments, two indicating they phoned for help – one after 10 pm – and had to leave messages on the answering machine, and the third emailed for help. However comments for question 2 above are also relevant to this question.

Although the majority of participants did require help using the software remotely (Q3.3) and three found this experience very difficult (Q3.2), it was a positive sign that, after using the software for a few times, eight respondents found it quite or very easy and the other two found it 'a little difficult but not too bad' (Q2.2) (see Table 4-8).

4.4.3 Content and pedagogy

Cycle 1 was the first opportunity for the content and pedagogy team to observe the reaction of educators, unfamiliar with the TIMSS Video Study research and lessons, as they worked through the course. The team was interested in the appropriateness and level of the content including the selected research findings and the mathematics; the engagement and reaction of participants to the lessons and associated tasks; the effect on participants' analytical skills of working through three video cases; the transfer to participants' own practice; and the length of the course.

The following discussion will incorporate these points noting areas that worked well and others where problems were identified and refinements planned and implemented.

4.4.3.1 Task 1 – first reactions to the lessons

Both observers noted that, during the time the participants worked on the online task 1, *Getting your feet wet* (4.4.2.3), they were very absorbed while watching the videos. "Teachers were very engaged in the activity, basically the only questions teachers had were technical ones". "Some teachers found themselves laughing out loud to parts of the video". "…some teachers were working out question 1 using computational methods". (O.1.P.1)

As the participants moved from the computers to the tables for the group discussion, the researcher (M2) talked to one of the participants:

```
00:54:52:02 M2    How did you find it?
00:54:53:04 T     Well, you know, I was looking at the
similarities and differences at the end.  That was an
interesting question,
```

```
00:54:58:17 T     because working with the whole class
(inaudible) versus really working with individual students,
that was a style of two different countries.
00:55:08:12 T     ...I think I could reflect more and get
more from it (inaudible)
00:55:15:19 M2    Yeah.  And how did you find using the
software?
00:55:19:24 T     Oh, the software.  Yes.  Oh, I loved
(inaudible) the styles.
00:55:26:03 T     And I- I had to adjust from reading the
script where they weren't speaking English.  You know?
00:55:35:21 T     And to actually listen, because I- I would
often not look.
00:55:39:28 T     I would just watch the class and the
interactions and listen, except when (inaudible) to read the
script (inaudible).
00:55:48:00 T     So, I didn't- I didn't feel like I got to
observe as much of what the students were doing.
00:55:52:22 M2    So you probably need a couple of viewings
or something where you can-
00:55:55:00 T     Yeah, so it would help me, because then I
would kinda know where- where they were heading.
00:55:58:23 T     Because I like to watch the interaction and
what's the response of the student, because that helps me to-
00:56:04:04 T     to look at the teacher as well.(V.1.P.1)
```

The participant above discussed the experience of looking at very different classrooms and then moved on to the challenge of watching the video while needing to read the transcript for the translation. It was noted that multiple viewings may be necessary to get maximum benefit from the experience. The video cases that follow in the course are designed around multiple viewings by first exploring and then analyzing the lessons.

The responses to the online questions of the task varied in depth and length as shown by the following comments on the teacher's goal(s) and emphasis of the Australian lesson.

> The teacher is giving the students a direction in finding the relationship with the given amount of block. She wants the students to demonstate their knowledge of differing ratios(00:09:04 TIMSS-R Video Study Mathematics - Australia P...) (T.IE.5.P.1.6)

Participant 6 above, had provided a minimal response while participant 11 below had been more expansive including direct quotes and comments on the pedagogy.

> First, she is checking understanding of concept of ratios by using manipulatives to visualize the concept of ratio Secondly, she taught the dividing process in ratio development Then, she worked on literacy in math by writing the problem in English or words. Constantly clarifying and checking for understanding. I like the process of constant concept clarification with numerous activities. She modeled the correct way to write ratios. The affective domain of each student is kept positive by her statements of "You're getting it" or "It is easier now" "You got it right" Constantly checking their conceptual understanding of ratios; checking their

> understanding of how to divide different numbers into to ratios; excellent questioning for student understanding; always starting from small numbers for the concept development and transferring the concept to larger numbers; I really like the literacy, language development of wrti (T.IE.5.P.1.11)

Again for the Hong Kong lesson participants 1, 2 and 7 showed very different levels of reflection on the clips watched.

> (00:01:55 TIMSS-R Video Study Mathematics - Hong Kong S...)Teacher is attempting to make the connection between prior learing and new material (T.IE.5.P.1.1)

The response above showed little thought whereas participant 2 below addressed the mathematical content, made connections to other mathematics and discussed the teaching pedagogy including the use of the chalkboard.

> The teacher explained the basics of squares in order to establish a base for all. With this knowledge added to a sequence of steps she was trying to get the students to transfer their knowledge to other similar problems with squares, including the adding of a variable. The chalkboard was used as a medium of teaching with the complete questions written on the board as an aid for students who would need the visual. This gave them a reference point and help with transfer to other similar problems. The teacher did the questioning and students the answers. Students did not pose questions at this point (T.IE.5.P.1.2)

Participant 7 commented on student behavior that obviously differs from his/her own experience. The response included three video markers with accompanying comments within the set clip time. The final observation of students remaining seated indicates that the participant had watched beyond the set clip, but this does not necessarily mean that the whole lesson has been viewed.

> (00:00:56 TIMSS-R Video Study Mathematics - Hong Kong S...)student stands to answer lesson: squaring numbers many ways to write answer student go to baord introduced algebra (variables with something they know (root of nine = a) writing an equation (00:07:21 TIMSS-R Video Study Mathematics - Hong Kong S...)at this point i think the lesson objective might be learning to write variable equations (00:09:18 TIMSS-R Video Study Mathematics - Hong Kong S...) I still don't know the clear objective of the class all students stayed in their seats when the bell rang (T.IE.5.P.1.7)

Question 5 of task 1 asked participants to compare the four lessons:

> What are the major similarities and differences that you noticed among the four lesson clips you watched? Now that you have watched the opening segments of lessons from four countries, what have you noticed? (T.IE.5)

Although not all participants had responded online, this was discussed face-to-face providing the opportunity for the researchers to hear participants' reactions to watching the lesson segments as well as reading their individual online responses. As anticipated, some participants did relate what they saw back to their own classrooms.

```
00:01:27:10 TN    I think that one of the things that I liked
about it is that they have the same behavior issues that we
would have.
00:01:33:15 T     The not doing the homework, the not
listening to the teacher, the- the playing with the
camera.(V.1.P.1)
```

This conversation was very similar to the online response from participant 6:

> The students are the same every where it is nice to see that teacher every where have the same homework, behavior issues, and and time constrants.(00:06:56 TIMSS-R Video Study Mathematics - Netherlands...) (T.IE.5.P.1.6)

In the Australian lesson the teacher's use of manipulatives moved the participants onto talking about students' individual learning and involvement. After the discussion below, the participants also mentioned that the manipulatives gave the teacher a means to quickly check each students work and provided a link to more difficult problems in the topic.

```
00:03:53:02 TN    I liked the Australia one because it looked
like to me that the students were actually experiencing a
learning on their own,
00:03:56:28 T     without the teacher just saying, here's the
answer or do this kind of problem.
00:04:01:00 TN    They all have their Manipulatives and they
were trying to come up with-
00:04:03:15 T     well, what happens- it didn't add up to
twelve or something like that, they had to go tracking back
to-and every student was actively involved.
00:04:10:14 T     Where in the other classes, you could have
some student hiding, not knowing the answer, not
participating,
00:04:15:07 T     even though there was a lot of students
raising their hand. (V.1.P.1)
```

The discussion also provided insight into the participants' actions while they watched the video. For example the segment below shows that, although not directed to think about the mathematics of the lesson, the participants had worked to understand the concepts of the problem the students were solving, and had used the lesson graph ("the paper that was our handout") as an aid.

```
00:06:35:29 M     Oh, in the Czech lesson?
00:06:42:14 T     And as I kept thinking, Pythagorean
Theorem, what is she doing?
00:06:45:21 TN    And then I realized-
00:06:47:19 TN    It's the- the diagonals are across-
00:06:48:12 TN    The diagonals are perpendicular and the-
00:06:50:07 TN    Yeah, it took me a while to figure-
00:06:51:16 TN    Trying to figure out the sides based on the
two diagonals.
00:06:53:25 TN    Right.  You've got four right triangles
there that you can use.  But at first, I didn't know what she
was doing.
00:06:58:12 TN    I actually had to use the paper that was
our handout to actually have any understanding of what was
going on in the lesson. (V.1.P.1)
```

While the initial comments concentrated on individual lessons, participants did see some common characteristics and other features that again related to their own areas of interest.

```
00:08:18:29 TN    I noticed that in every- in every lesson
there was the- the mathematical language and there were the
digits that were on the board.
00:08:30:06 T     But that students worked from that, back to
a word problem.   Or from a word problem to- to the
expression.
00:08:38:26 T     That both processes were always there.
00:08:41:09 TN    And because I'm interested in literacy, I
was seeing that the literacy was right there, in that.
(V.1.P.1)

00:08:56:16 TN    It almost seemed to me like in the
Australian lesson and the Hong Kong lesson, she was teaching
to the whole class. Everyone was participating.
00:09:04:03 T     But, in the Czech lesson and the
Netherlands lesson, it was an individual- really an
individualized thing. (V.1.P.1)
```

Similar ideas are seen in the online response of another participant.

> SIMILIARITIES: Students involved in doing the work; concept development and math vocabulary spoken and written; word problems written by most countries Differences: Manipualtives used in Austrailia teacher did the writing; Czech, netherlands some countries focused on students doing the writing (T.IE.5.P.1.11)

The self-paced program shown in the Netherlands lesson resulted in many comments about the students' and teacher's behavior.

```
00:13:01:07 TN    Some of them were on lesson twelve;  Some
of them were on lesson fifteen...
00:13:05:28 TN    They kept saying, "I don't get fifteen."
00:13:06:21 TN    It appeared that- it appeared that it was
whining drone of, I didn't get it either, so, it's okay that
that you don't have it done either.
00:13:07:14 TN    And some had paper and some didn't.
```

```
00:13:13:10 TN    I felt there was a lack of direction in the
last one.
00:13:16:00 TN    And also, you know, he had- I saw several
students saying, "well, I didn't understand."
00:13:22:00 TN    And his response was, well, then you need
to go back to this lesson.
00:13:25:05 T     Why didn't he step back and say, okay, very
quickly let's review-
00:13:27:17 TN    Reteach.
00:13:28:15 T     one or two or three problems, and see if
you can write it down? And follow the proc- you know, the
math procedures.
00:13:34:04 T     And, this way you can look at the other
problems and see if you can apply these procedures to those
problems.  Instead of just saying, figure it out. (V.1.P.1)
```

The four lesson segments, although short, were diverse with enough similarities and differences to generate a rich discussion and prepare the teachers for the research findings and the video cases to follow. In this pilot it was seen to fulfill its role of opening participants, through the medium of video, to a variety of teaching and classrooms unfamiliar on one level but related to one another.

During the evaluation following the face-to-face session (see 4.4), one of the observers raised concerns about the first four questions of the task:

> We should re-visit the questions teachers are asked to answer about the videos. Currently, all the questions are the same – goal of the lesson, what's being emphasized. On one hand, it was helpful to the teachers to have the same question as they got comfortable with watching the videos and posting their comments. On the other hand, I'm not sure that the question was equally effective for all the video segments, especially the Netherlands lesson. (O.1.P.1)

After further discussion, the content and pedagogy team decided to leave the questions asked about each lesson segment the same for the reason expounded by the observer above. The task had fulfilled its roles of simulating the TIMSS Video Study researchers' first viewing of the videos, and of providing participants with the experience of watching a diverse group of unfamiliar lesson segments.

4.4.3.2 Research findings discussion

For this pilot, a group discussion was held on the TIMSS Video Study research findings presented in the course. The moderator showed the graphs contained in the course pages and discussed these in terms of the question asked earlier "Do all high achieving countries teach like Japan?" (V.1.P.1.M) Participants, having seen evidence from the task just completed, knew that the answer was no, and joined in the discussion linking the findings back to their classrooms and to the videos they had just seen.

Discussion on the graph showing the use of physical materials (see Figure 3-12) centered on the Australian lesson they had viewed and just how common it was in Australian lessons and those of other countries. Talk on the categories ‘public demonstration’, ‘private work’ and ‘student presents’ linked the research findings graph, the lesson graphs and the video segments watched. Participants keenly discussed the research finding of a high level of private work in the Netherlands also evident in the lesson segment.

In the discussion on problem solving being a common feature of all mathematics’ lessons, the moderator talked about the problem types identified in the research (see Figure 3-14 and Figure 3-15). Two participants related the findings to what they had read about the previous study in the book *The Teaching Gap* (Stigler & Hiebert, 1999).

```
00:27:31:06 TN    And then the teaching gap, it did talk
about the fact that- that how they- do this- the- the
concepts, and using the concepts.  Procedures.  (V.1.P.1)
```

The moderator continued the discussion on how the problems change when they are worked on publically, even to the point of needing a new category. Participants recognized this in their own teaching.

```
00:28:51:17 M     So, this graph shows the problems and how
they were classified, when they were worked on publicly.
00:28:58:19 M     And then they gave a fourth category called
giving results only.
00:29:02:13 M     Because, sometimes teachers reduce the
public discussion to just giving an answer.
00:29:07:26 M     So, that was a fourth category added for
the public discussion that wasn't part of categorizing.
00:29:12:24 M     So, here's the graph of how that
transformed.
00:29:18:29 TN    Oh, I fell victim to that.
00:29:19:11 TN    The U.S.
00:29:20:00 TN    Us and- Us and the Australians are giving
the answers away quite a bit.
00:29:25:23 TN    Not that we're far behind.
00:29:28:05 TN    That's what I'm saying.  We're the only two
that fall in that direction.
00:29:29:18 TN    And I fall victim to that just about
everyday.
00:29:32:16 TN    Just give me the answer.
00:29:33:00 TN    Well, I do it to self-correct.
00:29:36:11 TN    You know, I have the children self-correct
their homework by,
00:29:37:00 TN    Right.
00:29:38:00 TN    you know, either putting it in an overhead,
so they can self correct-
```

```
00:29:42:14 TN    Discussing them out loud.
00:29:43:20 TN    You know, more than anything.  Because I
can't grade- I can't correct- actually, physically correct a
hundred pieces of paper everyday.
00:29:52:03 T     And then do a test, and then do quizzes,
and plan. (V.1.P.1)
```

An observer notes that this discussion did not always stay on track and, instead, the participants:

> Got distracted with discussing the large number of students in HK class (around 40). They wondered how many students a teacher has for the whole day and how they check student work for that many students. Not much discussion about what a "making a connection" problem was or that US teachers start with a fair number of those kinds of problems, but then reduce them to lower-level problems.
>
> Questions/comments on class schedules, national curriculum, standards, textbooks, education and respect of teachers (O.1.P.1)

At this point the team was generally satisfied with the content on the research findings. Links were seen between the *Getting your feet wet* task and the findings and also between the participants' teaching experiences and the findings. Participants also recognized similarities and differences between the different countries participating in the study.

However, the lack of discussion about the "making connections" category and the implications of reducing this was a concern to the team. While the discussion above showed that participants recognized that they often reduced such problems, questions arose on whether or not, having worked through the course, they would recognize such actions in others and be able to suggest possible changes.

4.4.3.2.1 **Refinements – Reflections: making connections**

A new topic was added to the end of the course to provide the opportunity for participants to apply some of the analytical skills developed through the three video cases. It was also expected to reinforce some of the TIMSS Video Study research findings discussed in the *TIMSS Video Study Up Close* topic. The content and pedagogy team anticipated that this would also be a place where participants could reflect and share implementations in their own practice but this was not added at this stage.

Feedback in the post-course questionnaires had included the wish to see "American teachers from parts of U.S.A" (Q2.14.P.1.1) and "See an American study"

(Q2.14.P.1.10). In the design phase the team had recognized that course users may have expected a US lesson to be included but the design of the course did not facilitate this option. For these reasons, and since on overall objective was to link back to participant's own experiences, this was seen as an ideal opportunity to use a clip from a US public-release lesson. The following task was added:

Table 4-10 Reflections Task 1

T_R.1 Task Reflections: Making connections problems revisited	
Cycle 1 Original	**None**
Cycle 1 Refined	**Implementation Making Connections problems** In this U.S. lesson the teacher presents a problem to the class: *"You have an after school job. You make seven dollars an hour. But this week, you're busy, you can only work two hours. But, next week you can work ten. So I am going to put up here on the board, seven dollars h."* After a few clarifications, the teacher asks the students the following question: *"Say that job that I have represented up here. You get a raise. You now make seven fifty an hour. How will that change?"* • Watch this segment of the lesson: (00:00:27-00:03:30 TIMSS 1999 Video Study Mathematics - US Publi...) **Write a brief analysis of how this problem is taught in the classroom. How would you change the lesson?**

4.4.3.3 Case 1: Japan – Introduction to the problem

In line with the design principle of providing the opportunity for participants to explore subject content, Case 1 started with participants being asked to solve and post solutions to the first problem:

> It has been one month since Ichiro's mother entered the hospital. He has decided to give a prayer with his small brother at a local temple every morning so that she will be well soon. There are 18 ten-yen coins in Ichiro's wallet and just 22 five-yen coins in his younger brother's wallet. They decided to place one coin from each of them in the offertory box each morning and continue the prayer until either wallet becomes empty. One day they looked into their wallets and found the brother's amount was bigger than Ichiro's. How many days since they started prayer? (T.JP.I.1)

The demographics (see 4.4.1) led the team to believe that participants would not have any difficulties with the year 8 problem. However this was not the case as noted by an observer:

> Teachers went to computers and read the Japanese word problem online. A few teachers were obviously flustered immediately. Some didn't understand the problem and said there was missing information. A variety of solution strategies

were used by the teachers: manual counting (2), chart (5), and at least one equation format (4). (O.2.P.1)

The transcript of the video of the session shows some of the confusion and the search for irrelevant information seemingly due to the participant not understanding the problem.

```
00:24:44:09 T     And then I looked at the month and I'm
thinking: Is it 30 days, or 31 days, or 28 days?
00:24:49:16 M1    Yeah.
00:24:50:27 T     You know?
00:24:52:27 T     Is their calendar like our calendar?
(V.2.P.1)
```

The conversation below, between two participants, highlights the confusion between number of coins and their value.

```
00:25:27:17 TN    When you have 22 times five (inaudible)
which is, um, 110.
00:25:34:26 TN    They're each putting one in?
00:25:36:17 TN    Right, they're each putting a coin.  So
each coin is worth one boy's coin for ten and one boy's coin
for five.
00:25:43:18 TN    But why does that matter.  Why does that
matter if they're putting one (inaudible). (V.2.P.1)
```

The first participant explained in detail why it does matter and as the discussion finished a cultural misunderstanding is revealed.

```
00:26:49:21 T     I see what you do.  Okay, the step that I
didn't do was the multiplying by ten, right?
00:26:55:26 TN    Right.  Cause I don't know what a yen is,
but ten yen I figure it's- that is multiplied by ten,
(inaudible) it started out with ten-
00:27:02:21 TN    So I was taking this literally.
00:27:04:20 TN    Right.  (V.2.P.1)
```

In the Japan lesson video the students present on the chalkboard five ways to solve the problem – manipulatives or trial and error; table of amount left by days; differences (5 yen per day); simultaneous equations; and inequalities. The participants' online solutions to the task question were coded for these five methods (M1 - M5) and a category for any other method (M7). Incorrect solutions or misunderstandings were also coded. The following table summarizes the findings.

Table 4-11 Task: Introduction to the problem Japan Q1 coded responses

Method	M1	M2	M3	M4	M5	M7
#Participants	4	2	0	0	2	3
#Errors	2	1	0	0	1	3

It can be seen that only four of the eleven participants got the correct solution. Five of the posted solutions are included below.

1. 15 Guess and check (T.JP.I.1.P.1.1)

2. Let "n" be the number of days the coins were donated. 18-n equals the number of days Ichiro gave, and 22-n equals the number of days the younger brother gave. (18-n) (10<(22-n) 5 Then 180-10n<110-5n Then 180<110+5n Then 70<5n So14 (T.JP.I.1.P.1.3)

3. I had started to simply subtract the number of days that each had given a donation. However, upon review of the instructions I realized that we were to subtract 10 Yen from one side and 5 Yen from the other side, until we came to a point wher the younger brother had more money than Ichiro. I came up with 15 days. (T.JP.I.1.P.1.4)

4. Algebra 18(10) =180 -10 22(5) =110-5 The problem hard to explain. (T.JP.I.1.P.1.5)

5. The problem did not state that the brothers were putting in equal amounts of money every day, just that they would be each out in one coin per day. The problem states that the mother has already been in the hopsital for a month and that the brothers were just starting to give offerings. Solution: Ichiro's brother already had more coins than Ichiro so on any given day the brother would have a larger amount of coins. (T.JP.I.1.P.1.9)

The first solution above used method 1 (M1) and had a correct but incomplete solution. The second used inequalities (M5) but gave the value when the amounts would be equal. The third talked about an initial misunderstanding but then rethought the problem (M1) and posted a correct answer. The fourth recognized that algebra may be involved and had some correct numbers but no solution was reached (M7). The final one showed lack of understanding of the problem and, after repeating most of the problem, used the number of coins rather than their value to find the (incorrect) solution (M7).

The problems and discomfort of participants during the online working period led the course facilitators to add a discussion session at this point.

> A discussion time was added after this activity. It was obvious that the teachers needed to discuss their experience and feelings at this point. (O.2.P.1)

Much like the Japanese teacher in the lesson, the moderator selected volunteers to share their solutions with the group in order of difficulty. Six people indicated they had used tables in their solutions and one showed the solution correctly using the value of the coins. In the discussion that followed several participants talked about their misunderstandings.

```
00:43:51:22 TN    I saw where I made my mistake.
...
00:43:54:29 TN    I didn't make the value the 180.  I just
took the coins away.
00:43:58:19 T     I didn't really pay any attention to the
fact that the ten had a value.
...
00:44:13:25 TN    'Cause it said "amount".  It didn't say
"amount of money"-
...
00:44:37:06 TN    Well I started using: what's their 30 days?
00:44:40:02 T     I mean what is- what is that- what was the
question about the mom being in the hospital for a month?
00:44:47:13 T     And I asked myself well what's a month?  I
mean is it 28 days, 20- 30 days, 31 days? (V.2.P.1)
```

Again this supports the previous observations of misunderstandings from the transcript when the participants were working through the problem, from the observers' notes, and from the individual solutions posted online. Comments captured by the observers during the discussion period reiterate the participants' discomfort with the lesson content task:

- Flustered when she saw the problem. Brought back unpleasant school experience with word problems.
- Three people indicated that they were intimidated by the problem, and even more so by response posting #3
- Not enough information in the problem
- Wanted to see video for comfort zone in order to answer question
- Helpful to know others didn't get it
- Some didn't want to come and discuss it; afraid about not having the answer
- All worked out the solution strategy on paper, but most found it difficult to explain how they solved it when they went to post their responses. (O.2.P.1)

Other methods were demonstrated and/or discussed and the moderator handed-out the focus on content pages from the course. It was noted that the graphing method presented by one participant and included below from the participant's journal (see Figure 4-6), was not included. This was later added to the online content notes.

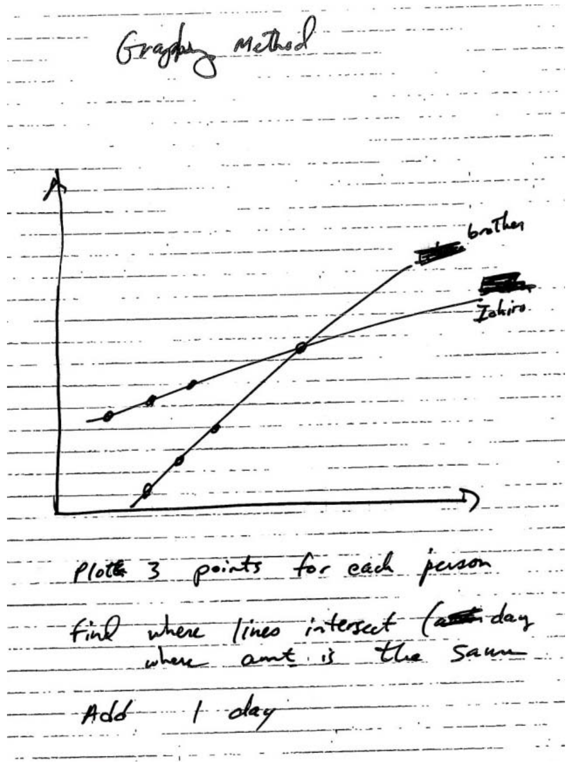


Figure 4-6 Graph solution to JP problem (T.JP.I.1.P.1.10.J)

4.4.3.3.1 **Refinements – Case 1: Japan – Introduction to the problem**

The following excerpt from one of the observers about the problem experienced by the participants during the content task, succinctly summarises the discussion by the implementation and content and pedagogy teams after the pilot:

> While observing the teachers and their subsequent discussion, I initially believed that it would have been better to present this word problem by allowing the teachers to view the video section where the Japanese teacher explains the problem to his students (along with having the word problem available in print), and then the teachers could at that point try to solve the problem. Viewing the video would have alleviated a lot of the confusion over the word problem's meaning as well as much of the sometimes severe panic about not being able to solve the problem or not finding the correct answer. However, that anxiety actually enhanced the next section and allowed them to appreciate the teacher's presentation of the problem in a very visual manner. Although the teachers did not pick up on this, I think an easy parallel could be made with how they felt and how many of their own students feel with working through a word problem without any visual or verbal cues. A discussion posting could be added after viewing the first five minutes of the video to discuss how the presentation of the problem in this manner helped the students' understanding of the problem and met a variety of multiple learning styles. But getting to my first point, I am still unsure whether the initial anxiety is worth the appreciation that occurs in the next part of the course, especially when this course is completed completely online. We don't want to alienate and frustrate some of the teachers to the point that they either don't continue with the course or they have lingering negative feelings about the course. (O.2.P.1)

After weighing up the advantages and disadvantages of having the participants view the video as part of the task, it was decided to ask participants to try the problem before seeing the video but then have them watch it before submitting their solution online. The old and new wording for the task is shown in Table 4-12 below. Participants are initially given the problem to solve on the course page before they open the task window and watch the video clip of the teacher presenting the problem. This catered for totally online, facilitated or non-facilitated, and blended face-to-face and online implementations.

Table 4-12 Case 1 Japan Task 1

<table>
<tr><th colspan="2">T_JP.1 Task: Introduction to the problem: Japan</th></tr>
<tr><td>Cycle 1
Original</td><td>1. Solve the problem.
What solution did you get for the Japanese lesson problem? What strategy did you use to get this solution?
Here is the problem again.
"It has been one month since Ichiro's mother entered the hospital. He has decided to give a prayer with his small brother at a local temple every morning so that she will be well soon. There are 18 ten-yen coins in Ichiro's wallet and just 22 five-yen coins in his younger brother's wallet. They decided to place one coin from each of them in the offertory box each morning and continue the prayer until either wallet becomes empty. One day they looked into their wallets and found the brother's amount was bigger than Ichiro's. How many days since they started prayer?"
2. What other strategies could be used to solve the problem?
Describe other methods you think eighth-grade students might use to solve the problem.
3. Identify the solution strategy you think the teacher had in mind when he selected the problem.
Refer to the strategies you described in questions 1 and 2.</td></tr>
<tr><td>Cycle 1
Refined</td><td>1. Post your solution to the problem
Before you post your own solution to the problem, watch the teacher present the problem to the class by clicking the following link:
(00:01:14-00:04:55 TIMSS 1999 Video Study Mathematics - Japan Pu...)
Does this change your initial understanding of the problem?
Check your solution, and when you are ready, submit it by clicking the POST RESPONSE button below. Include a brief explanation of the strategy you used to solve the problem.</td></tr>
</table>

The other refinement that can be seen in Table 4-12 is that questions two and three have been removed. The main reason for this decision was the need to cut down course content to be within the time limit of ten hours for the course. Nine of the participants in Pilot 1 answered question two and eight answered question three but overall the responses did not elicit as many new ideas as expected.

4.4.3.4 Case 1: Japan – Exploration

The second task, *Exploration Japan*, was the first opportunity for participants in Cycle 1 to see the lesson. Question 1 of the task provided a guided exploration through the lesson and participants were asked to mark and comment on points they found interesting. Question 2 linked Task 1 to this task by asking participants to compare their solutions to the problem with those presented by the students in the lesson. The final question provided the opportunity for participants to link the lesson to their own classrooms by asking what instructional features might work for other lessons.

Overall the participants had few problems with viewing the video and posting responses. Most wrote in the task response window as they watched the video. The average time taken to finish the task was 35 minutes with a range of 28 to 45 minutes. This was an obvious improvement over the first question of the *Getting your feet wet* task where the time range was 14 minutes to 45 minutes (average 30 minutes). Looking more closely at the online responses, it was noted that all eleven participants completed question 1, seven completed question 2, and six completed question 3.

Using the coded data for the task, as described previously in 4.3.3.1, seven of the eleven students included video links (codes V1 or V2) to the lesson in their responses. Three of these had three or fewer links while two had more than 20. Table 4-13 below shows a selection of the codes for question 1 of the exploration task. The number of words, #Words, excludes the video time links; #Codes are the total number of codes for the question; P2 is an observation of teaching pedagogy with discussion; P4 is a pedagogical critique or value judgment; and V2 is a video marker with explanation. It is interesting to note that participants 10 and 11 who had the most extensive and detailed responses to question 1 as shown in the table, did not answer questions 2 and 3.

Table 4-13 Selected codes from Pilot 1 Task Exploration: Japan Q1

Participant	1	2	3	4	5	6	7	8	9	10	11
# Words	111	159	95	112	122	159	96	62	149	318	478
# Codes	8	11	9	7	14	14	17	18	21	74	67
# P2	4	8	3	3	3	5	2	3	9	14	11
# P4	0	0	0	1	0	3	0	3	0	4	9
# V2	0	0	0	0	1	0	9	7	2	22	21

As the task name suggests this exercise was designed for participants to look generally at the lesson before analyzing it more deeply in the next task. For the participants in this pilot, it was the first time they had seen the teacher present the problem after they had solved it in its written form. Although the participants had shared a variety of solution strategies for the problem, they had not covered the five methods presented by the students in the lesson. The participants had seen the opening of lessons in the *Getting your feet wet* task but this was the first time they had watched segments of a whole lesson.

The teacher's presentation of the problem is commented on at different levels. Participants 2 and 4 provided a basic description of the presentation, both emphasizing the visual aspect.

> The teacher gives each student a copy of the problem then proceeds with a visual of the two boy's wallets and a coin box to visually explain the format of the problem. He shows the total amount of coins for the first two coins put into the coin box as they are removed from the wallets. (T.JP.2.1.P.1.2)
>
> Then when he used coins on the board to help the students visualize what they were going to do. (T.JP.2.1.P.1.4)

Participant 7 provided video markers with very brief reactions to the materials used by the teacher, while participant 9 provided a possible reason for the presentation.

> (00:02:38 TIMSS-R Video Study Mathematics - Japan Publi...)great manipulative (00:04:07 TIMSS-R Video Study Mathematics - Japan Publi...) that box is great (T.JP.2.1.P.1.7)
>
> The teacher realized that the question was difficult to understand so he brought put visual aids to help students and even demonstrated. (T.JP.2.1.P.1.9)

Participant 10 further linked the video to the US experience commenting on some of the cultural differences.

> (00:01:59 TIMSS-R Video Study Mathematics - Japan Publi...) The class starts with the students in the class and the teacher passing out materials before the bell has rung!! When the bell rings, the students all rise. Then the teacher begins class officially and reads the math problem of the day. All the students have a copy as the teacher reads the math problem to them word for word. (00:02:22 TIMSS-R Video Study Mathematics - Japan Publi...) The teacher places material of some type on the board so that students can understand the problem visually instead of just orally. The teacher leads the students as a group through the problem so that they all understand the dynamics of the problem. (T.JP.2.1.P.1.10)

Participants were directed to several points in the lesson where the students work privately and the teacher walks around the class encouraging and challenging students and selecting some to present their solutions. The presentations of the five solution methods by the students were commented on in most of the responses. Participant 2 recognized the significance of the order of the presentations while participants 8 and 10 noted the teacher’s preparation.

> The selected students are then called to the board in it seems like an order of the levels of solutions that the teachers was sequentially presented to the other students. (T.JP.2.1.P.1.2)
>
> Different methods are presented by the students to the class.(00:31:25 TIMSS-R Video Study Mathematics - Japan Publi...) The teacher seemed very well prepared - having "signs" ready made to label the various methods used by his students. (T.JP.2.1.P.1.8)

Participant 10 also talked about the use of the chalkboard and the teacher’s strategies including how he acted more as a facilitator to promote student thinking. At the end of the response the participant interpreted the pedagogy and why it seemed to work with the students.

> The teacher already has materials ready to put on the board...He has anticipated students' strategies and supplements the learning that is being explained to the class ... (00:24:46 TIMSS-R Video Study Mathematics - Japan Publi...)A third solution is offered and the teacher has the student present on the board in a particular spot. The teacher helps students in the class organize their thinking after each solution is finished... ...Again the teacher's role is as a facilitator... (00:29:07 TIMSS-R Video Study Mathematics - Japan Publi...)… Finally the teacher introduces the inequality which is the actual lesson. This strategy is excellent because the students are "set up" to work hard and inefficiently and then the final solution shows that algebra can be used as a shortcut. (T.JP.2.1.P.1.10)

The segment below from the response of participant 11 shows understanding of the teaching pedagogy of the lesson. The use of upper case letters emphasized a very positive reaction to the lesson, shown here and in the discussions that followed.

> Presenting so many ways to solve the same problem validates everyone's thinking as well as stimulates other processes for children who otherwise see one way... Students are using their own oral language to explain the solutions at which they arrived (00:24:40 TIMSS-R Video Study Mathematics - Japan Publi...) For something to truly said to have been learned, it must be worked through in terms of oral language. That of the learner, not the teacher.(00:26:17 TIMSS-R Video Study Mathematics - Japan Publi...) Time is not the issue. It is the student learning that appears as the issue. (00:27:07 TIMSS-R Video Study Mathematics - Japan Publi...) The teacher progresses from a visual solution to the more difficult solution using the algebraic solutions. Students can learn a progression of thought as they view the solutions of different students.(00:28:51 TIMSS-R Video Study Mathematics - Japan Publi...) I like the way he labels the problems as they work naturally through the solutions. Inequalities was introduced at the time of the student discovery. GREAT!!!!(00:31:18 TIMSS-R Video Study Mathematics - Japan Publi...) POWERFUL TEACHING STRATEGY!!!!!!! By waiting to the

> point of discovery and the natural progression of less difficult to difficult thought processes, students were ready to understand 'inequalities'. This is an easier more efficeint way to work to mastery. (00:34:01 TIMSS-R Video Study Mathematics - Japan Publi...) ... By choosing carefully the students to present their work, he has set up an environment of trust and willingness to try or share(00:37:43 TIMSS-R Video Study Mathematics - Japan Publi...) Now he is able to present a problem with mathematical language "inequailities" knowing the students have been exposed to the terminology needed to work it. He also left the original solutions and charts for students to look at as they worked on the solution(00:47:58 TIMSS-R Video Study Mathematics - Japan Publi...) He continues to work from concrete to abstract processes(00:48:45 TIMSS-R Video Study Mathematics - Japan Publi...) the process is now rich with mathematical terms.(00:49:38 TIMSS-R Video Study Mathematics - Japan Publi...) working on two problems the entire class period gives the students the idea that mastery is the goal, not just completing the problems. Superior concept development, time usage is appropriate and math is learned. (00:53:15 TIMSS-R Video Study Mathematics - Japan Publi...) (T.JP.2.1.P.1.11)

4.4.3.4.1 **Refinements – Case 1: Japan – Exploration**

Basically the first question, as discussed above, worked very well in the task so only minor changes were made to the wording. The question was directed more at the overall objective of the lesson but the segments viewed remained the same (see Table 4-14).

Pilot 1 responses to question 2 tended to be an extension of question 1 as illustrated in the following segment from participant 2.

> The teacher used visual aids but more precisely than I had predicted. He very carefully and thoroughly put up two wallets and a coin box, then moved coins from each wallet to the coin box to visually set up each student in the process. (T.JP.2.1.P.1.2)

The content and pedagogy team decided that the reflective nature of question 3 was not appropriate in this task as the participants had not been through the analysis task where deeper thinking about the lesson was expected. As a result of these observations, the second and third questions were replaced by a question that was previously in the analysis task (see Table 4-17).

The new question (see Table 4-14) concentrated on exploring the different solutions presented publicly by the students. This was deemed appropriate for two reasons. One, it was a focus of the next task - analysis, and two, it was best explored before the participants read the *Focus on content* section that followed. A link to participants' experience was provided at the end of the question.

Table 4-14 Case 1 Japan Task 2

<table>
<tr><th colspan="2">T_JP.2 Task: Exploration Japan</th></tr>
<tr><td>Cycle 1
Original</td><td>
1. Exploring the Japanese Lesson

Take your time to go through this Japanese lesson. Use the links below as a way to focus your exploration. Think about the different segments of the lesson and how they are sequenced. Mark any points you think are interesting, and write a sentence or two about why you marked these points.
• The teacher starts by beginning class and presenting the problem. (00:00:02-00:02:12 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher then takes students through the problem in a thorough way. (00:02:12-00:05:00 TIMSS 1999 Video Study Mathematics - Japan Pu...)
The teacher walks around to observe students as they work on the problem. This goes on for approximately 13 minutes. Here are a couple of clips taken from this period
(00:08:53-00:09:42 TIMSS 1999 Video Study Mathematics - Japan Pu...)
(00:17:38-00:18:25 TIMSS 1999 Video Study Mathematics - Japan Pu...) .
• The teacher reconvenes the class and calls up several students to share their solution methods. (00:18:34-00:31:19 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher extends the last student's strategy by writing a chart on the board, asking students to fill it in, and summarizing the idea of inequality. (00:31:18-00:45:10 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher presents a second problem, asks students to work on it, and then discusses the solution. (00:46:02-00:53:15 TIMSS 1999 Video Study Mathematics - Japan Pu...)

2. How did the approaches you described for solving the problem compare with those presented by the students?

In the previous task, you were asked to describe the method(s) you used to solve the problem. How did the methods used by the students compare with your methods?

3. What instructional features of this lesson might work for other lessons?

Do you think the way in which the lesson was organized (or other features of the lessons that you noticed) would work for other mathematics lessons? Why, or why not?
</td></tr>
<tr><td>Cycle 1
Refined</td><td>
1. Explore the Japanese Lesson

You have already watched the beginning of the Japanese lesson in which the teacher presents and develops the problem. Now explore the rest of the lesson. Take your time, and use the links below as a way to focus your exploration. Think about the different segments of the lesson and how they are sequenced.

• The teacher starts by beginning the class and presenting the problem. (00:00:02-00:02:12 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher then takes students through the problem in a thorough way. (00:02:12-00:05:00 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher walks around to observe students as they work on the problem. This goes on for approximately 13 minutes. Here are a couple of clips taken from this period
(00:08:53-00:09:42 TIMSS 1999 Video Study Mathematics - Japan Pu...)
(00:17:38-00:18:25 TIMSS 1999 Video Study Mathematics - Japan Pu...) .
• The teacher reconvenes the class and calls up several students to share their solution methods. (00:18:34-00:31:19 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher extends the last student's strategy by writing a chart on the board, asking students to fill it in, and summarizing the idea of inequality. (00:31:18-00:45:10 TIMSS 1999 Video Study Mathematics - Japan Pu...)
• The teacher presents a second problem, asks students to work on it, and then discusses the solution. (00:46:02-00:53:15 TIMSS 1999 Video Study Mathematics - Japan Pu...)
</td></tr>
</table>

	After you have explored the lesson, post a response to the following question: **What do you think was the main thing the teacher wanted students to learn from this lesson?** **2. Describe the five strategies Japanese students used to solve the problem.** In the previous task, you solved the problem and looked at how others solved it. Now you've seen some of the strategies Japanese students used to solve the problem. To review, you've seen strategies presented by: • Daishi (00:18:52 TIMSS 1999 Video Study Mathematics - Japan Pu...) • Etsumi (00:20:38 TIMSS 1999 Video Study Mathematics - Japan Pu...) • Bunmei (00:24:29 TIMSS 1999 Video Study Mathematics - Japan Pu...) • Fujita (00:26:15 TIMSS 1999 Video Study Mathematics - Japan Pu...) • Choshi (00:29:15 TIMSS 1999 Video Study Mathematics - Japan Pu...) **Describe the five strategies used by the Japanese students. Do you think that U.S. eighth-graders would use similar strategies?**

4.4.3.5 Case 1: Japan - Analysis

The analysis task was completed by participants in their own time between sessions 2 and 3. The task, as detailed below in Table 4-17, had seven questions. The content and pedagogy team was always aware that this was too many for the time available for the course, but wanted to see the response from the first cycle before modifying them.

Table 4-15 shows the number of questions answered by each participant for this task. Only two participants tackled all questions, three answered questions one and two, while four of the eleven participants did not answer any questions. The table also shows the total frequency of codes (see 4.3.3.1) for all questions answered by each participant and individual code totals for questions one and two.

Table 4-15 Data from Pilot 1 Task Analysis: Japan

Participant	1	2	3	4	5	6	7	8	9	10	11
Questions	1-7	1, 2	0	0	0	1-4	1, 2	1, 2	1-7	1-5	0
All Codes	33	12	0	0	0	31	15	9	40	59	0
Q1 Codes	6	6	0	0	0	2	8	4	6	23	0
Q2 Codes	13	6	0	0	0	20	7	5	11	12	0

Figure 4-7 and Figure 4-8 below show some comparisons between the exploration task (task 2) and the analysis task (task 3). In Figure 4-7, the graph compares the overall frequency for all codes generated by each participant in response to task 2, question 1 and task 3, questions 1 and 2. These questions were selected as in task 2, question 1 generated 80% (260 of 326) of all codes and in task 3 the figure for questions 2 and 3 was 59% (117 of 199). It should be noted that in task 3, three participants (1, 9 and 10) generated 93% of the other codes (73 of 82).

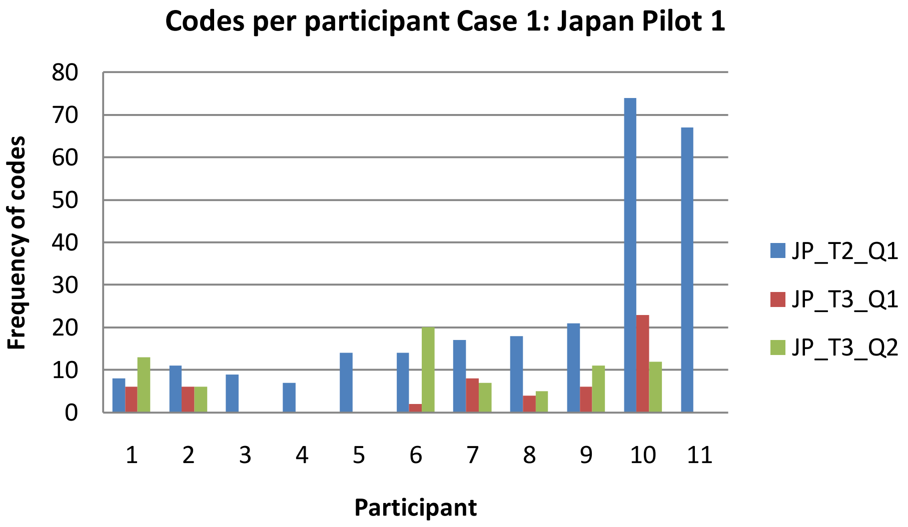


Figure 4-7 Case 1: Japan Pilot 1 data for selected questions Tasks 2 & 3

In most cases participants scored higher frequencies for the exploration task. While this does not necessarily indicate the responses were more substantive, it can be seen on closer examination that many of the responses in task 2 did address, to differing degrees, the questions posed in task 3. For example ten of the eleven participants included reference to the teacher's actions while the students worked privately on the problem, the first question of task 3. The responses of participant 1 to task 2 and 3 below show many of the same ideas, even if reworded somewhat.

> The teacher takes anecdotal records during the private time of the lesson and records which students he feels will be able to present adequate examples in the front of the room for the different types of strategies in solving the problem. He then uses resident experts from the class to help the individual students to solidify their concepts through explination and to put the other students at ease in asking questions. (T.JP.2.1.P.1.1)

> The teacher was taking notes in order to be sure that the students that he called on during the student led public instruction would understand thoroughly as to be able to verbalize their strategies. He also wanted to be able to facilitate the lesson according to the notes that he had prepared previously. The comments that the teacher had for the students appeared to be individual instruction. The comments did seem to build conmfidence for the students in that they all seem willing and ready to present when asked. (T.JP.3.1.P.1.1)

Participant 7 extended the response to task 3 by moving from the mention of one student to many. There is also recognition that the teacher's style avoided coaching but instead used comments to promote individual approaches (however few specific details were included).

(00:17:50 TIMSS-R Video Study Mathematics - Japan Publi...)found a student that had something he thought should be shared and asked him to share with the class and made sure the student would say what he wanted him to.. (T.JP.2.1.P.1.7)

The teacher was roaming to see who was doing the problem different ways. he wanted a solution by pictures, graph, chart, and equation. By roaming he knew what students he could ask to come up to the board and present their unique soluton.

There was no coaching to help them discover different way but comments to help them succeed in their individual approaches.

His comments were positive and helpful to the students. (T.JP.3.1.P.1.7)

The responses to question 2 of task 3, “What were the five solution strategies presented by the students?” were, as could be expected, descriptive. As discussed above (see 4.4.3.4.1) this question was moved to task 2 and the emphasis in this task shifted to analyzing the order of the presentations.

Figure 4-8 compares the frequency of codes measuring pedagogical comments. P2 is coded when the participants observes and discusses teaching pedagogy and P4 when a pedagogical critique or value judgment is made.

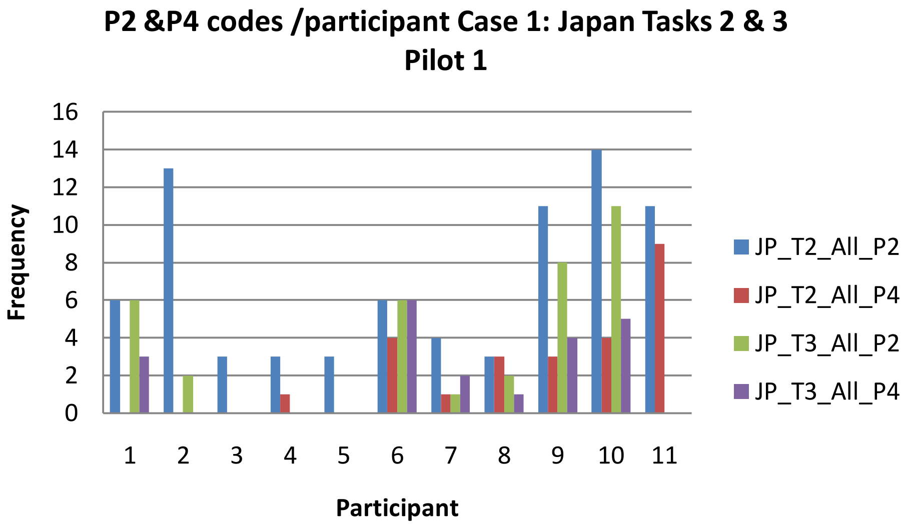


Figure 4-8 Case 1: Japan Pilot 1 P2 & P4 codes for Tasks 2 & 3

Again task 2 outscored task 3 for P2. This indicated that comments on the pedagogy were being made in the exploration task by all participants. P4 increased for some participants in task 3.

Table 4-16 below shows the frequency and percentage frequency of selected codes for all questions answered by participants of Pilot 1 for tasks 2 and 3 in Case 1: Japan. Codes P2 and P4 have been discussed above, S2 measures a reference with discussion to student thinking or understanding and V2 is a video link with discussion.

Table 4-16 Frequency of selected codes tasks 2 & 3 Case 1: Japan Pilot 1

Task	Total	P2	P4	S2	V2	P2	P4	S2	V2
JP_T2_AllCodes	326	77	25	13	63	24%	8%	4%	19%
JP_T3_AllCodes	199	36	21	16	34	18%	11%	8%	17%

Here again task 2 stands out as having far more overall codes embedded in participant answers even though it had three questions compared with task 3's seven. P2 codes occur more frequently, P4 and V2 are closer in percentage across each task while S2 show an increase in task 3 indicating participants are including more comments from the students' perspective.

4.4.3.5.1 **Refinements – Case 1: Japan – Analysis**

Major changes were made by the content team to the questions for the analysis task as a result of the observations and analysis of participants' responses made during Cycle 1. The focus of the questions narrowed and concentrated on the teacher's presentation of the problem and the students' presentation of solution strategies. Question 1 provided the opportunity to reflect on the difference between just giving the written problem and the way the teacher in the lesson used aids to help students understanding. The next question moved back to the solution methods used by the students and the order the teacher had them present to the class. This question included links to previous research on how Japanese teachers plan their lessons and also linked the pedagogy and students' learning. Question 3 addressed the pedagogy again and encouraged reflection on this lesson compared with the more common practice of demonstration/practice, linking both to US classrooms and the research findings discussed previously in the course (Figure 3-14). The number of questions decreased from seven to three (see Table 4-17).

Table 4-17 Case 1 Japan Task 3

<table>
<tr><th colspan="2">T_JP.3 Task Analysis: How the Japanese Lesson Unfolds</th></tr>
<tr><td>Cycle 1
Original</td><td>
1. What did the teacher do during private student work?

Recall that the lesson began by the teacher presenting the problem to the students and then illustrating the problem using concrete materials to ensure that the students understood the problem. The students then worked on the problem privately. During the working time, the teacher moved about the room, making comments and taking notes.

Why was the teacher taking notes? How did he use them?

What kinds of comments did the teacher make to the students? Did the comments suggest ways to solve the problem? Did they lead students to a particular strategy? Did the comments provide encouragement?

(00:08:50-00:09:41 TIMSS-R Video Study Mathematics - Japan Publi...)

(00:17:37-00:18:25 TIMSS-R Video Study Mathematics - Japan Publi...)

2. What were the five solution strategies presented by the students?

You can refer to the notes you took while watching the video earlier to describe the solution strategies of the five students - Watanuki, Kurata, Mochiji, Emi Watanabi and Egawa.

For each strategy shared
• Insert a video marker to show where it starts.
• Describe the strategy.
• Indicate whether the strategy was one you predicted.

The part of the lesson is: (00:18:34-00:44:32 TIMSS-R Video Study Mathematics - Japan Publi...).

You can also use the Text Track below to help find the points.

* You may respond to this Question more than once.

3. Why were the strategies presented in this sequence?

The teacher seemed to know which strategies students would invent based on the summary descriptions of the strategies that he prepared beforehand. He also seemed to have something in mind with the order in which the strategies were presented.

Comment on why the teacher had the students present their solutions in the order they did.

If you thought of a strategy that was not presented by the students, where in the sequence would the teacher have asked you to present your strategy?

4. Did the teacher connect the strategies for solving the problem?

One way in which teachers can help students understand more advanced strategies for solving problems is to show how more elementary strategies, that some students are using, are related to more advanced strategies.

Did the teacher show how the strategies were related? Describe this.

Could the teacher have made additional connections? Describe this

5. Why did the teacher ask students to 'complete the chart'?

After Egawa's presentation, the teacher wrote ($180-10x<110-5x$) on the chalkboard and labeled it "inequalities". The students then had to complete a chart with columns (x, $180-10x$ and $110-5x$) where the range of x was 13 to 18.

In order to follow the teacher's method you should complete the chart yourself.

You may also want to watch the class discussion: (00:41:46-00:44:32 TIMSS-R Video Study Mathematics - Japan Publi...)

What point did the teacher make from the chart?
</td></tr>
</table>

	6. Why did the teacher present a second problem near the end of the lesson? The teacher ended the lesson by presenting a problem that continues the scenario of the first problem: (00:46:02-00:47:27 TIMSS-R Video Study Mathematics - Japan Publi...) Contrast this with the first problem and the expected solution strategy. **7. Did the teacher engage the students in mathematical thinking?** A major goal of this course is to learn how to engage students in mathematical thinking. How do the core problem and the teaching in this lesson achieve this?
Cycle 2 Refined	**1. Examine the teacher's presentation of the problem.** **I**n the Introduction to the Problem part of this case, you watched the teacher present the first problem of the lesson to the students . Look again at how the teacher presents and elaborates the problem. (00:01:14-00:04:47 TIMSS 1999 Video Study Mathematics - Japan Pu...) **How effective is it? How does the teacher's presentation of the problem help students understand the problem, i.e., what is being asked?** **2. Think about the order in which students' strategies are presented.** During the working time, the teacher moved about the room, making comments and taking notes. This allowed him to know which strategies students had invented. Previous research has shown that Japanese teachers attend very carefully to the order in which different strategies are presented. **Why do you think the teacher in this lesson had students present the strategies in the order that he did? How might the order assist students' learning of the content?** If you want to review the strategies, you can watch them again by clicking the links below: Daishi (00:18:52 TIMSS 1999 Video Study Mathematics - Japan Pu...) Etsumi (00:20:37 TIMSS 1999 Video Study Mathematics - Japan Pu...) Bunmei (00:24:29 TIMSS 1999 Video Study Mathematics - Japan Pu...) Fujita (00:26:15 TIMSS 1999 Video Study Mathematics - Japan Pu...) Choshi (00:29:15 TIMSS 1999 Video Study Mathematics - Japan Pu...) Note: You can also use time links in the Text Track below to navigate the lesson. **3. How effective is the method of having students share their solution strategies?** Students in this lesson were exposed to five different methods for solving the problem. Some were quite sophisticated, but others were simple and unsophisticated. **What, if any, are the advantages of having students share their alternative solution methods with the class? Would it have been better to just demonstrate how to write an inequality statement to represent a situation and then use the time for practicing the method? Why or why not?**

A major refinement of the case was the addition of a forum to replace question 7 (see Table 4-17 and Table 4-18). As discussed previously in 4.4, it was planned that the discussions in Cycle 1 would be used to design the content and placing of online forums for Cycle 2. From the observations made at the face-to-face sessions, and feedback from the facilitators and participants, it was agreed to add a forum at the end of each case.

Table 4-18 Case 1 Japan Forum

F_JP.1 Forum Case One: Japan	
Cycle 1 Original	**None**
Cycle 2 Refined	**FORUM: Did the teacher in the Japanese lesson engage the students in serious mathematical thinking?** A major goal of this course is to learn how to engage students in mathematical thinking. How do the core problem and the teaching in this lesson achieve this?

4.4.3.6 Case 2: Hong Kong SAR

As for Case 1, the two equations given to the students at the start of the Hong Kong lesson, 2x+4=x+6 and 2x+10=2(x+5), were given to the participants of Pilot 1 to solve and discuss towards the end of the second face-to-face session. The first equation was generally straightforward for participants although, as with task 1, the mathematics was a challenge for some participants.

```
00:33:53:24  TN    What do you think about those, Debra?
00:33:55:29  TN    Well, there's two variables.
00:33:57:00  TN    No, there's one variable.
00:33:58:04  TN    (Both X on each side).
00:34:00:04  TN    X is equal to ten.  (V.2.P.1)
```

The facilitator asked why the teacher would use these two problems to start the lesson.

```
00:35:00:08  TN    One has one solution.  One has infinite
solutions.
00:35:04:16  TN    Right.
00:35:05:25  TN    Oh, I see.
...
00:35:13:05  M     So how- so which one has a solution?
00:35:16:27  TN    One.
00:35:17:08  TN    My guess is number one.
00:35:18:03  TN    The first one has.
...
00:35:25:19  M     What is the solution to number one?
00:35:27:17  TN    Two.
...
00:35:29:06  TN    What?
00:35:30:10  TN    X is two.
00:35:31:11  TN    Two?
00:35:32:01  TN    Yeah.  It's two.
00:35:33:02  TN    Two times two is four.
00:35:34:06  TN    X equals two?
00:35:38:18  TN    Yes. ...
00:35:39:15  TN    Yeah.
00:35:40:09  M     And how do you know that?
00:35:42:02  TN    Because it solves.
00:35:43:03  TN    Because that's the only one that you're
gonna get eight to equal on both sides. (V.2.P.1)
```

The above discussion shows that some of the participants recognized the basic difference between the equations but with others there was guess work and a general lack of confidence evident. The discussion then moved onto the second equation.

```
00:35:58:06 M     Okay, so then what about number two?
00:36:01:02 TN    Number two is a problem.
00:36:02:12 M     Number two is a problem?  Why is number two
a problem?
00:36:04:12 TN    Because five does not equal zero.
00:36:06:03 TN    Because five does not equal zero?  How did
you get five?
00:36:09:01 TN    Forget it.
00:36:10:03 TN    So is it a set?
00:36:11:01 TN    Where'd you get the five?
00:36:12:01 TN    Do you need a set of numbers?
00:36:13:03 TN    Is it equal to zero?
00:36:14:01 TN    Zero equals zero? (V.2.P.1)
```

The group continued to help one participant work through the problem to a correct solution. The discussion continued on what the solution they have found really meant.

```
00:36:33:02 M     What does that mean?  Zero equals zero.
00:36:35:10 TN    That there is no (inaudible), it's messed
up.
00:36:37:13 TN    No.
00:36:38:06 T     (It's an identity), and therefore it's true
for all X.
00:36:41:13 M     Okay.  So can you- does everybody
understand exactly what Bill said?
00:36:44:11 TN    Well, Mike- Mike said it's all numbers.
00:36:45:17 TN    I just went through a portal somewhere.
00:36:49:28 TN    I don't understand (inaudible).
...
00:36:59:01 T     You have gone way beyond sixth grade math
at this point.
...
00:37:06:09 M     So could you find another way to explain
what it is you're saying?
00:37:10:27 TN    Yeah.
00:37:11:09 TN    Well you have the students come up with
their each numbers because each of them whoever put whatever,
the student puts in there number, it's gonna come out true.
00:37:18:26 T     But you're neighbor is gonna have a
different number than yours.
00:37:21:09 T     And then they're gonna have a different
number.
00:37:23:13 M     Mm-hm.
...
00:37:35:15 T     And that's were you can bring in the fact
that infinite number of- infinite set would be any number you
plug in, you're gonna get-
00:37:41:26 TN    True for all- true for any number you put
in for X. (V.2.P.1)
```

Although one participant mentioned the term identity at the start of the above discussion, it is not referenced again and the discussion that followed showed that many of the participants did not have an understanding of this mathematical concept. The facilitator questioned the participants further.

```
00:37:56:15 M     . . . how could you know that without- can
you try all numbers?
...
00:38:01:29 TN    Well, I think you would try a-
00:38:02:03 TN    (Inaudible) try enough to accept it-
...
00:38:06:27 M     Is there another way to-
00:38:07:29 TN    Guess and check again, huh?
00:38:08:21 TN    Yeah.
00:38:09:14 M     You're gonna do guess and check?
00:38:12:04 M     You say: at 1150 I am convinced.
...
00:38:19:02 M     Well, is there any other way to look at
that equation?
00:38:22:11 TN    You could break it down to where it says "X
equals X".
00:38:25:01 T     Would that help you out? Where it sais X
equals X-
00:38:28:25 T     And then for any X, it would be the number
you plug in for X, you gotta plug in for the other one.
00:38:33:24 TN    On each side.
00:38:35:08 TN    Or it (inaudible) more sense than zero
equals zero, because zero equals zero is gonna fry their
mind.
00:38:40:11 TN    You can say that the expression on the left
side of the equation is equivalent to the expression on the
right side of the equation.
00:38:47:05 M     How do you know that?
00:38:48:29 TN    By using the distributive property.
(V.2.P.1)
```

The discussion continued with mention of fifth grade knowing “distributive, associative, communitive” and then moved to the use of concrete materials to introduce the concept.

```
00:40:01:00 TN    Well I was thinking of another way that you
could- you could do that and you can have some algebra tiles,
and you could set up-
00:40:05:26 TN    Right.
...
00:40:09:18 TN    Kind of like the Japanese teacher had the
bag of coins or whatever and you could have these things that
represent units
00:40:16:23 T     like one, two, three, four, five, six,
seven, eight, nine, ten.
00:40:19:15 T     You could have some other shapes to
represent X's.
00:40:22:07 T     And so you could have two X's, and then you
could have ten.
00:40:25:19 T     And then you could have two groups of these
five and these X's and then you could see that they're really
the both- the same.
00:40:32:24 T     So you wouldn't necessarily need to
understand the distributive property.
00:40:35:03 T     You could just look at the algebra tiles
and you could say "oh-" (V.2.P.1)
```

So, at this point, before the viewing of the lesson, only one participant had mentioned identity but no-one had followed up on the term nor offered a rigorous explanation or proof for the second equation.

This lack of understanding of the concept was seen again when participants discussed the lesson after they had completed the online tasks. The teaching style was very different from that experienced in the Japanese case study. Aside from this, it was the unfamiliarity of the mathematics that was the focus of much of the discussion.

```
00:06:46:15 TN    My ears hurt at the end of the Hong Kong
lesson.
00:06:48:18 TN    Why?
00:06:50:10 T     Just listening and it was confusing- it was
just confusing to me.
00:06:56:01 T     Continuous repetition of words and I wasn't
sure what "identity" meant.  I didn't know what he meant by
expanded form. (V.3.P.1)


00:07:57:28 TN    The LHS and RHS.  I'm going, what is that?
What is that?
00:08:01:11 T     And the only reason I knew is because I
tried to figure it out. (V.3.P.1)

00:08:45:00 T     And also I really- I liked the lesson
because of the fact that I thought that he hooked the
student's interest.
...
00:09:00:12 T     What do you mean zero equals zero?
00:09:03:02 T     You know, so it was a little bit of a hook,
in that, he helped the kids kind of go through it in that.
...
00:09:17:00 T     that identities aren't solved, they're
proved.
00:09:21:05 T     That you could come up with random numbers
over and over again and about the time that you say "oh, it's
an identity",
00:09:25:08 T     that you don't prove it, you're going to
come up with your next trail actually not working in the
equation.
00:09:31:13 T     So it has to be proved, which is I think
the primary focus of his lesson. (V.3.P.1)
```

The discussion below shows that the participant wants to change the method used by the Hong Kong teacher into something more familiar.

```
00:09:47:01 T     One of the things that I would have changed
with that, and we talked about that, is the stacking of left
hand right hand.
00:09:51:22 T     I would have physically made it left hand,
right hand. (V.3.P.1)
```

Although it is difficult to see from the transcript exactly what was meant by the participant, watching the video seemed to indicate that the participant meant developing both sides in equation format, an interpretation supported by one of the observers notes “I think she was saying she would show LHS = RHS rather than two separate things” (O.3.P.1). This is a common mistake that shows a lack of understanding of the difference between solving equations and proving facts about equations.

The above idea is supported by another participant.

```
00:09:55:12 T     Because I've worked my problems, even when
I do them, work them straight down, and-
00:09:59:11 TN    And it would still tie in with the
identity-(V.3.P.1)
```

Segments below, from the online responses of three participants, further illustrate the confusion with the (unfamiliar) concept of mathematical proofs and, in the case of the third segment (participant 7), a lack of understanding of the importance of types of solutions to equations.

> Left /Right hand side has to Match??? (T.HK.3.1.P.1.5)
>
> I think that after watching it again I still really like the the use of L.H.S & R.H.S. however in a modification I would repesent the problem with the same acromyns using them in an left side grid and a right side grid (T.HK.3.1.P.1.6)
>
> I do not see a strong correlatiopn between identifying properties and understanding their solutions are all real #s. If i was going to talk about identities, I would let the class know from the beginning we were going to describe identities and as a extension to the lesson, show them that their solutions were all real #s. I don't see an importance to knowing that some equations have all real numbers. One class dealiing with all solutions and no sloutions to equations, one describing the com. and asoc. property, and one on the distrib prop. is how I would approach it. (T.HK.3.1.P.1.7)

4.4.3.6.1 **Refinements - Case 2: Hong Kong**

The first task of Case 2 was found to fulfill its role of making participants think about the mathematics and the teacher’s reasons for selecting the two equations. Participants completed their responses online between the second and third face-to-face sessions. Only minor changes were made to the explanatory components of each question (Table 4-19).

Table 4-19 Case 2 Hong Kong Task 1

T_HK.1 Task: Introduction to the Problem: Hong Kong SAR	
Cycle 1 Original	**1. Solve the first two problems of the lesson.** The teacher begins by writing the following two equations for the students: 1. 2x+4=x+6 2. 2x+10=2(x+5) Solve the problems and write down your solutions. **2. What point will the teacher make by comparing the two equations?** Why do you think the teacher chose these two equations? What kinds of questions will the teacher ask the students about the questions? What point will the teacher make when comparing the two equations?
Cycle 1 Refined	**1. Solve the first two problems of the lesson.** The teacher begins by writing the following two equations for the students: 1. 2x+4=x+6 2. 2x+10=2(x+5) Solve the problems and post your solutions. **2. What point will the teacher make by comparing the two equations?** Why do you think the teacher started with these two equations and what point will he try to make with them?

Five participants had completed Task 2 before the start of the third face-to-face session, three completed it at the session and three did not submit any responses.

Similar to Task 2 in Case 1: Japan (see 4.4.3.4.1), at the end of Cycle 1, it was decided to remove the analytical aspect of question 3 from this task and concentrate on its basic objective of having participants explore the lesson. As a result, only one question consisting of video time markers that identify key moments in the lesson and two sub-questions, covering the lesson objective and organization, was asked (Table 4-20).

Table 4-20 Case 2 Hong Kong Task 2

T_HK.2 Task: Exploration Hong Kong SAR	
Cycle 1 Original	**1. How is the lesson organized?** Take your time to go through the Hong Kong lesson. You can use the outline and links below to focus your exploration. Think about the different segments of the lesson and how they are sequenced. **Mark any points you think are interesting, and write a sentence or two about why you marked where you did.** 3. The teacher begins the lesson by presenting the problem (00:00:09-00:01:28 TIMSS 1999 Video Study Mathematics - Hong Kon...). 4. The teacher then asks different students to solve each equation, in turn, and asks the class questions about the meaning of the solutions(00:01:28-00:09:07 TIMSS 1999 Video Study Mathematics - Hong Kon...). 5. The teacher focuses on the "special" equation, asks students to check some additional solutions, and discusses their results (00:09:07-00:12:47 TIMSS 1999 Video Study Mathematics - Hong Kon...). 6. The teacher examines the special nature of the equation to see why it has multiple

	solutions, labels it an "identity", and describes how one might prove it is an identity (00:12:51-00:19:24 TIMSS 1999 Video Study Mathematics - Hong Kon...). 7. Students are asked to check whether several additional equations are identities (00:19:24-00:27:00 TIMSS 1999 Video Study Mathematics - Hong Kon...). 8. The teacher summarizes the point of the lesson and assigns some practice problems (00:27:00-00:32:01 TIMSS 1999 Video Study Mathematics - Hong Kon...). **2. How did the discussion of the two equations and the major point made by the teacher compare with what you predicted?** In the previous task, you were asked to predict the kinds of questions the teacher might ask about the two equations and the major point he would make. How did the actual lesson compare with your prediction? **3. What instructional features of this lesson might work for other lessons?** Do you think the way in which the lesson was organized (or other features of the lessons that you noticed) would work for other mathematics lessons? Why, or why not?
Cycle 1 Refined	**1. Explore the Hong Kong Lesson** Take your time to go through the Hong Kong lesson. You can use the outline and links below to focus your exploration. Think about the different segments of the lesson and how they are sequenced. • The teacher begins the lesson by presenting the problem (00:00:09-00:01:28 TIMSS 1999 Video Study Mathematics - Hong Kon...). • The teacher then asks different students to solve each equation, in turn, and asks the class questions about the meaning of the solutions(00:01:28-00:09:07 TIMSS 1999 Video Study Mathematics - Hong Kon...). • The teacher focuses on the "special" equation, asks students to check some additional solutions, and discusses their results (00:09:07-00:12:47 TIMSS 1999 Video Study Mathematics - Hong Kon...). • The teacher examines the special nature of the equation to see why it has multiple solutions, labels it an "identity", and describes how one might prove it is an identity (00:12:51-00:19:24 TIMSS 1999 Video Study Mathematics - Hong Kon...). • Students are asked to check whether several additional equations are identities (00:19:24-00:27:00 TIMSS 1999 Video Study Mathematics - Hong Kon...). • The teacher summarizes the point of the lesson and assigns some practice problems (00:27:00-00:32:01 TIMSS 1999 Video Study Mathematics - Hong Kon...). **What do you think is the main thing the teacher wanted students to learn from this lesson? And, how does the organization of the lesson facilitate this learning?**

The analysis task of Case 2: Hong Kong was completed by all participants, the majority of them at the start of the third face-to-face session. While all participants had been impressed with the teaching in the Japanese lesson, opinions were far more diverse with this lesson. Responses ranged from “This did not seem an effective lesson” (T.HK.3.1.P.1.2), through “… Teacher is giving all answers before students answer any of the problems …”(T.HK.3.1.P.1.5), to “The way the teacher introduces it provokes the students thinking about why they are different and discovering for themselves the differences and how to identify the identities. …” (T.HK.3.1.P.1.8) and “… It appears to me that the teacher has made a connection visible for them” (T.HK.3.1.P.1.4).

This was seen also during the discussion that followed, after the participants had worked on all of the cases:

```
00:12:45:00 TN    See if I were a student, I'd learn better
from the Japanese or the Switzerland ... teacher.
00:12:50:28 TN    Me, too.
00:12:52:13 M     And the reason for that?
00:12:53:19 TN    Well, they just went through some concrete
activities.
00:12:58:10 T     And help- and gave me some real concept of
what those numbers- what the process was. - (V.3.P.1)
```

Refinements at the end of Cycle 1 meant that questions one and two in the analysis task remained with some modifications to the explanation accompanying each question. The third question was removed with the plan that another topic would be added to the course linking the cases to participant's own practice (Table 4-21).

Table 4-21 Case 2 Hong Kong Task 3

T_HK.3 Task: Analysis: How the Hong Kong Lesson Unfolds	
Cycle 1 Original	**1. Why did the teacher introduce identities by presenting two equations?** As you have seen, the teacher begins the lesson by presenting two equations, one that has a single solution (x = 2) and one that yields an unusual result (0 = 0). The teacher did not alert the students that something different would happen when trying to solve the second equation. This prompts a discussion about whether there are no solutions to this equation or whether there are lots of solutions. (View the segment (00:09:00-00:12:51 TIMSS 1999 Video Study Mathematics - Hong Kon...)) Early in your exploration of the Hong Kong lesson, you were asked to comment on this approach. In particular, you were asked why the teacher used these two equations to introduce identities. Now that you have had a chance to view the lesson and read the background information, think again about this question. Can you add to or revise your earlier response? • What are the advantages (or disadvantages) of this approach? In what ways is it more or less effective than defining an identity, showing the students an example, and practising? Would you describe the task of comparing the two equations as a 'Making Connections' task (see earlier presentation of the TIMSS-R Video Stud)? How did the teacher succeed or fail in making mathematical connections visible for students? **2. Why does the teacher emphasize proving that the equation is an identity?** After showing that the second equation has more than one solution, the teacher suggests that one must still prove that the equation is an identity. That is, one must prove that all real numbers will make the equation true. (View the segment (00:12:47-00:19:24 TIMSS-R Video Study Mathematics - Hong Kong S...)) • Why does the teacher emphasize proving that the equation is an identity? What does he hope the students will learn? • What features of this segment promote or undermine students' engagement in

	serious mathematical work? **3. Can some of the features of this lesson apply to your teaching of other mathematical topics?** There are a number of general features of this lesson that make it an interesting case to examine: the way in which the different segments were designed and sequenced; the opening task with the follow-up discussion; the idea of proving that a mathematical claim is true; and the summary of the main point of the lesson. (View the segment (00:27:00-00:27:53 TIMSS-R Video Study Mathematics - Hong Kong S...)). Where in your teaching have you used, or could you use, these or other features that you noticed? Give examples.
Cycle 1 Refined	**1. Why did the teacher introduce identities by presenting two equations?** As you have seen, the teacher begins the lesson by presenting two equations, one that has a single solution ($x = 2$) and one that yields an unusual result ($0 = 0$). The teacher did not alert the students that something different would happen when trying to solve the second equation. This prompts a discussion about whether there are no solutions to this equation or whether there are lots of solutions. (View the segment (00:09:00-00:12:51 TIMSS 1999 Video Study Mathematics - Hong Kon...)) **Why do you think the teacher chose to introduce the concept of identities in this way? And, how effective do you think it is?** **2. Why does the teacher emphasize proving that the equation is an identity?** After showing that the second equation has more than one solution, the teacher suggests that one must still prove that the equation is an identity. That is, one must prove that the equation is true for all real numbers. (View the segment (00:12:47-00:19:24 TIMSS 1999 Video Study Mathematics - Hong Kon...)) **Why does the teacher emphasize proving that the equation is an identity? What does he hope the students will learn?**

A forum at the end of the case was added in line with the decision made after Case 1 (see 4.4.3.5.1 and 4.4.4.2). In this case, the forum links the two lessons studied so far in the two cases, Japan and Hong Kong (Table 4-22).

Table 4-22 Case 2 Hong Kong Forum

F_HK.1 Forum Case Two: Hong Kong SAR	
Cycle 1 Original	**None**
Cycle 1 Refined	**FORUM: Compare the teaching styles of the Japanese and Hong Kong lessons.** The styles of teaching you have seen in the lessons so far are quite different. Why these differences - for example, is the teaching style dependent on the content?

4.4.3.7 Case 3: Switzerland

The online tasks for *Case 3: Switzerland* were completed during the third face-to-face session. Seven participants responded to the first task, *Introduction*; ten started the second task, *Exploration*, with four completing all questions; and nine started the last task, *Analysis*, with all finishing question 1, five finishing question 2, four question 3, one question 4 and nobody answered question 5. Lack of time was the main problem for the group but it was not a surprise to the content and pedagogy team that the number of questions in tasks 2 and 3 was too much of a challenge for the group time-wise.

4.4.3.7.1 **Refinements - Case 3: Switzerland**

The first task on the problem in this case focused on the participant’s practice, asking about their approaches for introducing students to variables. Ideas were diverse and included “… use of a brown paper sack in place of a variable. …” (T.SW.1.1.P.1.1), “I start with a picture of a plug that has a number posted then a letter to each of the two outlets. …” (T.SW.1.1.P.1.3), “… by reminding them of their time in first grade … like 1+_=5 …” (T.SW.1.1.P.1.9) and “This is my second year teaching 8^{th} grade and thought my students have a clear idea of what a variable is.” (T.SW.1.1.P.1.7).

Since the task question did elicit the expected range of responses, the essence of it remained unchanged but the wording was made more succinct (Table 4-23).

Table 4-23 Case 3 Switzerland Task 1

T_SW.1 Task Introduction to the Problem: Switzerland	
Cycle 1 Original	**1. Do you know of approaches that are effective for introducing students to variables? Describe them briefly.** Many algebra teachers have searched for meaningful ways to introduce students to the concept of a variable and to help students understand expressions such as x - z, 4x, and y + 2z. The main purpose of this lesson is to introduce the concept of a variable and to help students understand how to interpret algebraic expressions. The teacher uses physical representations to illustrate variables. Describe an approach that you think might be effective for introducing students to the concept of a variable. Include in your description any physical materials that could be used to illustrate variables. Explain why the materials are helpful representations.
Cycle 1 Refined	**1. Using physical representations for algebraic expressions.** Before watching the lesson, think about how you could use physical materials to represent expressions such as • x - z • 4x, and • y + 2z. **Describe the physical materials that you think would be most useful, and explain how they would support students' understanding of the concept of variable within expressions.**

The second task in Case 3, had three questions for this cycle. Two of the questions required participants to link first, to their responses to the previous task and, second, to their own teaching. The latter relied on participants analysing the lesson which was not expected until the next task. As a consequence, and as with the other cases, refinements made after the pilot resulted in there being only one question focused on a guided exploration of the lesson (Table 4-24).

Table 4-24 Case 3 Switzerland Task 2

<table>
<tr><th colspan="2">T_SW.2 Task Exploration: Switzerland</th></tr>
<tr><td>Cycle 1
Original</td><td>1. How is the lesson organized?
Take your time to go through this Swiss lesson. You can use the outline and links below to focus your exploration. Mark any points you think are interesting, and write a sentence or two about why you marked where you did.
The teacher introduces the idea of computing with directed line segments, and asks the students to work out a second problem. (00:00:23-00:11:19 TIMSS-R Video Study Mathematics - Switzerland...).
The teacher introduces the idea of using colored strips to represent line segments (00:14:22-00:16:51 TIMSS-R Video Study Mathematics - Switzerland...) .
The teacher introduces the idea of using directed line segments to represent variables (00:29:54-00:34:22 TIMSS-R Video Study Mathematics - Switzerland...) .
The teacher assigns practice problems to pairs of students, they demonstrate their solutions at the chalkboard, and the teacher and students discuss each, in turn. Lengths for x, y, and z have been drawn beforehand on the chalkboard (00:34:22-00:42:25 TIMSS-R Video Study Mathematics - Switzerland...) .
The teacher and students read a story problem from the text in which variables represent values associated with objects other than line segments. The teacher assigns the problem for homework (00:42:28-00:45:41 TIMSS-R Video Study Mathematics - Switzerland...) .
2. How did the approach for introducing variables and the physical materials used by the teacher compare with what you described?
In the previous task, you were asked to describe an approach for introducing students to the concept of a variable. How did the teacher's approach compare with your description?

3. What instructional features of this lesson might work for other lessons?
Do you think the way in which the lesson was organized (or other features of the lesson that you noticed) would work for other mathematics lessons? Why, or why not?</td></tr>
<tr><td>Cycle 1
Refined</td><td>1. Explore the Swiss Lesson
Take your time to go through this Swiss lesson. You can use the outline and links below to focus your exploration.
The teacher introduces how to represent a numeric sentence graphically with line segments. He then asks the students to work out a problem (00:00:24-00:11:20 TIMSS 1999 Video Study Mathematics - Switzerl...).
The teacher introduces the idea of using colored strips to represent quantities (00:14:23-00:16:52 TIMSS 1999 Video Study Mathematics - Switzerl...).
The teacher introduces the idea of using directed line segments to represent variables (00:29:55-00:34:22 TIMSS 1999 Video Study Mathematics - Switzerl...).
The teacher assigns practice problems to pairs of students, they demonstrate their solutions at the chalkboard, and the teacher and students discuss each, in turn. Lengths for x, y, and z have been drawn beforehand on the chalkboard (00:34:22-00:42:26 TIMSS 1999 Video Study Mathematics - Switzerl...).
The teacher and students read a story problem from the text in which variables represent values associated with objects other than line segments. The teacher assigns the problem for homework (00:42:28-00:45:41 TIMSS 1999 Video Study Mathematics - Switzerl...).
What do you think was the main thing the teacher wanted students to learn from this lesson? How effective was the lesson in achieving this goal?</td></tr>
</table>

The first two questions of the analysis task concentrated on the participants' understanding of the teacher's use of directed line segments and strips to represent arithmetic equations and later algebraic expressions (see Original, Table 4-25). As mentioned above, nine of the eleven participants answered question 1 and five answered 2. Most responses to the first question illustrated understanding although one participant introduced a variable into the answer "… 2 times 4 = 8x-5 = 3 the variable x …" (T.SW.3.1.P.1.5) seemingly missing the purpose of the teacher's exercise and the task question. One other participant showed some frustration with the technology "I don't know how to do it on the computer. I could do it on the blackboard though." (T.SW.3.1.P.1.3)

Question 3 linked the ideas of the first two questions to the meaning of algebraic expressions. Unfortunately only four participants answered this question indicating that most did not reach the more analytical thinking that was the task objective. Three of the four responses were substantial, based on the transaction from concrete to abstract with one participant adding a comment linking their and other teachers' failure to use manipulatives in this way (T.SW.3.3.P.1.1) and another noting the teacher's recognition of the different levels of understanding within the class (T.SW.3.3.P.1.10).

Refinements to this task basically eliminated questions 1 and 2 and focused on the bigger ideas of the original questions 3, 4 and 5. The revised question 1 analysed the transition from numeric to algebraic expressions, question 2 analysed the next transition to variables and the last question linked back to the "Making Connections" findings of the TIMSS 1999 Video Study (Table 4-25).

Table 4-25 Case 3 Switzerland Task 3

T_SW.3 Task Analysis: How the Swiss Lesson Unfolds

Cycle 1
Original

1. **Using the same procedure as the students, show how they would illustrate the arithmetic equation 2 x 4 - 5 = 3 with line segments.**

The lesson begins with the teacher demonstrating how the arithmetic equation 5 - 3 = 2 can be illustrated with directed line segments (view the segment (00:00:31-00:05:14 TIMSS-R Video Study Mathematics - Switzerland...)). The teacher then asks students to use the same procedure on the equation 3 x 5 - 2 x 3 = 9.

See if you can use the same procedure to show 2 x 4 - 5 = 3**.**

2. **Using the same procedure as the students, show two ways of illustrating the number 19 with the blue and yellow strips.**

In the second segment of the lesson, the teacher introduces colored strips to represent quantities, blue for 5 and yellow for 3. Note that instead of asking the students to represent a particular arithmetic equation, such as 5 - 3 = 2, the teacher now asks the students to represent a number, such as 17. (View the segment (00:14:22-00:16:51 TIMSS-R Video Study Mathematics - Switzerland...)).

Draw two different ways of showing the number 19 with the blue and yellow strips. While you are working on this task, think about the relationship between the first two lesson segments (why did the teacher move from line segments to colored strips, and why did he shift from arithmetic equations to single numbers?)

3. **What features of the first two segments would help students understand the third segment (Introduction of Variable)?**

The third segment of the lesson focuses on the meaning of algebraic expressions, such as x + y - z. The segment comes almost 30 minutes into the lesson, allowing the students to the line segment models in familiar arithmetic situations. (View segment (00:29:54-00:34:22 TIMSS-R Video Study Mathematics - Switzerland...)). What features from the first two segments of the lesson would help students develop appropriate meanings for variables and algebraic expressions?

- As you think about this, consider the following specific questions: What features of the first two segments might help students see that, for example, 3x = x + x + x rather than 3 + x?
- The teacher drew line segments on the chalkboard to represent x, y, and z, and students used these to illustrate their solutions. Would colored strips have been better than line segments? Why or why not?

Do you think the students followed the transition from arithmetic to algebraic expressions? Why or why not?

4. **How could the lesson be extended to emphasize that x, y, and z can be variables?**

The line segments on the chalkboard representing x, y, and z were of particular, unknown lengths. As noted in the earlier Focus on Content discussion, this is one meaning for letter symbols. What follow-up activities to this lesson might help students to see that the letters can assume any values?

5. **How did the design of the lesson and the teacher's actions support students engagement in serious mathematical work?**

The lesson contains a number of mathematical tasks, a number of discussions between the teacher and students about the solutions, and a sequence of activities that moved from concrete and familiar to more abstract and new. There were a number of important mathematical connections that could be made (see the comments on making connections in the earlier pages on findings of the TIMSS-R Video Study).

Identify events or interactions where the lesson supported (or not) the making of mathematical connections. In other words, identify events or interactions where the lesson supported (or not) students' engagement in serious mathematical work.

Cycle 1 Refined	**1. Making the transition from numeric to algebraic expressions.** In the third segment of the lesson the teacher makes the transition from numeric to algebraic expressions, such as x + y - z. (View segment (00:29:55-00:34:22 TIMSS 1999 Video Study Mathematics - Switzerl...)). **Do you think the students followed the transition from numeric to algebraic expressions? Why or why not? If not, what could have made the transition clearer?** **2. Extending the lesson from unknowns to variables.** The letters x, y, and z, which were used to label the line segments on the chalkboard, were treated as if they designated particular, unknown lengths. As noted in the earlier Focus on Content discussion, this is one meaning for letter symbols. Another meaning is that of variables, which could assume any value. **What follow-up activities to this lesson might help students to see that the letters can assume any values?** **3. Engaging students in serious mathematical work.** The lesson contains a number of mathematical tasks, a number of discussions between the teacher and students about the solutions, and a sequence of activities that moved from concrete and familiar to more abstract and new. There were a number of important mathematical connections that could be made (see the comments on *Making Connections* in the earlier pages on findings of the TIMSS 1999 Video Study). **Identify events or interactions where the lesson supported (or not) the making of mathematical connections. In other words, identify events or interactions where the lesson supported (or not) students' engagement in serious mathematical work.**

A forum discussing the three lessons from the cases and the four lessons from the *Getting your feet wet* task was added to the end of Case 3 (see Table 4-26 and also 4.4.4.2).

Table 4-26 Case 3 Switzerland Forum

F_SW.1 Forum Case Three Switzerland	
Cycle 1 Original	**None**
Cycle 1 Refined	**FORUM: What have you learned from watching lessons from different countries?** You have had glimpses into teaching in seven countries in this course. What things stood out for you? What ideas have you discovered for engaging students in serious mathematical work?

4.4.3.8 Summary of content and pedagogy Cycle 1

As mentioned previously in 4.4.2.5, two questionnaires were conducted on the last day of Pilot 1. Question 5 in Questionnaire 2 asked participants to rate each section of the course in terms of interest and usefulness (Q2.5). Five levels of ratings were provided: 5=Extremely; 4=Very; 3=Undecided; 2=Somewhat; and 1=Not at all. Table 4-27 below shows the ratings and mean values (n=11) for each measure.

Table 4-27 Questionnaire 2.5

Course section	Interesting					Usefulness				
Score	**2**	**3**	**4**	**5**	**Mean**	**2**	**3**	**4**	**5**	**Mean**
Introduction		2	7	2	4.0	1	2	7	1	3.7
Initial exploration		1	8	2	4.1	2	0	6	3	3.9
TIMSS Video Up Close		2	7	2	4.0	1	3	5	2	3.7
Case 1 – Japan			3	8	4.7	0	2	3	6	4.4
Case 2 – Hong Kong	2	1	3	5	4.0	2	2	3	4	3.8
Case 3 - Switzerland		1	6	4	4.3	1	1	6	3	4.0

As can be seen in the table above, the majority of participants scored all sections of the course as very or extremely interesting with all means also in this level. The high degree of interest in all sections of the course was very positive for the content and pedagogy team given the challenges faced during Pilot 1 including, for most, the new experience of watching videos of non-English speaking teachers, using online software where individual responses were made available to the group, accessing the technology remotely, and time restraints.

The only ‘somewhat interesting’ score from two participants was in Case 2 – Hong Kong. This was not surprising as generally participants found the pedagogy of the Hong Kong lesson very conservative, and the mathematics more challenging, when compared to that in the preceding case, Japan (see 4.4.3.6). The very high scores for Japan were also not surprising given the task responses, discussions and general positive reactions to the case (see 4.4.3.3 to 4.4.3.5.1).

More of the scores for the usefulness aspect were in the ‘somewhat’ and ‘undecided’ categories and the means were slightly lower (by 0.2 or 0.3), although aligned with the means of the interesting aspect. This may be a more difficult aspect for participants to measure so close to having completed the course and not having had time to consolidate some of the material and see its application to their own practice.

Only four participants added comments to their responses. Two specifically mentioned the Japanese lesson describing it as “interesting and useful” (Q2.7.P1.5) and “awesome” (Q2.7.P1.10), one found similarities in the lessons (Q2.7.P1.3), and the other found the videos very interesting due mainly to “the view that other countries have on education. My students would not appear in those videos” (Q2.7.P1.1).

Question 7 in Questionnaire 2 posed the following question of three critical aspects of the course: “Please indicate the extent to which the tasks helped you in the following areas.” In this question the five levels of ratings were: 5=Extremely helpful; 4=Very helpful; 3=Undecided; 2=Somewhat helpful; and 1=Not at all helpful (Q2.7). Table 4-28 below shows the ratings and mean value (n=11) for each aspect.

Table 4-28 Questionnaire 2.7

Indicate the extent to which the tasks helped you						
Score	**1**	**2**	**3**	**4**	**5**	**Mean**
In understanding the content of the course	0	0	1	7	3	4.2
In learning a framework for the analysis of classroom practice	0	1	1	7	2	3.9
In applying the content to real classroom situations	0	2	0	4	5	4.1

The very positive responses to this question were very reassuring given that the content and pedagogy team recognized from the design stage that the number of sub-questions in most tasks was too onerous in the time allowed for the course. This outcome supported the team’s belief that the online interactive components of the course enabled individuals to achieve a deeper understanding of the lesson content and pedagogy while developing analytical skills that would transfer to practice. The participants’ beliefs that these outcomes were achieved supports the evidence found by the researcher when analyzing the face-to-face discussions and the individual task responses (see 4.4.3.1 to 4.4.3.7 above).

One of the guiding principles of the course was that participants should understand the content of the lessons before analyzing them. Observations about this aspect were discussed previously (see 4.4.3.1 to 4.4.3.7). Question 9 in Questionnaire 2 asked participants “Did you learn anything new about mathematics?” (Q2.9).

Ten participants answered yes for the question and one, no. In the comments only one participant addressed their own learning “Algebra from years passed” (Q2.7.P1.1). The other comments related to teaching mathematics including strategies (Q2.7.P1.2, 4, 11); concrete to abstract concepts (Q2.7.P1.3, 10, 11); student learning (Q2.7.P1.5, 6, 7); and the connections of concepts (Q2.7.P1.8, 10, 11).

4.4.4 Implementation

Since it was necessary to closely monitor the technology and content, Pilot 1 had more face-to-face sessions than it was anticipated would be the case in blended model implementations. One objective for the implementation group was to identify sections of the course best suited to face-to-face sessions within blended models. Another was to consider how a totally online delivery model could support the sharing of observations and thinking within the course.

4.4.4.1 Link to practice

At the end of the second face-to-face session the participants were asked to think about how they could use aspects of the teaching pedagogy of the Japanese lesson in their own teaching. They were also asked to find a rich problem that would be suitable for such a lesson. In the next session most reported back that they had tried this and the rest indicated they had thought about how to do it.

The first participant shared how the students had been asked to teach sections of the lesson. However, it was not clear whether or not the students had worked privately on the work beforehand as in the Japanese lesson.

```
00:02:03:04 TN    I did some adjustments in my teaching.
00:02:11:27 TN    I used for example we were working with
graphs- or function tables, you know, um one that- Chapter
five? …
00:02:26:26 T     And one of the things my ELD kids are have
difficulty is, is making that connection
00:02:31:16 T     between the line plots and moving it into
the frequency table and putting it in and-
00:02:36:16 T     and what I did is I had a few of the
students teach the lesson.
00:02:40:10 T     In the fact that they went up with what- I
gave them the problem, they went up and they taught that
portion-
00:02:46:24 T     that portion using the mean; the medium and
the mode,
00:02:49:20 T     and going through that and doing the whole
table thing.
00:02:52:02 M     How did it work?
00:02:53:01 TN    It went okay.  I mean they're not used to
it.  It was-
00:02:56:18 TN    She kept turning around and wanting me to-
00:03:00:25 TN    But other than that, she was excited to be
at the board using the board. (V.3.P.1)
```

Another participant brought along a videotape of the lesson he had taught. Not surprisingly he found that he had to do more coaching than the Japanese teacher to get the variety of solution methods he wanted.

```
00:03:07:02 TN    Yeah, I did a lesson similar to the
Japanese style lesson that we did.
00:03:13:29 T     It was on proportions.  It was my algebra
class.
00:03:17:29 T     And I set a question up that JoJo, instead
of Ichiro, JoJo read a research study that said that for
every three cigarettes a person smokes, they lose 15 minutes
off their life.
00:03:33:01 T     And she was upset because she has lost two
hours of her life.
00:03:36:16 T     And the question would be: how many
cigarettes has JoJo smoked?
00:03:42:09 T     And then I had them solve it in different
ways.
00:03:46:01 T     And, like he did in the example, I kind of
roamed around.
00:03:49:00 T     I had to do a little extra coaching than he
did.
00:03:51:17 M     Did you?
00:03:53:05 M     In what kind of way-?
00:03:54:05 T     In saying: "why don't you try it this way,
and why don't you try it this way."
00:03:57:03 T     But some people - the majority of them -
did it in a chart.
00:04:01:23 T     A couple of people actually (got it and)
made the picture.
00:04:05:05 T     I had to coach someone into making it into
an equation actually.
00:04:10:03 T     Then we had one that did it into a graph.
00:04:12:07 T     You know, why don't you take this chart and
put it into a graph.
00:04:15:21 T     And they all displayed the work on the
board and then I explained how to solve it as a proportion,
00:04:22:14 T     which was the lesson and the objective I
was trying to get across to them. (V.3.P.1)
```

The teacher had also interviewed several students after the lesson.

```
00:04:26:11 T     Afterwards I- after the whole lesson was
done, I sat down and interviewed about five or six of the
students.
00:04:32:23 T     And I videotaped it, by the way.
00:04:36:25 T     And they for the most part, I'd say
probably 70 percent, 75 percent liked doing it the way that
we did it in class,
00:04:45:27 T     because they liked to show that they know
how to solve one problem several different ways.
00:04:50:29 T     The others that didn't like it,
00:04:53:11 T     they liked the other way of doing where I
give them information and then they have information in their
notes to solve similar problems. (V.3.P.1)
```

The participants selected a range of problems and most talked about how they had introduced them to the class. While in most cases the problems were ‘old’ classics, it was the way the participants introduced them to the class and had students work on them that had changed as in the case above.

```
00:08:20:10 TN    Mike inspired me.
00:08:22:05 T     'Cause he was telling me he was gonna have
cigarettes and a coffin, so I decided I would have two trains
meeting on the track.
00:08:28:07 T     So there you go.
00:08:30:03 T     Did that work?  Did your visuals work?
00:08:32:00 TN    Yeah...(V.3.P.1)
```

The facilitator commented on some aspects that the participants seemed to draw from the Japanese lesson.

```
00:08:56:09 M     So- so it sounds like so the- there are a
couple of things you pulled from.  One is the visualization.
00:09:02:02 M     Visually representing a problem for access;
you talked about that the last time.  And another one is the
multiple ways of solving a problem.  (V.3.P.1)
```

Linking the research to practice was a guiding principle of this resource. The above discussion shows how one aspect of this was achieved by a group using a blended model of delivery. The challenge for the content and pedagogy, and implementation teams was to provide such opportunities for participants who would be taking the course totally online. The content and pedagogy team needed to design online activities that would work with all delivery modes. The implementation team needed to identify ways that facilitators could enhance this new course content in blended delivery models.

4.4.4.2 Face-to-face discussions

Throughout the discussion above on the content component of Cycle 1 (4.4.3), many observations were drawn from the face-to-face sessions. The value of these and the challenge of providing such opportunities for totally online delivery modes were recognized by the observers:

> The teachers are very engaged and interested in the videos and course content. The group discussions have definitely enhanced the learning experience. Teachers are learning a lot from each other as well as from the videos. Having a face-to-face component to the course has really helped to maintain the teachers' interest, as well as to provide a necessary outlet for expressing their concerns, insights, and frustrations. It will be a challenge for the future facilitators of the fully online course to maintain even a fraction of dialog at this level. (O.2.P.1)

In the third session for example, and on many other occasions including during the short segments watched in the *Getting your feet wet* task, discussion returned to the use of manipulatives or concrete materials within the lessons. Below, reference is made to the Swiss lesson but the link is soon made to the participants' own practice and the challenges they experience.

```
00:13:13:21 T     But then, I appreciated when he started
with the strips.
00:13:17:17 TN    That really worked out.
00:13:18:00 TN    And then he actually had them doing the
sharing and the pairing and the thinking with the compass and
those kinds of things.
00:13:23:29 TN    And the color strips.
00:13:24:13 TN    So, yeah.
00:13:25:21 TN    For the kids that need that visual.
...
00:13:31:09 TN    I think that's part of why I liked the
other lesson.  Is because to me, I go, "oh God, those
manipulatives work so well."
00:13:38:22 T     But I get so frustrated trying to take the
time.
00:13:42:01 T     I mean, I see that they're useful and I
know that I need to use them with the kids, but I just go,
"oh my God it's going to take me thirty-"
...
00:13:53:28 TN    I'm like, oh my God.  They're gonna throw
these little pegs; they're gonna do this; they're gonna do
that. (V.3.P.1)
```

One participant had found a way to overcome the challenges.

```
00:14:18:21 TN    I use manipulatives on the video.  And I
video myself with the manipulatives.
00:14:24:21 T     And then I have students just have a
representation where they draw the pictures on their own
paper.
00:14:29:20 T     We don't actually get the cookies out or we
don't get the bars out.  They have to draw it.
00:14:32:29 TN    Right.
00:14:33:12 TN    That way I don't have to pass anything out.
00:14:34:03 T     They're not dropping it on the floor and
the custodian says, hey …, your room's dirty.  And that kind
if stuff. (V.3.P.1)
```

These segments show that participants, when given the opportunity, wanted to talk both about what they had seen and also about their own practice. It seemed that the lessons they watched provided the impetus for them to see new possibilities in their teaching and to look with a critical eye at their current practice.

Later in this session, after participants had finished working on the online tasks for Case 3, the group reconvened to discuss the three cases they had studied.

```
00:18:41:08 M     So if you could think of one thing that you
picked up from these three cases that you would use or have
used.
00:18:51:27 M     Or already are thinking of using in your
own classroom, what would that be? (V.3.P.1)
```

The first response focused on students presenting solutions or leading discussions about the mathematics.

```
00:18:57:07 TN    I'm trying to do the student led public
instruction. (V.3.P.1)
```

The participant talked about the immature attitudes of her students and, as a result, the challenges faced when trying to get such involvement. She talked about the long-term advantages for the students and their teachers in the future if the practice could be implemented. Another participant supported the idea.

```
00:19:28:20 T     And then I watch it from these people that
have obviously had a lot more practice with it than I,
00:19:34:02 T     and it's really something that I want to
try and make work. (V.3.P.1)
…
00:19:52:22 TN    I truly believe, you learn by doing.  And
if they can do it and show- show others, it's going to be
concrete.  It's going to be theirs. (V.3.P.1)
```

Engaging students but letting them do the problem solving in their own way was a highlight for many participants.

```
00:20:17:23 TN    I've- I've taken that where the teachers
engage the students initially and then turned over the
problem solving to the students. (V.3.P.1)
```

They recognized that many mathematical concepts can be used within the one lesson when students are given the opportunity to work at their own level using prior knowledge. Sharing the different ways for solving the problem opened the concept of multiple methods to all students.

```
00:20:31:14 TN    I liked how they brought more than one
concept for one lesson.
00:20:38:13 T     You know, even the Japanese lesson were
there was charts, graphs, equations-
00:20:59:01 T     So they- they learned more than one way to
do a problem.(V.3.P.1)


00:21:11:09 TN    I think to have some prior knowledge.  All
three of them really tapped from the prior knowledge.
...
00:21:49:11 TN    And that's the thing I heard in most of the
teaching.
00:21:50:29 TN    You've done this.  You've seen this.  Look.
00:21:53:27 T     Now let's see what you've done and known
before and look what you can add. (V.3.P.1)
```

The participants saw the excitement in all lessons adding that this was even the case in the more conservatively delivered Hong Kong lesson.

```
00:21:57:27 T     There's excitement in them.
```

```
00:21:59:23 T     Even in the one we all, you know, some of
you thought was boring.  He had excitement in his- was it
equal or was it not equal? (V.3.P.1)
```

A deeper understanding of one of the research findings of the TIMSS 1999 Video Study, ‘Making Connections’, was important for some of the participants.

```
00:22:11:00 TN    The one thing I got out of this was to make
connections.
00:22:12:29 T     I always thought that to make connections
you had to show how the previous part of the chapter was
related to this part.
00:22:19:15 T     And how what you're learning today is
really gonna help you with tomorrow.
00:22:22:11 T     But I think now I think of connections as:
There is abstract and there is concrete.
00:22:27:21 T     We have to make connections between them.
00:22:29:10 TN    Exactly.
00:22:30:02 TN    It merges into the other.
00:22:31:18 TN    And maybe if I become a master, I can
actually connect something from way back in the past to
something way in the future. (V.3.P.1)
```

As mentioned in the content and pedagogy section (4.4.3.5.1), forums were added at the end of each case to provide the opportunity for online discussions. The implementation team noted that the facilitation of these both online and in the blended delivery modes needed to be addressed in the training of facilitators in the future.

4.4.4.3 Summary of implementation Cycle 1

One question in each of Questionnaires 2 and 3 related directly to the implementation team. Question 3 in Questionnaire 2 addressed the total time taken for the course (Table 4-29), while Question 4 from Questionnaire 3 looked at time spent on specific activities outside of the scheduled pilot sessions (Table 4-30).

Table 4-29 Questionnaire 2.3

How many hours did it take you to complete the Course?	n
Less than 8	0
8 – 10	4
10 – 12	5
13 - 15	2
More than 15	0

The figures in Table 4-29 show that most participants took between eight and twelve hours to complete the course. The calculated mean time for the eleven participants is 10.8 hours. This was close to the original objective of 10 hours for the course to be eligible for one continuing education unit from UCLA.

Table 4-30 Questionnaire 3.4

How many hours did you spend on the Course outside of scheduled Pilot sessions?	
Hours (mean, n=10)	2.1
% time on assigned homework	80
If you did additional activities, what were these?	**n**
Reading/exploring Course text	2
Finishing Tasks	1
Reading other people's responses to tasks	1
Viewing the Lessons	3
Exploring Resources associated with lessons	3
Reading Commentaries in lessons	2
Other	1

Table 4-30 displays the summary data for the question (Q3.4.P.1). An examination of the raw data shows that only one participant did not spend any time outside of the sessions on the course (Q3.4.P.1.2) while other times ranged between one and four hours with a mean time, as shown in the table, of 2.1 hours. Three participants spent 100% of this time on assigned homework (Q3.4.P.1.5, 7, 8), four spent between 50 and 75% (Q3.4.P.1.4, 6, 9, 10) and three did not respond to this sub-question. Note that the mean time, 2.1 hours, added to the approximately 8.5 hours of pilot sessions, correlates closely with the mean time of 10.8 from Question 3 of Questionnaire 2 (Table 4-29).

All of the additional activities listed in the question were attempted by one or more participants. Four did not respond to the question (Q3.4.P.1.1, 2, 5, 8). Two participants selected four or five activities (Q3.4.P.1.3, 9) while the other respondents selected one each. Three additional comments were included, one noting a technical problem encountered when trying to read other responses (Q3.4.P.1.7), another included time developing a lesson (Q3.4.P.1.8) and the third on trying to get everything working (Q3.4.P.1.3).

4.4.5 Evaluation – General Cycle 1

Questionnaire 2, conducted at the end of the cycle included several general questions. Question 4 asked for a rating of participants' overall experience with the course (Q2.4). The rating scale provided five categories from very poor to very good. Nine of the eleven participants rated the experience as very good and the remaining two as good. Seven participants added comments "I feel honored to be part of this study and learned a great deal. I now understand the things I've learned about Education in Japan" (Q2.4.P.1.6), "I enjoyed having the discussions" (Q2.4.P.1.8) and "I appreciated the variety of teaching strategies modeled – and the students doing the talking and doing" (Q2.4.P.1.11). Other participants focused on the links to their own practice, "excited to try new strategies" (Q2.4.P.1.3), "Got some excellent ideas" (Q2.4.P.1.10), and "It was very interesting and has made me reflect on my own practices" (Q2.4.P.1.7)

These latter ideas were continued in the responses to Question 11 "How might this Course assist you in your teaching practice?" (Q2.11) Several responses centered around the reaction of seeing the videotaped lessons. The public-release videos were selected because they were representative of the research findings for their country and their affect on the participants varied significantly. "This gives me the opportunity to see "good" teaching as a model. It is hard to observe good teaching while working." (Q2.11.P.1.3) and "I saw teachers that reminded me of my teaching style and didn't like what I saw. I am going to try other ways to bring math alive to my students." (Q2.11.P.1.7) are two responses that viewed the videos as models, one on what to do, and, the other on what not to do.

Participant 5 mentioned three ways the course may assist "… 1. Demonstration of a problem solves in more than one way. 2. Students hands on. 3. Using material for math problems" (Q2.11.P.1.5). Each of these points, multiple solution methods, student involvement especially in presenting solutions, and, the use of manipulatives or concrete materials, appeared in responses to this and many other questions in the questionnaires and in face-to-face discussions and online task responses throughout the pilot and have been discussed a number of times in the foregoing examination of Cycle 1.

Responses to questions 12 and 15, as shown in Table 4-31, reinforce the positive reaction indicated in other responses and discussions.

Table 4-31 Questionnaire 2.12 & 2.15

	Yes	No
12. Would you recommend this Course to a friend?	10	0
15. If you were invited to take a similar course, would you take it?	11	0

Participants were asked if there was anything missing in the course that would make it better (Q2.14) and if there was anything else they would like to add (Q2.16). Two of the four responses to question 14 wanted to see a US lesson included. This had been discussed during the initial design stage but it was felt that this was not appropriate in the course as planned. As discussed in 4.4.3.2.1, this was addressed by including a video segment from the US in a task within the new topic *Reflections*.

Most of the additional comments were to thank the team for the opportunity (Q2.16.P.1.2, 5, 6, 7, 11). One participant addressed the support given during the pilot "I really appreciated the way in which I was given help. As slow as I am with computers I felt good. I was not made to feel badly." (Q2.16.P.1.1). Other comments included the popularity of a Japanese style lesson tried in a class (Q2.16.P.1.10) and a request for more information on TIMSS (Q2.16.P.1.2).

4.4.6 Summary of refinements from Cycle 1

Table 4-32 below provides a brief summary of the main refinements made as a result of the testing conducted in Cycle 1. These changes were implemented ready for Cycle 2.

Table 4-32 Refinements from Cycle 1

Technology	Add third-party programs to disks distributed to participants
Technology & Implementation	Develop protocols for computer laboratory set-ups
Support materials	Prepare technology support materials both text and online in course including addressing saving online responses
Initial Explorations	Use video clips in *Getting your feet wet* online task. Make full lessons available in *Resources*.
Case 1	Change task *Introduction to the problem: Japan* • Facilitate a viewing of the problem being introduced to the class before solutions are posted by course participants. • Remove sub-questions that predicted student and teacher strategies
Case 1	Change task *Exploration: Japan* • Remove sub-questions that moved beyond an exploration of the lessons – Q2 & 3 • Keep the guided exploration, Q1 • Add a closer exploration of the five strategies presented by the students in the lesson – Q2
Case 1	Change task *Analysis: How the Japanese lesson unfolds* • Change the 7 broad analysis questions to 3 more focused questions: o Teacher's presentation of the problem o Order of the student strategies presented in the lesson o Effectiveness of students sharing their solution strategies
Case 1	Add forum addressing serious mathematical thinking
Case 2 & 3	Change tasks in line with changes for Case 1
Case 2	Add forum at end linking Case 1 and Case 2
Case 3	Add forum linking the 3 cases and the four lesson segments used in Initial Explorations.
Reflections	New topic added to course
Reflections	Add task *Making connections problems revisited* where participants analyze clip from US public release lesson and suggest ways to maintain the original intent of the problem.

4.5 Cycle 2

Cycle 2 started after the refinements from Cycle 1 had been completed. For this cycle, two groups, 2 and 3, piloted the course concurrently.

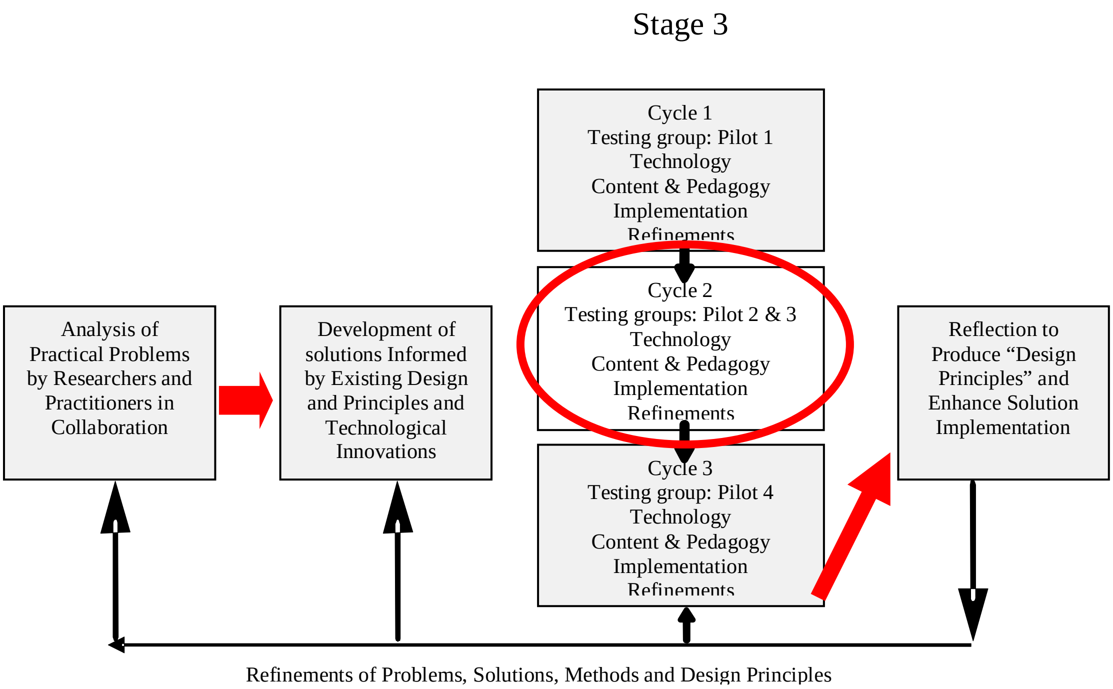


Figure 4-9 Cycle 2 of Stage 3

The course for this cycle, as shown below, had the changes implemented from Cycle 1 and now had seven topics, eleven tasks (three in each case) and three forums, one in each case.

- Introduction
- Initial Explorations
  - Getting your feet wet (Task)
- TIMSS 1999 Video Study Up Close
- Case 1: Japan
  - Content
    - Introduction to the problem: Japan (Task)
  - Exploration
    - Exploration: Japan (Task)
  - Focus on content
  - Analysis
    - Analysis: How the Japanese lesson unfolds (Task)
    - How did the teacher engage the students in serious mathematical thinking? (Forum)
  - Viewpoints on the lesson
- Case 2: Hong Kong
- Case 3: Switzerland
- Reflections
  - Reflecting on mathematical thinking (Task)

As was discussed in 4.3.1 above, two delivery modes were implemented in this cycle, both different from that used in the first cycle. Pilot 2 used a blended model with an initial face-to-face meeting and then worked independently under the guidance of a facilitator. Pilot 3 worked independently online without face-to-face meetings or a facilitator. However as a group they had access to each other's task responses and discussions via the online forums. Each group completed the three questionnaires as in Cycle 1 and met with the implementation team at the end of the time allocated for the course (see Table 4-1).

While the discussion on this cycle will focus on the refinements made during the previous cycle, other observations pertinent to the design principles will be included. These will form the basis for refinements to be implemented before the next cycle, Cycle 3. As with Cycle 1, the three development areas, technology, content and pedagogy, and implementation, will provide a structure for the evaluation.

Although the delivery modes differed between the pilots, it was preferable that the participants, overall, had similar experiences in mathematics content and pedagogical knowledge, teaching and technology use. To establish that this was the case, participants' backgrounds will first be examined.

4.5.1 Participants' backgrounds

The questionnaire on demographics was given to both pilot groups in this cycle before they started the online course. As in Cycle 1, this provided valuable background on the participants' formal mathematics study, their teaching experience and their current computer usage. Each pilot group will be discussed separately.

4.5.1.1 Pilot 2

Questionnaire 1, demographics, found that eight of the ten participants were credentialed teachers, and the remaining two had emergency credentials (Q1.6.P.2). Mathematics' teaching experience in the group ranged from 0.5 to 20 years with two groups of four participants being clustered in the modal intervals (3, 5) and (9, 11) (Q1.8.P.2 results Table 4-33). Thus all participants had some teaching experience with one half of the group at the lower end of the scale for degree of experience and the other at the middle level.

Table 4-33 Mathematics teaching experience Pilot 2

8. Not counting this year, what is your mathematics teaching experience?										
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Elementary	4		15		4	5		3	7	
Middle	5	1	2		1	5	10		2	3
High		3	3	0.5			1			
College										
Total	9	4	20	0.5	5	10	11	3	9	3

The majority of the group, eight, had taught mathematics at middle school level with five of this group also having taught elementary (primary) level, and three also at high school. Of the two participants who had not taught at middle school, one had taught mathematics at elementary level and the other at high school (see Table 4-33). This course is centered around mathematics lessons from year 8 where the majority of participants had experienced teaching mathematics.

Table 4-34 Level of mathematics studied Pilot 2

9. What was the highest level of math you studied in:										
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
High	Pre-C	An	G	Pre-C		Pre-C				A&T
College	C	M	T	A		Pre-C				C
Graduate								MEd		
A: Algebra An: Analysis C: Calculus G: Geometry M: Mathematics MEd: Mathematics Education T: Trigonometry										

Although not all participants answered question 9, all respondents (7) had studied mathematics at secondary and tertiary levels (Table 4-34). This, along with the mathematics' teaching experience, indicated that the participants should be confident with the mathematics of the course.

Table 4-35 below shows the subjects studied at tertiary level (Q1.10.P.2). The original responses, like those in Table 4-5 for Pilot 1, are very diverse and extensive. For this reason the subjects have been grouped into six categories – Mathematics plus five others. Administration covers education and business administration; Education as well as general education, includes the specific education subjects technology, mathematics, business, language arts, child development and curriculum instruction; and Sciences includes biology, engineering, geography, chemistry, health science, geology, physics and computer science. Other subjects have been grouped into Other Mathematics and Other Non-mathematics. The former includes economics, and the latter English, liberal arts, psychology, art, music, sociology, history, physical education, anthropology and languages. The shaded cells in the table indicate subjects with some mathematics content – mathematics, sciences and other mathematics.

Table 4-35 Subjects studied at tertiary level Pilot 2

10. What was your:										
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
College major	ON	M	ON	ON	ON	ON	M ON	A	ON	A
College minor	E			ON				OM	ON	
Grad-school major	E	E	E	ON	E	E ON	M OM	E	E	E
Grad-school minor				M						
A: Administration E: Education M: Mathematics S: Sciences OM: Other Mathematics ON: Other Non-Mathematics										

Subjects with a mathematics focus are not as extensive for this group as they were for Pilot 1 (see Table 4-5). However, there were more education subjects nominated which should support the pedagogical aspects of the course. Since details of other subjects, and of the education subjects themselves are not known, it is hard to develop a strong picture of the participants' mathematical background. Participant 7, who did not answer question 9 (Table 4-39) has listed mathematics subjects in response to this question, so the number of participants with tertiary level mathematics increased by one.

The majority of Pilot 2 participants were regular computer users both at school and home (Table 4-36).

Table 4-36 Computer usage frequency Pilot 2

Computer usage	**School**	**Home**
Rarely	1	
Once a week		1
Every other day		
Once a day	1	4
More than once a day	8	5
Total	10	10

Internet connection speed varied with the majority of participants having fast connections at school but not at home (Table 4-37). This was a potential problem as much of the online work was outside of the laboratory, and Pilot 1 participants who had slow connections, had experienced problems playing the video.

Table 4-37 Type of internet connection Pilot 2

Internet connection	School	Home
DSL/Cable Modem	1	3
Dial-up		6
Ethernet	7	
Not sure	2	1
Don’t have internet access		
Total	10	10

Of the ten participants, eight had access to PCs at school and four to Macs (two used both). At home nine used PCs and two Macs (Q1.4.P.2).

4.5.1.2 Pilot 3

Since Pilot 3 did not have any face-to-face meetings, all materials were sent to participants and each was responsible for completing and returning consent forms and questionnaires and registering to have access to the course. The consent forms were sent first to be completed, signed, and returned. Although it was anticipated that there would be ten participants in Pilot 3, only nine returned the forms and, after being sent follow-up materials, registered successfully onto the LessonLab site. Only seven participants returned the first questionnaire, demographics.

Table 4-38 Mathematics teaching experience Pilot 3

8. Not counting this year, what is your mathematics teaching experience?							
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Elementary	1	1		3			
Middle	13	8		8	7	11	3
High		14	3		11	1	
College							
Total	14	23	3	11	18	12	3

As can be seen in the summary table above (Table 4-38) there were two participants with three years teaching experience while the other five all had more than ten years teaching mathematics. All except one had taught at middle school, with five of these teaching at two or more levels.

Table 4-39 Level of mathematics studied Pilot 3

9. What was the highest level of math you studied in:							
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**
High	T	An	C	A	C	PreC	PreC
College	T	C&S	C	A	C	C	
Graduate							
A: Algebra An: Analysis C: Calculus G: Geometry M: Mathematics MEd: Mathematics Education T: Trigonometry							

Six of the seven respondents studied mathematics at college level (Table 4-39) but only one participant indicated this was a major subject (Table 4-40). Participant 7, who did not include a college mathematics in the response to question 9, did indicate, in question 10, that science was a major subject at college. Overall it could be expected that this pilot group would bring their considerable experience with mathematics and pedagogy to the fore as they participated in the interactive components of the course.

Table 4-40 Subjects studied at tertiary level Pilot 3

10. What was your:							
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**
College major	ON	ON	ON	ON	ON	M	S
College minor		ON		ON		E	
Grad school major	A		E			E	A
Grad school minor							
A: Administration E: Education M: Mathematics S: Sciences OM: Other Mathematics ON: Other Non-Mathematics							

Six of the seven participants from Pilot 3 responding to this question were regular computer users both at school and home (Table 4-41).

Table 4-41 Computer usage frequency Pilot 3

Computer usage	School	Home
Rarely	1	
Once a week		
Every other day		3
Once a day	1	1
More than once a day	5	2
Total	7	6

Internet connection speed again varied within the group but, for more than half the group, connections at home were not fast (Table 4-42). As this group did not complete any of the online work face-to-face in a computer laboratory, this was of some concern to the technology group.

Table 4-42 Type of internet connection Pilot 3

Internet connection	School	Home
DSL/Cable Modem	2	2
Dial-up	1	4
Ethernet	1	
Not sure	3	
Don’t have internet access		
Total	7	6

Of the seven participants responding to the first questionnaire, four had access to PCs at school and four to Macs (one used both). At home four used PCs and three Macs (one used both) (Q1.4.P.3).

4.5.1.3 Participants' backgrounds Cycle 1 and Cycle 2

Data from the demographics' questionnaires suggest that the participants across each of the three pilot groups were similar in range in the level of mathematics they had studied; their qualifications; their teaching experience; and their usage of, and access to computers. Overall, participants indicated a level of experience and/or qualifications in the first three of these variables that would suggest that the mathematics and teaching included in the course were well within their grasp.

While the technology experience and access generally appeared adequate across the groups, online courses such as this, especially with streaming video and interactive tasks and forums, were new to most. Some of this lack of experience was obvious in Cycle 1 particularly when the participants needed to access the software remotely, away from the face-to-face sessions. Other general problems observed, due largely to the networks available at the time of testing, included the speed of connections and the network provider often requiring a specific set-up that restricted the connection to the LessonLab portal. The technical team was prepared for this in Cycle 2.

4.5.2 Technology

Three main technology refinements were made after Cycle 1 - extra support materials were provided on- and off- line; third-party programs were made more accessible; and video clips replaced full lessons in the *Getting your feet wet* task (Table 4-32). The effectiveness of these refinements will be discussed below. The support materials and the access to third-party programs will be considered together as they are both integral to the start-up experience especially for participants of Pilot 3 who did not have the face-to-face support provided in a laboratory.

4.5.2.1 Support materials and third-party programs

Print materials were prepared for distribution to new participants and the online support materials continued to be developed and added to the software.

Local access to third-party programs was provided by adding these to the CD-ROM containing the higher quality video that was distributed to all course participants (see 4.4.2.1.1). The disk also had a *Start here* icon that initiated a check of the computer before opening the pertinent browser at the LessonLab site. The check warned of missing software and indicated if the computer did not meet the basic specifications for using the LessonLab software. Once the requirements had been met, or the user had decided to continue regardless, the LessonLab portal was loaded ready for the registration process or logon. Although the required software, or a link to the free online software, was provided on the disk, participants were required to manually start the installation process.

Both pilot groups still experienced some problems with the technology. General experiences with the technology were the focus of questions 1 and 2 from Questionnaire 2 and question 2 from Questionnaire 3.These will be examined before reference is made to more specific instances and feedback from participants and organizers.

4.5.2.1.1 **Questionnaire responses – Technology Pilots 1-3**

Responses are shown in Table 4-43 below for the three pilot groups. Pilot 1, discussed in detail in 4.4.2.5, has been included for ease of comparison.

Table 4-43 Summary data Questionnaires 2.1, 2.2 & 3.2

	Pilot 1	Pilot 2	Pilot 3
How did you find using the LessonLab software the first time?(Q2.1)			
Very difficult	2	0	3
A little difficult but not too bad	2	0	3
Okay	2	4	1
Quite easy	3	3	0
Very easy	2	1	2
How did you find using the LessonLab software after using it several times?(Q2.2)			
Very difficult	0	1	0
A little difficult but not too bad	2	2	2
Okay	0	0	3
Quite easy	3	4	1
Very easy	5	2	3
Using the LessonLab software by yourself was (Q3.2)			
Very difficult	3	1	3
A little difficult but not too bad	1	1	2
Okay	2	2	1
Quite easy	3	2	1
Very easy	1	2	2

The responses to Q2.1 above show that, for Cycle 2, all participants accessing the software first in a face-to-face laboratory setting, Pilot 2, rated the experience as okay or better. This was an improvement over the first pilot group where 7 of the 11 participants (64%) gave this response. Two (18%) in the first group, found the experience very difficult.

Pilot 3 participants were required to access the software independently and remotely. Only one-third of the participants in this group (3 of 9) rated the experience as okay or better. Three participants found the experience very difficult.

The data for question 2 (Q2.2) show that after more experience using the software, the participants in Pilot 3 had overall improved their rating with 7 of the 9 (78%) choosing okay or better. Nobody in this group found the software very difficult at this point. In Pilot 2, after the initial two hour meeting, participants completed the rest of the course independently at home or school. For most this meant having to change computers and check specifications and software themselves. Data in Table 4-43 shows that instead of all participants finding the software okay as in question 1, 3 of the 9 respondents selected very (1) or a little (2) difficult. In Pilot 1 the majority, 80%, found it easy with the remaining two choosing a little difficult. It is important to note that this group had more face-to-face sessions including directly after they had accessed the software independently away from the laboratory.

Question 2 of questionnaire 3, asked for triangulation purposes confuses the issue further as the data seem to reflect the first-time using experience of Q2.1. Maybe the question was not clear enough to participants.

An explanation for this movement in level of confidence could be that the initial setting-up of the computer and accessing the software remotely outside of the laboratory setting was quite difficult for some participants regardless of their prior experience. Once this had been achieved confidence seemed to grow and participants were able to use the software without too many problems. Other factors may have been largely outside of LessonLab's control including internet connections, service providers, or computer hardware. However, as the course was intended for independent users as well as for face-to-face groups, it was imperative that the technology group understand the problems encountered in order to solve them, where possible. The comments added to the questions, the video-taped face-to-face discussions at the end of each pilot, and the notes kept by the help-desk staff were analysed for this purpose.

4.5.2.1.2 **Start-up and remote access**

As mentioned previously the start-up process for Pilot 2 was directed in a laboratory setting. The computers in the laboratory had been checked before the session and were found to be missing third party software required to play the video. A decision was made to use this as a learning opportunity for participants and have them 'discover' this through the start-up check and then install the player.

```
00:37:00:25 M2    Okay, the first thing you should do only
while you're in here and then if you go home again is check
the system before we start.
00:37:08:27 M2    So can you see on that screen where it
said: Systems Test?
00:37:13:28 M2    Just click on that.
00:37:14:28 TN    And is this what we do at home, too?
00:37:16:29 M2    Just the first time, yeah...

00:37:19:04 M2    To make sure you've got everything. ..

00:37:50:01 M2    Okay, so you can see most of you have
passed on everything except having Real Player installed.
00:37:56:29 M2    And then you can click here for your
installation instructions.  Do you see where it says: Click
Here?
...
00:38:04:29 M2    So if you find this problem at home, this
is what you need to do.  So it says: Click here for your
installation.
...
00:40:19:23 M2    That's going to take you through a number
of screens.  And you say Next, or Accept.
...
00:40:48:29 M1    You don't want a link on the browser.
00:40:52:27 M1    You don't want a shortcut for AOL.
00:40:55:09 M2    Undo all of those once and the first time
you get the boxes with ticks in- undo them and go "Next."
00:40:59:27 M1    Which one are they saving?  Are they saving
any of the boxes?
00:41:02:28 M2    Just say: no.  Not on that one...
00:41:07:04 M1    Keep my current Homepage?  Yes. (V.1.P.2)
```

As can be seen in the transcript above, there were no problems with the checking process and participants moved easily through the installation. However, it can be observed that the installation requires many decisions to be made by the user, many traps for the unwary such as adding superfluous links and changing user's homepage. In the laboratory this can be guided but the independent user relies on support notes.

Six participants in Pilot 3, see Table 4-43 above, ranked the first-time experience of using the software as difficult with half of these selecting very difficult (Q2.1.P.3). In the following comments added by these participants, ‘ Earthlink’ refers to their service provider and was one whose set-up requirements restricted access to LessonLab. “Tech support (20hrs plus) without tech support 15 with Earthlink” (Q2.1.P.3.2); “I had trouble loading the video because it was not clear that I did not have the video player installed” (Q2.1.P.3.4); and “Start here did not work” (Q2.1.P.3.5). The frustration of the participant number 2 was further displayed in the third questionnaire with the comments: “Each time I logged on (6 different times) I had to call for tech support for an approximate total 15 hours” (Q3.2.P.3.2) and “Because of all the "tech problems I was frustrated. I spent many additional hours with Earthlink trying to get my internet server back” (Q3.AC.P.3.2). Interestingly, only one of the ‘little difficult’ group added a comment: “Installation & Direction were good- just not compatible with my Mac” (Q2.1.P.3.1).

The technical support team reported that four of the nine participants in Pilot 3 contacted them for help with a total of five issues (E.P.3). Two issues were considered trivial (an incorrectly set-up link in the course and a lost email containing the content key) and were dealt with quickly. Participant 2, as discussed above, had issues with the LessonLab Macinstaller and her internet provider. Both would not work together. The support staff had the participant uninstall the LessonLab programs and then reinstall them and “the problems seemed to disappear”. LessonLab support staff were unable to reproduce the problem. The same participant had problems with videos stopping after 30 minutes. Again this could not be replicated but was thought to be due to the age of the computer. The fifth problem was that videos on Mac OS 8, a new operating system at the time, did not always play the first time a task window was opened. This highlights an on-going problem software developers have of keeping products compatible across platforms with all operating systems.

Interestingly the time logged by tech support did not seem to match that in the participant comments. Logged time, spent on phone, email and verifying problems but not investigating causes and solutions, was 2 hours 15 minutes. Seventy-five percent of this was with the one participant.

From the researchers notes made at the Pilot 3 debriefing, it seemed that the older computers, in particular Macs, along with poor internet connections seemed to cause most problems. Interestingly participant 2 was noted as being “one of the most vocal in praising the Course” (O.1.P.3). All participants who needed to contact tech support “were full of praise” (O.1.P.3).

4.5.2.2 Video-clips

In the *Initial Explorations* section of the course, the full lessons in the *Getting your feet wet* task were replaced by video clips of the segments to be watched (4.4.2.3). Pilot 2 participants started the task in their first face-to-face session, similar to Pilot 1. This meant that they were given general guidance and one-on-one help where necessary, on accessing the task, changing video and opening and saving the responses. Shortly after starting several participants had problems with headphones and hearing the audio track but the facilitators were able to help solve these. As with Pilot 1, there were problems with the concept of save as draft versus save as complete. The task was finished at home after participants had set-up their computers and accessed the LessonLab portal remotely. About a week after starting the task in the face-to-face session, the researcher checked progress made by the participants at home. In an email to the development teams she reports “I found that only 3 people had done more than on the first night. Of these 1 had saved as complete and 2 still In Progress” (I.P.2). Finally however, of the ten participants in Pilot 2, seven completed all five questions, one completed three questions and two completed one (in Pilot 1 the numbers were eight completed 5 questions, one completed 4, and two completed 2).

Pilot 3 participants had no face-to-face help setting-up their computers and registering to gain access to the course. As was discussed above (4.5.2.1.2), several of the participants had problems with the technology at this stage. They also had none of the direct support given to Pilot 2 when accessing and responding to this first online task, relying instead on the instructions and reminders on the page and the printed notes. Interestingly, all participants in Pilot 3 who responded to this task (7 of 9) answered all five questions.

Table 4-44 below shows a summary of a selection of the codes from the analysis as described previously in 4.3.3.1. It is interesting to note that, taking into account participants who answered at least one question of the task, the online group, Pilot 3, had a higher mean number of codes (44.9) than the other groups (33.3 and 32). However, if we consider the total number of questions attempted within each group, the means are then Pilot 1, 7.6 (48 questions), Pilot 2, 8.0 (40 questions), and Pilot 3, 9.0 (35 questions). Both numbers are important to researchers. The first means show that, on average, the totally online group, Pilot 3, submitted responses that generated more codes. The second figure shows that if we consider the work each group completed, then they achieved similar results in terms of number of codes generated.

Table 4-44 T_IE.1 Selected codes Pilots 1-3

	Pilot 1 (n=11)	**Pilot 2 (n=10)**	**Pilot 3 (n=7*)**
T=Total codes	366	320	314
Mean=T/n	33.3	32	44.9
Math'l content (C)			
C1/C2 (term/concept)	70	69	44
C3/C4 (+ discussion)	18	1	10
Pedagogy (P)			
P1 (observation of P)	33	4	9
P2 (+ discussion)	63	68	73
P4 (critique of P2)	26	30	30
P5 (reaction to event)	6	14	4
Student thinking (S)			
S1/S2	16	22	17
Video Evidence (E)			
V1 (video marker)	6	4	2
V2 (+ discussion)	48	11	49
Similarities/Differences			
SD1 (observation)	20	17	2
SD2 (+ discussion)	2	1	5
SD3 (comparison)	8	35	36
			*Attempted T_IE.1

In the table above, the "+ discussion" codes indicate that the participant has noted an event (code, pedagogy, video point …) and then annotated it. The annotations have been judged as significant by the coders to achieve these codes and, thus, earn a higher rating than the associated non-annotated codes. For the ones included here, C3/C4, P2, P4, V2, SD2 and SD3, the totals for Pilots 1 - 3 are 175, 146 and 203 respectively. The mean values per question answered within the groups are 3.65, 3.65 and 5.8 (note questions answered per group 48, 40 and 35 respectively). Pilot 3 therefore appears to have recorded significantly more high-level responses than the other two pilots. One explanation may be that this group did not have the opportunity to discuss the videos with their peers as they were watching them. This hypothesis is supported by comments made during the feedback session about their appreciation of the forums – this is discussed in more detail in 4.5.4.1 below.

Importantly for this research, all participants who responded to the task showed that they were able to view videotaped lessons from different countries and comment on what they were seeing, adding video markers to illustrate their responses. This process simulated the initial viewing of lessons by the TIMSS Video Study researchers thus providing a sound basis for participants to read the next course topic *TIMSS 1999 Video Study Up Close* (3.2.3.6.3). Responding to questions in the task also both prepared participants for the following tasks and scaffolded them towards Salmon's 'information exchange' stage (3) (see 3.2.3.6.2).

During the final session with Pilot 2, this task was discussed.

```
00:50:04:17 TN    At first you begin to question yourself.
"Am I thinking about this in the right way?"
00:50:10:23 T     And, so I found that a little frustrating
at first, and I said: "I know that they're asking me
something different here.
00:50:16:26 T     And I need to make some shifts in my
thinking and how I approach these problems."
00:50:21:28 T     At first I said: "Well these guys are after
me.  They want to know what I know about teaching."  You
know?
00:50:26:25 T     You know, like they're trying to peer and-
you know,
00:50:28:09 T     look at me rather than just to look at
program and evaluate how is this working and all that kind of
thing.
00:50:41:17 M     Any other reactions to that part?  Maybe
the Getting Your Feet Wet part?
00:50:46:24 TN    I thought it was positive.  You know-
00:50:47:29 M     Mm-hm.
00:50:48:03 T     I thought it was real useful.  But I- I
kind of think
00:51:03:17 TN    It wasn't nearly so interesting as the part
that followed.
00:51:07:21 TN    And it's a little bit tedious, and, you
know...(V.2.P.2)
```

A certain amount of unease is displayed here as some participants feel uncomfortable writing their ideas wondering if they are being tested rather than the program. The tediousness mentioned by one participant does simulate the TIMSS researchers' work mentioned above as they watched hour after hour of videotaped lessons, each one many times over. At this point the participants had completed the course and they mention at the end of this conversation that they found the cases, where they did watch each lesson several times each time looking at it in more depth, more interesting than the clips watched here. It also makes the reason for the problem, seen in Pilot 1, of participants watching the whole lesson rather than the clip, to be seen as an indication of level of interest rather than just a technology problem.

4.5.2.3 Navigation

The LessonLab course interface (Figure 4-10) contains a lot of information and for first-time users, especially ones who have minimal experience working online, navigation can be challenging. Interactive links work on different levels. The strip at the bottom of the title banner takes the user back to the portal, allows them to logoff, provides help, changes their video settings and lets them see their progress. On the left, the course topics expand when clicked and then provide direct navigation to a page in the course. Page turning buttons are placed at the top and bottom. Within the content section of the course links open task or forum windows or provide resources such as print files.

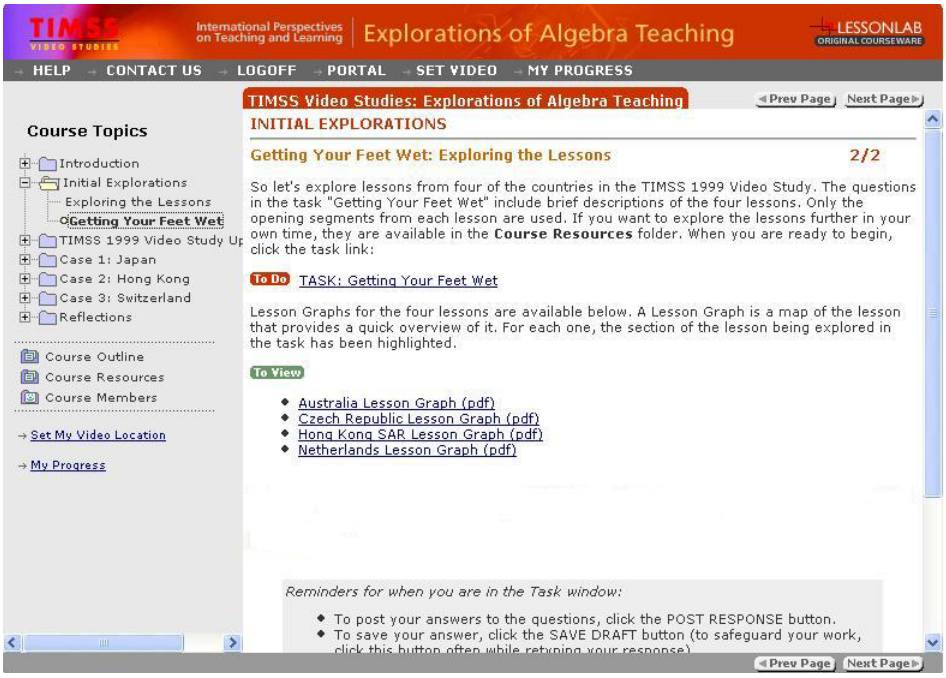


Figure 4-10 Sample page from course

Some participants in Pilot 3, without the benefit of face-to-face help, found it initially confusing:

```
00:17:23:06 TN    ... just trying to figure out the- the
structural organization of the data.
00:17:27:05 T     Yeah.  It's a busy screen.
```

```
00:17:28:00 T     Some of it is- is- is going down and then
you have the menu bar across, but then you also have another
paging system within it.
00:17:37:04 T     So there's actually three different methods
of organizing the data, and that got a little confusing if
you just picked one and then one.
00:17:45:05 TN    'Cause when you- When you close the task
00:17:46:00 TN    'Cause I didn't- I didn't notice the next
page-
00:17:47:15 TN    you still had to go next page, next page
00:17:48:10 TN    Yeah, previous and next.
00:17:49:00 TN    Previous and next?
00:17:50:02 TN    It- it took me a little while to figure
out.  Hey, there's another page to this. (V.1.P.3)
```

The course was designed to be completed in a linear fashion and development teams expected that users would mainly navigate with the previous and next page buttons. This is what happened in Pilots 1 and 2. However in Pilot 3 a difference was observed causing a flurry of emails between the researcher and other members of the different development teams and LessonLab observers.

> Hi All
> Checking the work done by Pilot 3 (totally online group) this morning I noticed that some participants have not worked through the Course in a linear fashion. For example one person has ignored the Getting your feet wet task and moved straight to Introduction to Japan and then Introduction to Hong Kong. ...
> The reason I mention this is that we cannot presume that by Task 2 participants will have had instructions on doing tasks in Task 1. We also must be careful when building Tasks that presume prior knowledge (Tasks) that we make this assumption clear - I think we do but we should keep it in mind when reviewing the Course again. (Email Researcher Dec 9)
>
> Hmmm... I wonder if we might want a feature that would "lock" folders until tasks in the previous ones have been completed... (Email Content and pedagogy.1 Dec 9)
>
> I agree that it would be easier to find a solution to guide them to "closing" activities rather than creating a curriculum that allows them to skip around. It also makes the evaluation plan a lot more sound- because you can assume that all participants went through the same curriculum in terms of scope and sequence. (Email Implementation.1 Dec 9)
>
> I would not favour this in general as most people will do the Course in the order we expect but others explore in different ways. I see this as healthy as, part of doing courses online, is that you can manage your own learning more than in a traditional setting. People who tackle it in different ways are usually resourceful, thinking outside of the box, so we need to make sure we offer instructions on task requirements in more than one place for example.
>
> So long as participants doing the Course for credit, eventually complete all tasks and Forums required, we should not dictate the order. The main variation so far has come from someone completing the Introduction to the lessons in two of the cases first - a healthy curiosity as far as I am concerned.

Please let's not get more prescriptive than we are now. (Email Researcher Dec 10)

I'm with [Researcher] on this. (Email LL observer Dec 10)

I too agree with [Rsearcher] on this issue. (Email Content and pedagogy.2 Dec 10)

The feedback session with Pilot 3 revealed some of the reasons behind the different approach.

```
00:16:30:16 T     I didn't understand the follow the page
thing.  So I thought I did all of Japan and then I'm at the
end of Hong-
00:16:35:00 TN    Yeah, that took me a little while to figure
out.
00:16:36:00 TN    I'm at the end of Hong Kong and realized
that if I had closed that, and went here instead of going
over to that folder.
00:16:42:05 T     Oops.  There's like all this more stuff on
the form and I bet there was one back in Japan.
00:16:46:12 T     So I went back where we started Japan I
found all that and finished it.
00:16:50:20 T     But I could have easily overlooked a huge
chunk.
00:16:53:23 M2    Oh, we thought that was deliberate.  We
noticed that you had gone in that direction.
00:16:58:26 TN    I did the same.
00:17:02:25 T     If you clicked it, it just- if you went
over and clicked on folder to go to the next task that- I
didn't realize you had to go to the next page. (V.1.P.3)
```

In a report back to all teams after the session the researcher summarized the situation.

> Some had problems navigating around the Course and missed the PREV and NEXT buttons for quite a while. In fact it seems that the ones who did the tasks out of order did so by mistake. It was only when they had gone on through Hong Kong that they realised that they must have missed something in the JP case (at least they did see the pattern to the Case Studies). (Email Researcher Dec 17)

The above incident shows that end-users had some problems navigating the course especially when first using it in a totally online implementation. Some new features in the software, discussed in the next section, improved this experience, as did the revised user notes and online help, and, after Pilot 4, additional scaffolding information added to the course.

4.5.2.4 New features and software changes

As mentioned previously, the course software was still being developed and tested while this research was being conducted. When ready, features were added to the platform. Since the software was dynamic, the features would appear immediately to the end-users, usually without prior notice. While many changes were not critical to the performance of the software, they were designed to enhance the online experience.

4.5.2.4.1 **My Progress**

The “My Progress” link provided a report for participants on the status of each task question and forum (not started, in progress, complete). It proved popular with participants and helped solve the problem identified with navigation as discussed previously (4.5.2.3).

```
00:29:01:01 M2    Did anybody find a new link called My
Progress.
00:29:06:22 TN    Oh yeah, I saw that. ...
00:29:09:18 M2    Yeah, that was pretty new.  That only came
out last week I think.
00:29:17:05 TN    Yeah, I would- I would never have figured
out I'd skipped something without that.
00:29:20:05 M1    Really?
00:29:21:00 M2    We have a way as leaders to see your
progress.
00:29:24:00 M2    And we said, "Well, wait.  Don't we want-
00:29:27:20 M2    You guys to be able to see that too?"  And
so, that's good.
00:29:30:24 M2    So you used that straight away.
00:29:35:06 M2    In fact, I generally I try to not let
people change anything while you're doing it.  But I thought,
well that one's a good one.
00:29:44:00 TN    It would have helped me if just before I
even started the first nine tasks in here, so I could just
mentally just go-
00:29:48:25 T     Okay, I got five more left.  (inaudible).
Just so I know when- how far to go.
00:29:51:28 TN    Or even at end before you can start Hong
Kong to let you know there's three left in Japan. (V.1.P.3)
```

4.5.2.4.2 **Start where I left off**

Another link in the software that proved popular with many participants was “Start where I left off”. Interestingly it was not mentioned in the user notes given to participants but it was useful to them as illustrated in the following conversation in Pilot 3’s debrief .

```
00:28:10:28 TN    I like to start where- where I left off.
00:28:13:20 M2    I do too and you (inaudible).
00:28:14:25 TN    Yes, I like that.
00:28:15:14 TN    Yeah, that was very convenient.
00:28:16:23 TN    That's how I found out stuff was missing.
00:28:19:01 M2    Oh, good.
00:28:21:12 TN    Like, it was perfect to where I had left
off.  E- even if I were to go ahead and-
00:28:25:10 T     say I skipped the video and just go ahead
and read what's- what's coming up.
```

```
00:28:28:20 T     I would- I would go to start where I left
off and it was right in the midst of where you were.
(V.1.P.3)
```

4.5.2.5 Summary of technology Cycle 2

Replacing the videotaped lessons in the *Getting your feet wet* task with video clips was deemed a success in Cycle 2. The new software features did help participants more easily navigate the course. The team continued working on their support materials both online and printed; on the setting-up procedures including the automatic checking of computers systems and software at the registration or login point; and on the streamlining of the help desk procedures. Keeping a log of all problems and their solutions enabled the technology team to identify commonly occurring issues and work out either ways to solve or minimize them or the best ways to provide help when the problems arose. Simplifying access to the technology and maintaining compatibility with new versions of the operating systems and third-party software across platforms was an ongoing responsibility and concern for the technology team.

4.5.3 Content and pedagogy

The main changes to the content from Cycle 1 was the provision for participants to watch the presentation of the problem in the Japanese lesson after they had solved it but before they submitted their solutions online. The number of questions in the online tasks was greatly reduced and the three broad areas in each case – the content of the lesson, an exploration of the lesson, and an analysis of the lesson – were more aligned between cases. Forums were added to complete each case (these will be discussed below in Implementation 4.5.4.1).

4.5.3.1 Introduction to the problem: Japan

This task caused concerns in Pilot 1 when participants misunderstood the first problem of the lesson (4.4.3.3). The refinements of the task included facilitating the viewing of the problem after participants had tried the problem but before they responded to the question. Two sub-questions that asked participants to predict student and teacher strategies were removed.

The table below (Table 4-45) is an extension of Table 4-11 included in the discussion of Cycle 1. It shows the number of participants in each pilot (P1, P2, and P3) by the method(s) they used to solve the lesson problem. Methods 1 to 5 (M1-M5) correspond to the methods demonstrated by students in the lesson – Trial and error, tables, differences, equations, and inequalities. Method 7 captures any other method used such as graphs.

Table 4-45 T_JP.1 Methods used to solve problem

Method	M1	M2	M3	M4	M5	M7
#Participants P1(n=11)	4	2	0	0	2	3
#Errors P1	2	1	0	0	1	3
#Participants P2(n=8)	1	2	1	5	1	0
#Participants P3(n=8)	0	4	0	2	5	1

Errors have not been included for Pilots 2 and 3 as there were an insignificant number. Only one incorrect solution was entered in Pilot 2 (giving 14, the day the amounts were equal rather than ≥15 for the inequality) and none in Pilot 3. However, one person in Pilot 2 and two in Pilot 3 described their method and working correctly but failed to include an answer.

Two participants in each of Pilots 2 and 3 included more than one method in their response. No-one in Pilot 1 did this in the first question where they were asked to submit their answer to the problem but in questions two and three where they were asked about strategies they thought the students may use, or the teacher expects, seven of them did include other methods.

Table 4-46 T_JP.1 Explanations included

Explanation	E1	E2
P1 (n=11) Q1 only	6	0
P2 (n=8)	6	3
P3 (n=8)	8	3

The codes E1 and E2 shown in Table 4-46 measure the level of explanation included in the response to the first task. The first, E1, indicates that the participant has explained their working while the second, E2, shows more insight such as "the conceptual difficulty does not lie in the number of coins, but rather the comparison of objects of different value" (T_JP.1.P.3.5) or "This story gave itself very well for seeing the inequality method also, since the younger brother has more every day after the 15^{th} day until a wallet is empty" (T_JP.1.P.2.7) or "Decimal and fractional values have no meaning, because we are dealing with whole days…" (T_JP.1.P.3.7).

Several participants from both groups (2 and 3) included the watching of the video either directly or indirectly in their online responses. "It helped to have the teacher clarify the problem" (T_JP.1.P.3.1); "I used the box that he used …" (T_JP.1.P.3.3); "The lesson introduction did not change my mind about the problem… It did reinforce my picture of the problem." (T_JP.1.P.2.1); and "My inclination was that after the 18^{th} day Ichiro would have put his last coin in … Too easy. When I started watching the video, and I saw the charts on the board I realized the solution would be earlier than the 18^{th} day." (T_JP.1.P.2.6)

The refinements made to this task appeared to work very well. The number of incorrect solutions became minimal, and along with that, the anxieties shown in the first pilot were not evident. This was very important as it was one of the first tasks where participants posted their work online making it publically available to their peers. It was the first task where their mathematical knowledge and understanding was tested.

For the content and pedagogy team, one of the most important outcomes of this task was for participants to experience the power of a well prepared presentation of a problem over just providing it in written form. This was noted also by one of the participants in a Pilot 2 face-to-face session: "It really put things down and made things really concrete for a lot of these kids. And that's a step I think that I'm not always doing. I think that, that alone could make a big difference for a lot of these students that are very visual" (V.2.P.2).

4.5.3.2 Focus on Content

In each case study there is a succinct discussion on the mathematics of the lesson (see 3.2.3.6.4.4). In Pilot 1 the mathematics was generally discussed in the face-to-face sessions and the online material was not a focus of the course evaluation. In Pilot 3, the online material is the only coverage of the mathematics readily available to participants. In the debriefing session participants had been discussing that they liked the page numbering system in that it alerted them to the size of each case and their current progress. In the following discussion participants discuss why this system suits them and then move onto discussing *Focus on Content*.

```
00:35:15:17 TN    Well you have a bunch of math teachers who
want it pretty concrete and sequential, so that's the kind of
stuff we love...
00:35:27:16 TN    The concrete sequential part of me got real
tired with the math text to be honest with you.
00:35:31:26 T     ... I read it and I felt like I was reading
my textbook.
```

```
00:35:35:20 T     I'm like, get me back to the video and the
comment and the thing...I know the math stuff.
00:35:41:17 TN    I thought it was really insightful.  I mean
there were some obvious things that, you know ...
00:35:50:23 T     I mean it was- it was stuff that was so
second nature but I almost found myself challenged to see
00:35:55:05 T     if they could come up with anything new
that I didn't think- think off.
00:35:59:03 T     Like with the first example.  The Japan
lesson.  You know how they said- the five different methods.
00:36:08:00 T     I hadn't thought of graphing it.  It takes
too long.  Yeah, I know how to do that.
00:36:11:23 T     But man, as I was reading- I was, man this
is good stuff and I was really getting excited...
00:36:21:11 T     I felt like that's where the teacher
development came in...
00:36:36:11 T     I'm only a second year teacher and so I've
got a strong math background but as far as like the teaching
is they- as they discussed through the text step by step,
00:36:48:00 T     and some of the transitions and things they
could had done.  I don't know.  I was utterly fascinated.  I
really thought it was- wasn't tedious at all. (V.1.P.3)
```

It was interesting to see that for, at least, several of the participants this segment aligned more with their notion of teacher in-service. They appreciated that the content was offered in a different way, and, even when the topic was not new to them, they gained different insights into the mathematics.

4.5.3.3 The video cases

One of the main refinements from Cycle 1 was reducing the number of questions in the cases and aligning them more in scope. One of the guiding principles of Stage 2 was to use repetition of process in the video cases to provide participants with the means to move from being observers of a lesson to becoming critical observers able to analyse lessons on different levels. The length of the course limited the depth of analysis but it was hoped that participants would gain some skills and processes to take back to their own teaching. Basically the cases went through the process of understanding the (mathematical) content of the lesson; exploring the lesson to see what was happening overall; and then to analyzing more deeply some selected aspects.

The following tables summarize the number of questions (q) per task and the completion rates (n) of these and forums by cycle and pilot groups. For example column two adjacent to T_JP.1 in Table 4-47 shows the original task, Cycle 1, had 3 questions (q=3) and that 2 participants completed one question (q=1, n=2) and nine participants completed all three (q=3, n=9). Whereas in Cycle 2 the number of questions had reduced to 1 with two participants in Pilot 2 not completing any questions (q=0, n=2) and eight completing all questions (q=1, n=8).

Table 4-47 Completion rates for tasks and forums Initial Explorations and Japan

<table>
<tr><th></th><th>Cycle 1</th><th colspan="2">Cycle 2</th></tr>
<tr><th>Task/Forum</th><th>Pilot 1
(n=11)</th><th>Pilot 2
(n=10)</th><th>Pilot 3
(n=9)</th></tr>
<tr><td>T_GYFW
Getting your feet wet</td><td>q n
0 0
1 0
2 2
3 0
4 2
5 7</td><td>q n
0 0
1 2
2 0
3 1
4 0
5 7</td><td>q n
0 2
1 0
2 0
3 0
4 0
5 7</td></tr>
<tr><td>T_JP.1
Japan problem</td><td>q n
0 0
1 2
2 0
3 9</td><td>q n
0 2
1 8</td><td>q n
0 1
1 8</td></tr>
<tr><td>T_JP.2
Japan exploration</td><td>q n
0 0
1 4
2 1
3 6</td><td>q n
0 3
1 1
2 6</td><td>q n
0 3
1 0
2 6</td></tr>
<tr><td>T_JP.3
Japan analysis</td><td>q n
0 4
1 0
2 3
3 0
4 1
5 1
6 0
7 2</td><td>q n
0 2
1 0
2 0
3 8</td><td>q n
0 2
1 0
2 1
3 6</td></tr>
<tr><td>T_JP.1
Japan forum</td><td></td><td>n = 6 one comment each
Mean word count 112</td><td>n = 8one comment each
Mean word count 65</td></tr>
</table>

All participants in Pilot 1 started T_JP.2, the exploration task from the Japan case study, (Table 4-47), but only six of the eleven participants (55%) completed all 3 questions. Four participants (36%) completed only the first question. In the second cycle three participants in each pilot did not start the task but in each case, of those who did, six completed all questions. The analysis task (T_JP.3) contained seven questions in the first cycle. Only two of the eleven participants (18%) of Pilot 1 completed all questions and four completed 3 or more questions (36%). In the second cycle the number of questions was reduced to three for the analysis task and the completion rate for all questions improved – 80% for Pilot 2 and 66% for Pilot 3. It is interesting to note that in each of the pilot groups in Cycle 2 one participant who did not start the exploration task did complete the analysis task.

The forum added in this cycle generated a discussion where participants had clearly read other responses before adding their own "Yes, the teacher did…"; "I agree! The students…" and "Ditto Ditto Ditto... however…" (F_JP.P.3). Although Pilot 2 had met face-to-face, six participants added substantial comments and in Pilot 3, the totally online group, this first forum, had eight of the participants discussing the lesson.

Table 4-48 Completion rates for tasks and forums Hong Kong

	Cycle 1		**Cycle 2**			
Task/Forum	**Pilot 1 (n=11)**		**Pilot 2 (n=10)**		**Pilot 3 (n=9)**	
	q	**n**	**q**	**n**	**q**	**n**
T_HK.1 Hong Kong problem	0	2	0	2	0	1
	1	0	1	0	1	0
	2	9	2	8	2	8
	q	**n**	**q**	**n**	**q**	**n**
T_HK.2 Hong Kong exploration	0	3	0	3	0	2
	1	0	1	7	1	7
	2	0				
	3	8				
	q	**n**	**q**	**n**	**q**	**n**
T_HK.3 Hong Kong analysis	0	0	0	3	0	2
	1	2	1	0	1	0
	2	2	2	7	2	7
	3	7				
T_HK.1 Hong Kong forum			n = 6 Mean word count 191, 4 comments > 200		n = 7 (8 comments) Mean word count 85	

The change in number of questions asked in each task was not so significant in the Hong Kong case study. Two questions were deleted from the exploration task, one from the analysis task and a forum was added at the end. In the analysis task seven of the eleven participants (64%) from Pilot 1who started the task completed all questions, whereas with Pilots 2 and 3 all who started completed the two questions. Participants in both pilot groups again contributed to the online forum discussion with the mean number of words in individual comments increasing substantially from the first forum. In this forum participants were asked to compare the teaching styles of the two very different lessons they had studied, in particular thinking about whether the differences are a result of the different lesson content. Three segments of the discussions are included below.

> In the Japan lesson the teacher posed a problem and allowed the students freedom to work out a solution use any method that was comfortable to them …
> In the Hong Kong lesson the teacher did connect what he was teaching with what students already knew (identity problems with already familiar equations). The difference was that the teacher lead the students in the method of identifying and solving identities without allowing students to try different methods. …
> I believe each teacher effectively taught his particular lesson and while the concepts could have been taught differently, I don't think the Japan method (solving the problem through different methods) would have been effective in teaching the identity concept…. (F_HK.P.2.7)
>
> They are quite different because of content. In Japan one problem allowed for several ways of solving the problem. Some students had higher ability or knoweldge than others and the approach was for all students to work at their ability. In Hong Kong the concept was introcduced as new to all students. The ability or knoweldge level was approached as being the same for all students. (F_HK.P.3.7)
>
> The difference might be related to their curriculum. It appeared that the Japanese teacher was teaching from memory …The Hong Kong SAR teacher however, was cleasrly following some sort of text.
>
> I believe the differences are also related to the content. The Japan lesson took off from things the students (or at least some of them) already knew wheras the Hong Kong identity lesson was very new
>
> Perhapd the final reason is simply culture. We teach the way we've been taught either directly or through careful observation for many years. It doesn't mean we can't change but generally we don't. (F_HK.P.3.6)

The initial reaction to the Japan lesson by participants is very positive as, in general, it is quite different to anything they have experienced. The Hong Kong lesson does not have the same initial impact as it shows a more familiar, teacher-centric style. The quotes above show that the participants have moved beyond this initial impact when comparing the two lessons and instead looked at other aspects such as the curriculum, familiarity of content, and the cultural aspect of teaching.

Table 4-49 Completion rates for tasks and forums Switzerland

	Cycle 1		Cycle 2			
Task/Forum	**Pilot 1 (n=11)**		**Pilot 2 (n=10)**		**Pilot 3 (n=9)**	
	q	n	q	n	q	n
T_SW.1 Switzerland problem	0	4	0	4	0	2
	1	7	1	6	1	7
T_SW.2 Switzerland exploration	0	1	0	4	0	2
	1	5	1	6	1	7
	2	1				
	3	4				
T_SW.3 Switzerland analysis	0	2	0	4	0	2
	1	3	1	0	1	1
	2	2	2	0	2	0
	3	3	3	6	3	6
	4	1				
	5	0				
F_SW1 Switzerland forum			n = 5 Mean word count 122		n = 6 (10 comments) Mean word count 77	

The last case, Switzerland, shows a consistency in completion rates for Pilot 3, the totally online, non-facilitated pilot. From the start one participant had taken no part in the online activities and one other participant only submitted occasional responses. The other seven completed all task questions and most took part in the forums. The forum for the final case provides an opportunity for participants to discuss their overall responses to all of the lessons or lesson segments included in the course.

> I was awestruck at the tremendous respect that teachers recieve in most other countries. The students were extremely well behaved and on task with the lesson that it allowed the teachers to shine and show off their lesson writing skills….
> I enjoyed the majority of the lessons that I watched, excluding Netherlands and Australia, and I feel that I have learned something from each lesson that I will use in my classes. I enjoyed the manipulatives that the teacher from Japan used during his lesson, along with the idea of how to explain the ideas for identity equations and square roots (F_SW.P.3.4)

In the abridged quote above, participant 4 in Pilot 3 first discussed the respect shown to teachers in the countries included in the study and the behavior of the students. These points were a common focus throughout all pilots as is illustrated in some of the responses to this entry included below. Participant 4 also then added that the course would inform his/her own practice and mentioned two cases of content pedagogy in particular.

> Yes! Here here. I completely agree with the respect observation. I can only get that kind of attention in my Algebra 2 classes but never in my Algebra 1 classes. (F_SW.P.3.6)

> Yes!! and students were on time, prepared, had their supplies and textbooks and their were no interruptions, office slips, phone calls or announcements! (F_SW.P.3.9)

> I think more than anything else, this project has demonstrated that the fundamental difference between countries is not their teaching methodolgy (because there are huge differences) but that there are a lot of similarities among those that perform well. What is that commonality? The student. Who does the learning? The student. If there is a lot of learning occuring, it is not necessarily because of an amazing teacher, the learning must ultimately be the burden of the student. So what exactly is the role of the teacher? The teacher presents the information in a manner that is entertaining, accessible and supportive. Each country accomplished those teacher goals differently, but the student behavior and attitudes were not an issue with those instructors. This is the complete opposite of what we have here…. (F_SW.P.3.5)

The segments included below illustrate another common focus of participants, the number of problems used within the lessons of the three cases. Whenever this arose in discussion, online or face-to-face, it was followed by a comparison to the US situation, the curriculum and the textbooks.

> I am struck at how long teachers spend on one problem, particularily if it is an introductory one (F_SW.P.3.7)

> There seems to be real value in focusing on deeply developing one problem/concept as opposed to the U.S. rush to cover all the material very superficially (F_SW.P.3.9)

> I don't think this is necessarily a good thing. If a student is not understanding a particular approach to a problem, the heavy emphasis on that one particular problem can cause problems in understanding … (F_SW.P.3.5)

The last response above by participant 5 offered an alternative point of view to the more popular reaction. Participant 9 then made an observation that may provide a reason for some of the differences observed in the case lessons.

> Anyone notice the lack of diverstiy in the classrooms?! We cope with differences in language, culture, race and ethnicity everyday. (F_SW.P.3.9)

While it is necessary to analyse the content of participant responses to see the level of understanding that participants have achieved as a result of completing the cases, the discussion above shows that the refinements in numbers of questions in tasks between Cycles 1 and 2, had resulted in greatly improved completion rate. The addition of forums at the end of each case had provided the opportunity for participants to reflect on the case. As shown above, most Pilot 2 and 3 participants actively engaged in these online discussions.

Each case followed a pattern of understanding content, exploring the lesson and then analyzing the lesson at a deeper level. If participants did not complete each case then their chance of internalizing the process and using it in their own practice is diminished. The refinements made for Cycle 2 did improve the overall completion rates.

4.5.3.4 Reflections

The reflections topic was created after Cycle 1 with the one task, *Reflecting on Mathematical Thinking*, added at this point (4.4.3.2.1). The objective of the task was for participants to recognize where the intent of a problem was not maintained during implementation and to suggest possible changes. The number of participants attempting the task was quite low in each group – 6/10 in Pilot 2 and 6/9 in Pilot 3.

The response rate and the responses were very disappointing for the content and pedagogy team. The coding system discussed in 4.3.3.1 was applied, and the number of codes generated by the responses from Pilot 2 was a total of 28 for the 6 respondents given a mean value of 4.7, considered very low. For Pilot 3 the mean was higher at 9.3 (56/6). In Pilot 2, few participants talked about the segment at all but instead went straight to suggesting often vague ideas for the lesson: "I might use a visual that replaces the variable with a box which can be opened and the value inside the box can be changed" (T.RF.1.P.2.1) "I might give the students the following problem: Mark earned $90 one week from his after school job. How much did he get paid for each hour of work he did? Write down as many solutions as you can think of" (T.RF.1.P.2.3). The first suggestion seems to link back to the Japan lesson but no other details are included. The second example proceeds to show a variety of possible solutions but does not discuss the pedagogy of neither the video segment nor the proposed changes. The first of the two responses that included references to the segment was "This is an example of telling rather than exploring conjectures or engaging students by presenting a reflective abstraction…" (T.RF.1.P.2.6). The rest of this response talks about social knowledge and conventions before giving details of using different coloured polygons to introduce the concept of variables via the use of notation or symbol to represent the groups. The second response sees the segment as positive "The teacher is using real life experiences that the student can relate to explain how variables change. This is very good". (T.RF.1.P.2.7)

In Pilot 3 the responses were more detailed and referred more often directly to lessons in the cases "At each conceptual point, the teacher informs the student of what each step implies. This is not that different to the HK lesson. However, there is little or no input from the students …" (T.RF.1.P.3.3). Other references were made to participants own programs "… I have always used a guess and check method as described in the California Mathematics Program …) (T.RF.1.P.3.5). Another participant complimented and then qualified with a generalized claim before linking to his own practice "I think the teacher did a decent job … However like other US teachers, we have a tendency to dumb things down for the students. … I feel guilty because … try to make the problem as easy as possible" (T.RF.1.P.3.4). Overall participants in neither group discussed the downgrading of the lesson problem as it was worked publically, the main objective of the problem. Most focused immediately on changes they would implement.

4.5.3.4.1 **Refinements – TIMSS 1999 Video Study Up Close**

On seeing the lack of reference to, and understanding of, the concept of 'Making Connections' as used in the TIMSS Video Study, the content and pedagogy team reexamined the discussion in the research component of the course (see 3.2.3.6.3). It was realized that the discussion was a theoretical one around the findings that did not illustrate how this may look in practice. It was decided to add two examples from the study, one from the Netherlands and one from the Czech Republic (see Figure 4-11), to illustrate the type of problems that would be classified as 'Making Connections' and how this could be maintained or changed as the problem is worked on publicly.

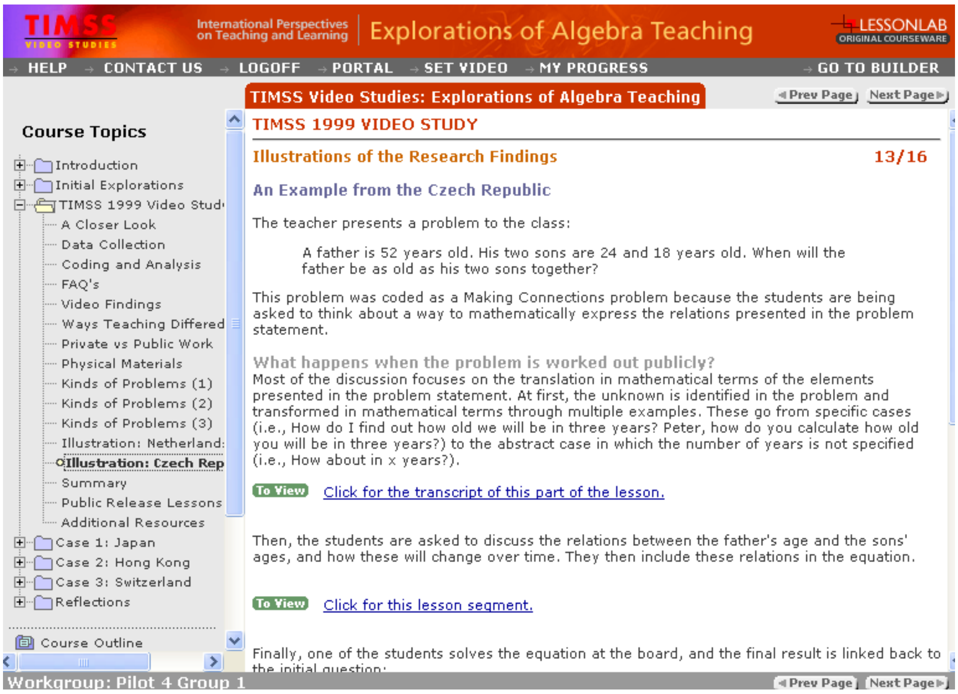


Figure 4-11 Example of ‘Making Connections’ problem, TIMSS 1999 Video Study

The examples included the problem from the lesson and the reasoning for them having been classified as ‘Making Connections’. Transcripts from the lessons were used to illustrate the decision about the possibly different classification once the problem was discussed publicly in the classroom. Conjectures about how the lesson may have proceeded for the original classification to be maintained were added.

4.5.3.4.2 **Refinements – Reflections: Reflecting on mathematical thinking**

Only minor changes were made to the task for the next cycle of testing. The overriding focus of the question was changed from having an emphasis on the problem classification, ‘Making Connections’, to one of relating the implementation of a problem to student mathematical thinking. The overall title of the task changed as did the main question asked. The details within the question remained the same.

Table 4-50 Reflections Task 1

T_R.1 Task: Reflecting on Mathematical Thinking	
Cycle 2 Original	**Implementation Making Connections problems** In this U.S. lesson the teacher presents a problem to the class: *"You have an after school job. You make seven dollars an hour. But this week, you're busy, you can only work two hours. But, next week you can work ten. So I am going to put up here on the board, seven dollars h."* After a few clarifications, the teacher asks the students the following question: *"Say that job that I have represented up here. You get a raise. You now make seven fifty an hour. How will that change?"* • Watch this segment of the lesson: (00:00:27-00:03:30 TIMSS 1999 Video Study Mathematics - US Publi...) **Write a brief analysis of how this problem is taught in the classroom. How would you change the lesson?**
Cycle 2 Refined	**How can the implementation of a problem encourage students' mathematical thinking?** In this U.S. lesson the teacher presents a problem to the class: *"You have an after school job. You make seven dollars an hour. But this week, you're busy, you can only work two hours. But, next week you can work ten. So I am going to put up here on the board, seven dollars h."* After a few clarifications, the teacher asks the students the following question: *"Say that job that I have represented up here. You get a raise. You now make seven fifty an hour. How will that change?"* • Watch this segment of the lesson: (00:00:27-00:03:30 TIMSS 1999 Video Study Mathematics - US Publi...) **Write a brief analysis of how this problem is taught in the classroom. How would you change the lesson?**

4.5.3.4.3 Refinements – Reflections: Reflecting on your teaching

Participants in both cycles indicated that they had tried, or intended to try, some aspects of the lessons in the course in their own teaching. In Cycle 1, as described previously in 4.4.4.1, several participants reported back to the group and one even produced a videotape of his lesson.

In Cycle 2, a participant in Pilot 2 described how he adapted a diagram in a text along the lines of the manipulative used by the Japanese teacher.

```
00:59:21:28 M2    Did any of you take on board any of this-
the teaching methods you saw and try anything out in your
classrooms?
00:59:32:10 TN    Yeah, I did.
00:59:44:05 T     They are getting into positives and
negatives in integers and how to just introduce that.
```

```
00:59:48:02 T     And in that little booklet, they have this
football field they showed just gains and losses, but they
didn't put numbers on it.
00:59:55:03 T     I thought, that's really good, especially
for my little kids.  Just give them something, they know how
it works...
01:00:04:28 T     And so, I'm thinking: "Gosh, I could make a
football field, then make a little football and actually, you
know, do that."
01:00:12:19 T     ...cause I was really impressed when he
pulls out this little box of his Yen, and over here he has
his little juice.  Wow.(V.2.P.2)
```

In Pilot 3 a participant talked about changing the usual routine of her lesson by immediately introducing an open-ended problem with the students sharing solutions publicly. Not only were the students able to grasp more difficult work quite easily, they enjoyed the experience.

```
00:47:28:04 T     I did something with my algebra classes,
...
00:47:35:22 T     Where I put up, what we used to call
diamond problems ...
00:47:40:10 TN    And I just put the X and ...  I had four on
the board and I said, we're not correcting homework right
now.
00:47:46:23 T     Just see if you can figure out the puzzle.
00:47:49:00 TN    Okay.  What did you do to these two
numbers, two and five, to get ten here?
00:47:53:16 T     And seven down here.  Those kids- and then
someone got the next one.  So I let somebody come up.  Do it
on the white board.
00:47:59:02 T     Good.  Got it?  And somebody else figured
it out.  So by the time we did four.  Then we went back and
stated:  Yes, product and sum.
00:48:05:16 T     So then I put more that were more
difficult, ...
00:48:12:08 T     So I wrote some binomials and we multiply
it out.  Then we went back and saw how it was similar.
00:48:17:10 T     So in about twenty-five minutes ... I could
give them a polynomial- trinomial and they'd look at it,
00:48:26:10 T     and make the X, figure out the things, and
tell me the two binomials that had to be multiplied to make
that.
00:48:32:21 T     And they said, can we do more of these?
(V.1.P.3)
```

The teacher tried the same idea with a different class, doubtful that she would get the same response.

```
00:48:54:22 T     ... And I thought my second period would be
kind of tough, 'cause it's all kids who've had algebra at
least once or twice.
00:49:00:15 T     I have one senior in there.  It's her
fourth time through.
```

```
00:49:04:04 TN    And they've really got into it.  They were
pretty disappointed- I said okay, well we're done at the-
with the board work,...
00:49:13:02 T     But a few kids were, "When do we get to do
that again?  I liked those."  Figuring out the binomials.
00:49:18:15 T     I said, "Okay, you liked factoring."  That
was interesting.  So it was fun.
00:49:23:10 T     It was exciting for me to try it, as a- you
know, just- what's a different way that I could show them
using some ideas I picked up from the video? (V.1.P.3)
```

The content and pedagogy team recognized that they needed to provide a formal way for course participants to share their ideas on ways they may change their teaching as a result of completing the course. A final task, *Reflecting on your teaching*, was added into the *Reflections* topic so that participants using any of the flexible delivery options could share their experiences. The task, as shown in Table 4-51, encouraged participants to think about changes that would increase students' mathematical thinking at a general level, then how they may implement these changes, and, finally, to report back to the group after implementation.

Table 4-51 Reflections Task 2

T_R.2 Task: Reflecting on Your Teaching	
Cycle 2 Original	**None**
Cycle 2 Refined	1. **How can I change my lessons to increase students' mathematical thinking?** After reflecting on what you have learned from exploring the lessons in this course, what changes could you try in your classroom to increase student mathematical thinking? Include the strategies you would use to maintain the level of complexity of problems you pose. 2. **Applying the changes.** How, exactly, will you go about making the changes you describe above? Think of a lesson you have coming up - how would you apply these changes? 3. **Implementing the changes.** If you have the opportunity, try the changes you described in question 2 in your classroom. Describe what happened. Was it as you expected?

4.5.3.5 Summary of content and pedagogy Cycle 2

As discussed previously in 4.4.3.8, Question 5 in Questionnaire 2 asked participants to rate each section of the course in terms of interest and usefulness (Q2.5). Five levels of ratings were provided: 5=Extremely; 4=Very; 3=Undecided; 2=Somewhat; and 1=Not at all. Table 4-52 below shows mean values of each measure by course topic for each pilot group. In the following tables and discussions, Pilot 1 has been included for comparative purposes. Note that for both Cycles 1 and 2, the topic *Introduction* contained very little information as it was still being developed and so will not be discussed at this point.

Table 4-52 Questionnaire 2.5

Q2.5 Please indicate the extent to which you found each course section:						
Measure	**Interesting (Mean)**			**Usefulness (Mean)**		
Group	**Pilot 1 n=11**	**Pilot 2 n=8**	**Pilot 3 n=9**	**Pilot 1 n=11**	**Pilot 2 n=8**	**Pilot 3 n=9**
Introduction	4.0	3.4	2.8	3.7	3.7	2.8
Initial exploration	4.1	3.0	3.2	3.9	3.6	3.3
TIMSS Video Up Close	4.0	3.7	3.6	3.7	3.7	3.3
Case 1 – Japan	4.7	4.9	4.9	4.4	4.3	4.7
Case 2 – Hong Kong	4.0	4.9	4.5	3.8	4.0	4.3
Case 3 - Switzerland	4.3	3.4	2.8	4.0	3.1	3.0

Initial exploration was not scored as highly on either measure by Pilots 2 and 3. However, usefulness did score higher than interest for these groups. This could be interpreted as having fulfilled its functions of preparing the participants for the following cases and simulating the process used by the researchers. The topic *TIMSS Video Up Close* scored similar mean values for all groups on usefulness and interest.

Cases 1 and 2 scored highly for both groups on both measures. In both groups only one person scored a 4 for the interest level with *Case 1- Japan*, the rest of the participants rated it the top choice, 5. This was the same for Pilot 2 with interest for Case 2, while for Pilot 3 four people gave interest a 4 rating and the rest a 5. Usefulness did not score as highly with any of the groups for Case 2, but, while individual scores varied more, all means were close to the 'very useful' rating. Case 3 did not score as highly on either measure with Pilots 2 and 3 all means being close to the 'undecided' or middle mark.

These results were not surprising for the content and pedagogy team. The consistently high scores for Case 1 reflected the very positive reaction demonstrated by most participants to the lesson overall both its content and pedagogy. Case 2 presents a very different teaching style and the mathematics is challenging for some (see 4.5.3.3 for more discussion on this). However the style of teaching is in many ways more familiar to the participants. The range of responses about Case 3 was greater than for the other cases. Pilot 2 ranged from 2 to 5 for interest and 1 to 4 on useful while Pilot 3 ranged 1 to 5 on interest and 2 to 5 on useful. It is also interesting to note that seven participants from Pilot 2 responded to the questions on Case 3 although only six of them had completed the tasks and forum (Table 4-49) – it is presumed that all watched the lesson. The differences in the reaction to Case 3 may be partially explained by comments made during the debriefing sessions. The first excerpt concentrates on the questioning techniques in each case.

```
00:57:50:27 TN    It seemed to me that both Japan and Hong
Kong used some very classical questioning techniques that
they- they were driven by the questions,
00:58:01:17 T     rather than necessarily giving any answers,
but it was always the question back at them.
00:58:07:10 T     Let the- the student reflect and respond;
ask another question.
00:58:19:10 T     I guess in the Switzerland scenario, there
was almost no questions.  "Here's the problem; solve the
problem."
00:58:28:20 T     And in fact, when he ran into problems with
that one child, who questioned the response on the board, no,
he just said: "No, this is the correct answer."
00:58:39:19 T     He didn't turn around and question the
student, to get from them what they were thinking about.
(V.2.P.2)
```

The more obscure pedagogy of the Swiss lesson proved to be a problem for some participants and the use of geometry within an algebra lesson an eye-opener for others.

```
00:09:01:15 TM    I didn't understand what the Switzerland
lesson was all about.
00:09:04:14 T     I could understand, you know, we could have
line links for X, Y, and Z.
00:09:10:21 T     And we could- we could come up with three X
and minus Y and plus Z and all those different combinations,
00:09:17:14 T     but I had trouble connecting that to the
idea of a variable. (V.2.P.2)

00:10:01:02 TN    But just the idea of using the compass to
lay off the lengths was-
00:10:05:29 TN    Was, to me, a good geometric technique.
(V.2.P.2)

00:00:11:01 T     Obviously their- their approach to
mathematics is very geometric.
00:00:15:01 T     'Cause, I mean, they're sitting there with
compasses, measuring things, (V.1.P.3)
```

Question 7 in Questionnaire 2 asked participants to rate three critical aspects of the course as: 5=Extremely helpful; 4=Very helpful; 3=Undecided; 2=Somewhat helpful; or 1=Not at all helpful (Q2.7). Table 4-53 below shows mean values for each aspect for each pilot group. The modes and medians (not shown in table) for each factor were 4, ‘very helpful’, for all pilot groups.

Table 4-53 Questionnaire 2.7

Q2.7 Indicate the extent to which the tasks and forums helped you			
Group	**Pilot 1 n=11**	**Pilot 2 n=8**	**Pilot 3 n=9**
In understanding the content of the course	4.2	4.1	3.6
In learning a framework for the analysis of classroom practice	3.9	3.8	3.6
In applying the content to real classroom situations	4.1	3.5	3.8

These statistics continue to support the observation from the first cycle (4.4.3.8) that the tasks and forums within the cases, and the repetition of cases, is supporting participants to develop their analytical skills and transfer them to their practice.

Table 4-54 below shows responses in each group to the question on whether or not participants learned anything new about mathematics.

Table 4-54 Questionnaire 2.9

Q2.9 Did you learn anything new about mathematics?			
Group	**Pilot 1 n=11**	**Pilot 2 n=8**	**Pilot 3 n=8**
Yes	10	4	7
No	1	4	1

Six participants added (optional) comments to this question. Two of those who responded in the negative wrote "No – just ideas of how to teach it better" (Q2.9.P.2.1) and "I am not sure if there was new information but the studies allowed for reflection on personal teaching style" (Q2.9.P.2.6). The other comments were similar, focusing on how the course had made them reflect on, or become aware of different aspects of pedagogical content knowledge. All Pilot 3 participants who responded 'yes' added comments. Like Pilot 2, they mainly focused on the pedagogy referencing the new approaches, multiple solution methods and different lesson structures (Q2.9.P.3.2, 3, 4, 6, 8, 9).

4.5.4 Implementation

This cycle was the first where one group completed the course totally online without any face-to-face meetings to set-up the technology and register onto the LessonLab site. As this was the way the course would initially be offered, the experiences of participants in this group, Pilot 3, were critical to the implementation team.

4.5.4.1 Forums

In the final debrief session held with Pilot 3 the role of forums was raised by one of the participants. Not unexpectedly, the forums did provide a means for the online group to share their thoughts at the end of each case. They discussed the possibility of having a general forum that was active from the start of the course where participants could, for example, ask each other questions, add general comments or raise issues. Some likened this to a chat room or bulletin board.

All of the development teams – content and pedagogy, technology and implementation - discussed the idea of a general forum, how it may be used and managed, but at this point it was decided not to add it inside the course. It was agreed that the general forums currently available to all groups in the workgroup area of the portal, and created and managed by facilitators, would be a better place for such discussions. The implementation team added this to their list to be included in the facilitator training.

The researcher raised the question of changing the last question in the *Getting your feet wet* task into a forum. The task had four similar questions related to the opening segments of lessons from four countries and the fifth question asked participants to compare the four segments.

```
00:07:33:10 TN    A forum there would've matched the format
of the other parts a bit better.
00:07:38:10 T     'Cause- well, (inaudible) miss the whole
Japanese forum and (look back) later.  You know?
00:07:43:03 T     But if I have a forum there, I would've
known to expect something.
00:07:46:06 T     And the sharing was kind of nice.  Just to
see what particular things and what responses-
...
00:07:52:28 TN    I found I went back and checked the forums
more than I did the (responses). (V.2.P.3)
```

Participants here indicated that they tended to revisit forums more than reading the task responses from other participants. Further, they found the sharing to be very positive. This latter point was one of the main objectives in including forums at critical points in the course and was believed by the designers to be especially important for totally online delivery.

The participants raised an important point in the above discussion that a forum in this introductory unit would have not only better prepared them for those in the video cases, but would have aligned the formats of the topics more closely. In fact this was very insightful as this was one of the core purposes and guiding principles of *Initial Explorations.*

4.5.4.1.1 **Refinements – Getting your feet wet**

As a result of observations and discussions with the participants of Pilot 3, the designers decided to change question 5 of the task *Getting your feet wet* into a forum as follows.

Table 4-55 Initial Explorations Forum

T_IE.1 Task: Getting Your Feet Wet	
Cycles 1 & 2 Original	**5. Final Question** What are the major similarities and differences that you noticed among the four lesson clips you watched?
F_IE.1 Forum: Initial Explorations	
Cycle 3 Refined	**FORUM: What are the major similarities and differences that you noticed among the four lesson clips you watched?** Now that you have watched the opening segments of lessons from four countries, what have you noticed?

4.5.4.2 Participant Course Guide

Since Pilot 3 did not have an initial face-to-face meeting, nor contact with a facilitator while taking the course, they proved to be an excellent source of ideas on what on support materials were needed in a course guide. When asked in the debriefing about critical resources, their first response was about the usefulness of the lesson graphs.

```
00:09:11:15 TN    The lesson graphs were fabulous...
00:09:18:00 TN    I could never have figured out the Swiss
lesson without it...
00:09:28:09 TN    I mean, I'm sorry, I've taught geometry...
00:09:30:24 T     I've taught algebra for 22 years.  I could
not figure out that what he was doing had to do with
variables, at first...
00:09:48:05 TN    And even for the lessons.  We didn't watch
the whole lesson- I'd be kind of saying: "Oh, where are they
going from here?"  I was really curious...
00:09:52:29 T     And I went to find out how to go see the
rest of the lesson.(V.1.P.3)
```

The majority of participants in this group indicated, as in the above discussion excerpts, that they used the lesson graphs both to get the bigger picture of the structure of the lesson and to understand details of the lesson such as its mathematics.

On the question of technical help within the guide, the participants suggested a frequently asked questions (FAQ) page to help with details such as enlarging the video, checking progress, saving responses, navigation and solving basic technical problems. On the last point they indicated that they generally liked to try to solve problems themselves before calling technical help. Many of these technical issues and possible solutions have been discussed in the technology section of this cycle (4.5.2). The implementation team had responsibility for the printed course guide while the technology team was responsible for the online help and the software features designed to support users.

4.5.4.2.1 **Refinements - Course guide**

The implementation group continued to design material for the course guide. The guide needed to provide enough support for participants, particularly those taking the course fully online, but not to replicate too much of the online course. As explained previously (see 4.3.1), Cycle 2, with its two pilots, was originally expected to be the last testing conducted, so, by the time of Cycle 3, the course guide was ready to be sent to participants as their main support for accessing and completing the online course. This provided the opportunity to test the guide in situ.

4.5.4.3 Task/Forum table

As has been discussed in the technology section of this cycle, several participants had problems with navigation and keeping track of the work needed to be done and the work completed. The researcher discussed this in her report to the development teams after Pilot 3.

> In the first letter I sent out, I included a table with suggested times for each section of the Course. They found this a great help and used it extensively. ...They would like to have had an idea about tasks/forums in each topic before they started and also to have something up front to show their progress (Jim S has suggested this in the past).
> So my recommendation is that we include such a table in the Introduction section that gives the topic with associated tasks and forums and status of each for the user (not started, in progress, complete). Each task or forum should have a link to the page on which it appears (not directly to the task as people may skip content and instructions). Those who wanted to revisit the tasks had problems finding them in the course as it is currently. (Email Researcher Dec 17)

4.5.4.3.1 **Refinements – Course planner**

A linked table, *Course Planner*, was designed and added to the *Introduction* topic of the course before Cycle 3. It was designed to give participants an overview of the scope of the course, and provided a quick way to navigate to the interactive components.

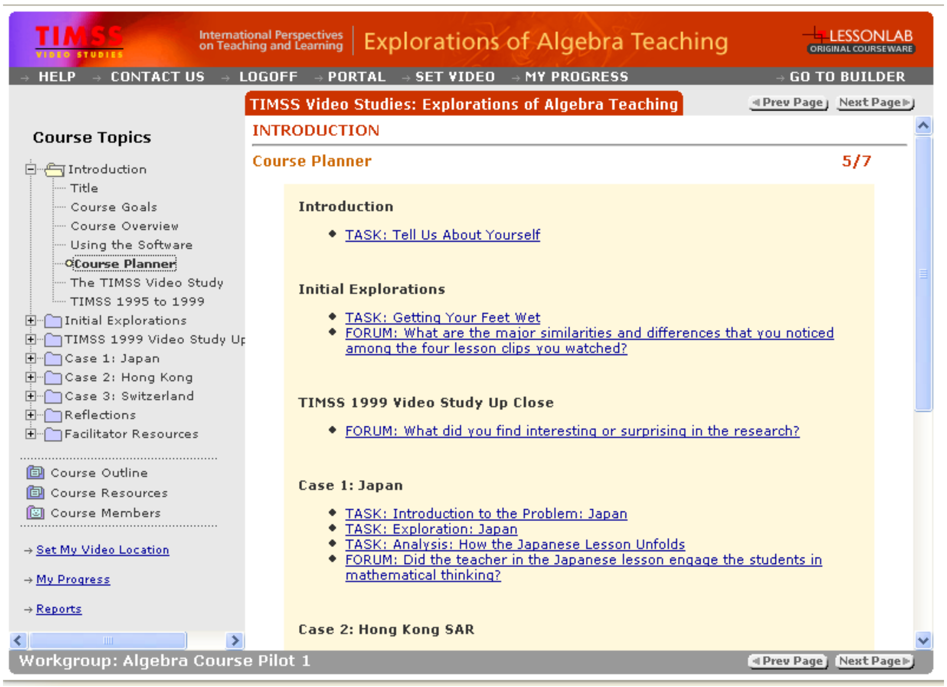


Figure 4-12 Introduction: Course Planner

A task and forum checklist was also designed for the course guide. It provided more details with each question listed for each task and with check boxes for participants to tick when they had completed draft and final responses.

4.5.5 Evaluation – General Cycle 2

At the debrief, apart from discussing the ideas they had tried with their classes, the Pilot 3 participants also talked about how the course had made them think about their profession. They discussed how teachers, after many years, can become over familiar with the content and pedagogy that they teach and how this can lead to a level of comfort that lacks new challenges and excitement. The video cases provided different perspectives that made them think about opening their classrooms and sharing ideas.

> 00:46:45:20 T Because what happens is, you get kind of lackadaisical about stuff.
> 00:46:48:20 T But this was really good to see different countries ...
> 00:46:53:00 T But just inside of your own school, it's really an important technique to do it.

```
00:47:10:22 T     ... asking for someone's help.  Maybe they
have a better way of showing it and be a little more open.
00:47:16:05 TN    (inaudible) interesting.  This morning,
Kenny and I were ... what are you trying?
00:47:22:05 TN    It was good.  (V.1.P.3)
```

All groups during both cycles commented frequently on the differences in countries' curriculums and in particular, between the amount of work expected to be covered in their lessons compared with the lessons in the cases. They also discussed other observed differences:

```
00:52:55:20 TN    Did you notice the phone never rang.
00:53:02:18 TN    And the night I watched that, the next day
I went in and the first period I had fifteen phone calls.
...
00:53:11:15 M1    There aren't interruptions during class
time in Japan.  It's not allowed.
00:53:13:22 TN    No.  No, but in Switzerland there weren't
and in Hong Kong there weren't.
00:53:16:19 M2    Most countries don't have phones in their
classroom.
00:53:19:02 TN    There were no office summonses.
00:53:36:20 T     ... And I had four of them during my lesson
in sixth period today.
00:53:44:02 T     We were going great, but four times I had
to stop (V.1.P.3)
```

One of the facilitators pointed out that cultural surprises work both ways.

```
00:53:20:14 M1    In fact the Japanese teachers have watched
video of U.S. teachers,
00:53:24:00 M1    and ... the first time they heard an
intercom announcement,
00:53:28:19 M1    they were like, "What is that?  Wait.  Stop
the tape.  What is that? ... There's a voice that comes into
their classroom in the middle of teaching".(V.1.P.3)
```

Responses to a question on how they would describe the goals of the course to someone else (Q2.6) included "show teachers different learning styles … and also have teachers reflect on their own teaching style…" (Q2.6.P.2.3); "… Provide thoughtful interaction between colleagues" (Q2.6.P.2.5); and "… an opportunity to step into a classroom in another country" (Q2.6.P.3.9). These responses and the transcript excerpts above illustrate that the cases provided opportunities for the participants to increase awareness of their practice and, by observing and analyzing other classrooms, become serious learners in their profession (see 2.5.2.3).

As for Cycle 1, all participants in Cycle 2, Pilots 2 and 3, said they would recommend the course to a friend and, if invited, take a similar course (Q2.12 and Q2.15).

4.5.6 Summary of refinements from Cycle 2

Table 4-56 below provides a brief summary of the main refinements made as a result of the testing conducted in Cycle 2. These changes were implemented ready for Cycle 3.

Table 4-56 Refinements from Cycle 2

Support materials	Continue to refine technology support materials both text and online help in course
Course Guide	Continue to select material for inclusion in participants' course guide
Introduction	Design and add *Course Planner*, table containing links to all task questions and forums
Initial Explorations	Change question 5 of the task *Getting your feet wet* into a forum
TIMSS 1999 Video Study Up Close	Add two examples to the research topic to illustrate the implementation of Making Connections problems and how the classification may be maintained or changed at this point.
Reflections	Change task *Reflecting on mathematical thinking* Change the emphasis in the initial question from Making Connections classification to students' mathematical thinking
Reflections	Add new task *Reflecting on your teaching* The task will have three components 9. How can I change lessons to increase students' mathematical thinking 10. How will I change? 11. What happened?

4.6 Cycle 3

As was mentioned in 4.3.1.4 above, Cycle 3 was conducted fully online with a facilitator guiding the experience. Since there were no face-to-face meetings planned at all with this group, known as Pilot 4, participants were able to be drawn from across the US. Thus this closely paralleled the initial implementation method planned for the course – individuals signing up to do the course totally online wherever, whenever, with or without facilitation. It was proposed that the implementation of the course would become more flexible at a later date with blended variations being conducted by trained facilitators at a district level.

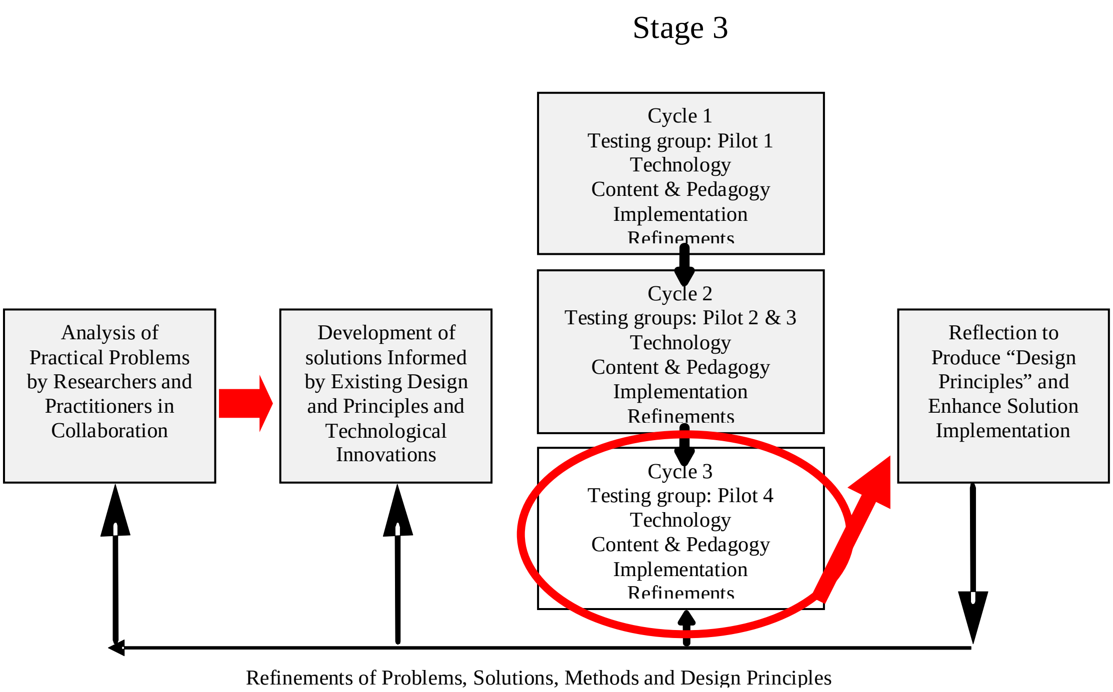


Figure 4-13 Cycle 3 of Stage 3

Originally it was expected that there would only be time for two cycles of testing incorporating three different implementation methods, but the opportunity for this cycle arose when the date for the release of the TIMSS Video Study findings was delayed. It was always planned that the course launch would coincide with the release of the findings. Intel Foundation funded the extra cycle thus providing the means to test the course with the modifications from Cycle 2; the course guide; and the online ordering and distribution system that had been developed at LessonLab. It was also an opportunity for the recently-trained facilitator to experience working with a group in the online platform; to tryout the facilitator tools; and to receive and give feedback on the role, before the launch.

The outline of the course for this cycle is shown below. It had seven topics, 12 online tasks (3 in each case) and four forums.

- Introduction
- Initial Explorations
  - Getting your feet wet (Task)
  - What are the major similarities and differences …?(Forum)
- TIMSS 1999 Video Study Up Close
- Case 1: Japan
  - Content
    - Introduction to the problem: Japan (Task)
  - Exploration
    - Exploration: Japan (Task)
  - Focus on content
  - Analysis
    - Analysis: How the Japanese lesson unfolds (Task)
    - How did the teacher engage the students in serious mathematical thinking? (Forum)
  - Viewpoints on the lesson
- Case 2: Hong Kong
- Case 3: Switzerland
- Reflections
  - Reflecting on mathematical thinking (Task)
  - Reflecting on your teaching (Task)

4.6.1 Participants' backgrounds

Twenty-nine participants, ten male and nineteen female, in Pilot 4 responded to the demographics survey, Questionnaire 1. The large number of respondents made it necessary to group the data rather that using the individual data as shown in the other cycles (4.4.1 and 4.5.1). In Table 4-57 below, the years of teaching have been grouped into intervals of five years and the number in each cell indicates the number of participants for each teaching level within each time interval (Q1.8.P.4).

Table 4-57 Mathematics teaching experience Pilot 4

8. Not counting this year, what is your mathematics teaching experience?							
Years	**0-4**	**5-9**	**10-14**	**15-19**	**20-24**	**≥25**	**Total**
Elementary	2	1					**3**
Middle	7	4	4	2		2	**19**
High	9	4	3			1	**17**
College	2	1				1	**4**
Total	**20**	**10**	**7**	**2**	**0**	**4**	**43**

The totals given in the rows and columns in Table 4-57 indicates that many participants had taught at more than one level during their careers. Twenty-seven of the twenty-nine participants answered this question. Twelve participants had taught in two levels and two in three levels with the majority of these in middle (12) and high (12).

As with the mathematics studied, the number and variety of responses on the subjects studied at tertiary level (Q1.10.P.4), required the researcher to group the subjects into six categories as shown in Table 4-58 below. Note that several participants included more than one response to each sub-question hence some totals exceed the number of responders (29).

Table 4-58 Subjects studied at tertiary level Pilot 4

10. What was your:						
	Maths	**Education**	**Sciences**	**Admin**	**Other (Maths)**	**Other (Non-maths)**
College major	17	8	4			8
College minor	6	5	4		2	4
Grad school major	3	19	4	2	2	1
Grad school minor	1	3				1

As with the previous cycles, the majority of participants were well qualified in mathematics and education. Only four of the 29 did not study any mathematics or science at tertiary level but all of these participants did have education subjects.

The majority of Pilot 4 participants were regular computer users both at school and home (Table 4-59).

Table 4-59 Computer usage frequency Pilot 4

Computer usage	**School**	**Home**
Rarely	2	
Once a week		2
Every other day	2	5
Once a day		7
More than once a day	24	15
Total	27	29

Table 4-60 Type of internet connection Pilot 4

Internet connection	School	Home
DSL/Cable Modem	10	16
Dial-up		11
Ethernet	9	1
Not sure	6	
Don't have internet access		1
Total	25	29

Twenty-two participants in Pilot 4 had access to PCs at school and nine to Macs (three to both). At home twenty-six used PCs and five Macs (two used both) (Q1.4.P.4). Connections to the internet were not fast for many of the participants from home with 11 of the 29 having dial-up (see Table 4-60). So long as the participants changed the source of the video for the course and accessed it locally from the CD-ROM resource, this should not have caused any problems.

As with the participants in Cycles 1 and 2, those in this cycle had the qualifications, teaching experience, and technology experience and access to enable them to participate in the pilot in an informed, engaged and constructively critical manner.

4.6.2 Technology

No major changes were made in the technology area from the last cycle. Continuing improvement to the online help and refinements to the process of handling help desk calls were ongoing for the group.

4.6.2.1 Online ordering system and materials distribution

As mentioned in 4.3.1.4, this cycle also tested the online database for ordering the course and the materials distribution process, both developed at LessonLab. Therefore Pilot 4 participants were required to order and pay for the course online and wait for the course materials to arrive before registering online and gaining access to the course. Ordering the course was handled by LessonLab software locally but to pay for the course materials online, users were redirected to a secure third-party provider.

The plan was to have participants start the course together, so, to cater for expected (small) differences in the time taken for the materials to be received, a mini-online course was developed. This course was available as soon as participants registered and it enabled them to try the software while waiting for the assigned starting date. The mini-course included the reflection on mathematical thinking task from the course.

Apart from making participants familiar with the videotapes, answering online tasks, and saving responses, an additional objective of including this task was to see if an effect of the course could be measured using pre- and post- testing.

The ordering system worked well as did the packaging of materials. However, problems were found with the distribution, by regular mail, of the materials with some of the early orders not being received in time for the pilot. Finally many of the materials had to be resent by courier.

The failure of the course materials to arrive on time resulted in many Pilot 4 participants not completing, or even starting, the course. Thirty-four people ‘ordered’ the course; 29 returned the demographics survey sent out with the ordering instructions; 20 started the course completing the *Getting Your Feet Wet* task (the first major one in the course); 14 finished the reflections tasks (mathematical thinking and your teaching); but only 12 completed the final evaluations that were sent at the end of the course.

4.6.2.1.1 **Feedback on ordering system and materials distribution**

An extra questionnaire was given to participants in Cycle 3 for feedback on the ordering and distribution system. Unfortunately this was part of the final evaluation so only 12 people, as mentioned above, completed it. Even so, the data highlights aspects of the preceding discussion.

Two questions focusing on the participants experience and confidence with buying from the internet need to be considered in light of the timing of the cycle – early 2003. This was very early in the history of internet shopping and many of the security features of current sites had not been developed. To the question “Do you purchase goods or book services over the Internet (online)?” one participant answered never, ten answered occasionally and one answered frequently (Q3.1d.P.4). To “Were you comfortable/secure supplying the information over the Internet?” nobody selected not at all and only one person chose a little insecure (Q3.1b.P.4). Of the other eleven positive responses, three were okay, four selected quite comfortable and four very secure. While the respondents represented only about a third of the thirty-four who had ordered the course online, no other negative feedback was received regarding the online process.

All respondents found the online order interface to be clear (2 okay, 5 quite clear, and 5 very clear) (Q3.1a.P.4). The problem with the delivery time for course materials was evident even in this small group who did complete the course and feedback process (Q3.2a.P.4).

Table 4-61 Time taken for materials delivery Pilot 4

From the day you ordered the Course the materials arrived in approximately:	
1-3 days	3
4-7 days	4
>7days	5

Table 4-61 shows that only a quarter of this group received the materials within three days of ordering online, although they were sent from LessonLab on the same or next business day after the order was received. The materials took more than a week for five of the twelve respondents. This spread is further evidenced by the dates that the online tasks were completed. The range for the task in the mini-course was from February 9 to March 3 with 26 participants submitting responses. The range for the first task in the Algebra course was from February 12 to March 6 with 20 submissions. The consent letter sent to participants on February 1 indicated that the expected time for the course being available was February 7. The other critical deadline was the finishing date as any refinements resulting from this cycle had to be ready for when the TIMSS Video Study findings were made public, as discussed earlier (4.6). Originally the course completion date was March 3 but it was later agreed to leave it opened until March 7. As can be seen by the task completion dates above, some people were just getting onto the mini-course by the first set date and others did not complete the first task until the day before the course had to be closed.

4.6.2.1.2 **Refinements – Materials distribution**

After the delays caused by using the regular postal system in Cycle 3, it was agreed that the course guide and CD-ROM would be couriered to participants in the future.

4.6.2.2 Using the software

As with the participants in the three cycles, it was expected that for the majority of people signing up to take the course once it was released, this would be their first experience participating in an online course. Apart from the challenges of using technology, experience in using the interactive tasks and forums with previous groups and the groups in this research had shown that, the first time participants saw their completed task responses online amongst the group's responses, many were a little shocked even though this feature had been explained. At first all they noticed were their mistakes such as typos and poor expression, but once they moved beyond this hurdle they could see the value in sharing their thinking and seeing other points of view.

4.6.2.2.1 **Refinements - Using the software**

To help address this problem in a non-threatening way and to provide a direct way for users to learn more about the software and its features, it was decided to design a new page *Using the Software* in the topic *Introduction* (see Figure 4-14). A practice task, *Tell us about yourself,* was embedded in the screen to give participants practice in the two stage process of saving task responses, draft and final, and in accessing all the group responses.

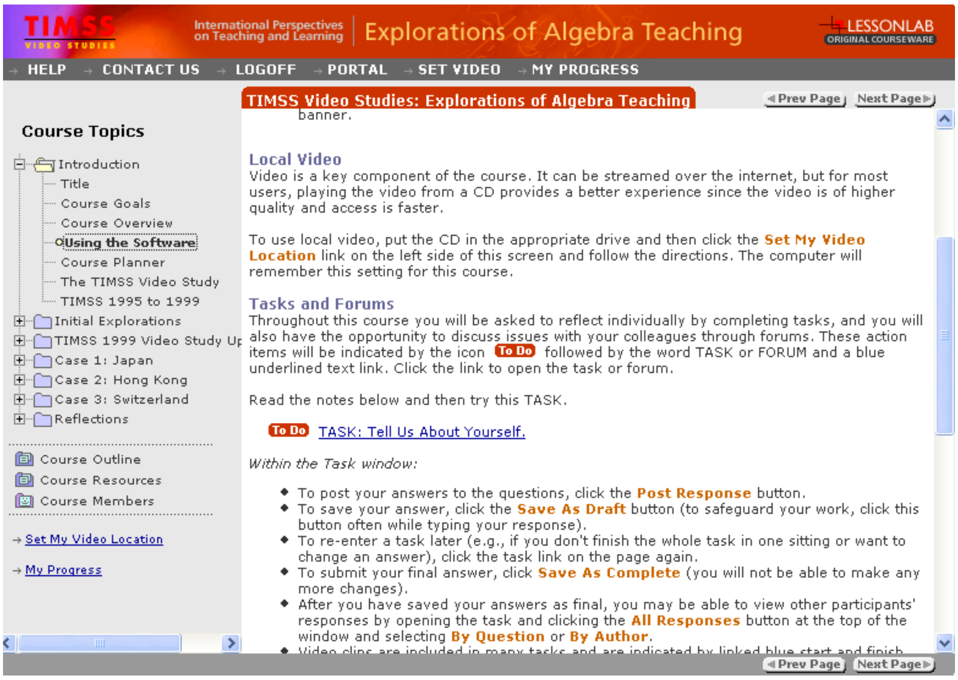


Figure 4-14 Introduction: using the software

This task also satisfied the first two stages of Salmon's five stage model for successful online learning as detailed in 2.5.6: 'Access and motivation' and 'Online socialization'. To be at the point of responding to this task, participants had set-up the software successfully, registered to gain access to the course and reached this point in the course. Once they followed the online instructions they would enter their information and read other responses within the group. Participants were now members of the online community that would move through the course together, sharing and discussing ideas.

This idea also satisfied the wish list of one participant in Cycle 3 whom, in response to the question on whether there was something else you would add to the course to make it better, replied "Course member intros or brief background bios …" (Q2.14.P.4.3).

Table 4-62 Introduction Task

T_IN.1 Task: Tell Us About Yourself	
Post Cycle 3	**Where, what and whom do you teach?** Share with others in the group brief details about yourself. When you have finished, click the SAVE AS DRAFT button (you can edit your answer). Then click the SAVE AS COMPLETE button to submit your response to the group (this is your final answer and cannot be changed). After this, you can use the ALL RESPONSES button to see what others have written.

4.6.2.3 Summary of technology Cycle 3

In all cycles the biggest challenge for many participants was setting up their computers and registering onto the site. The data in Table 4-63 showed that once through this process the majority of users did not seem to have too many problems with the software. In Pilot 4 four of the twelve respondents indicated that they found it a little or very difficult to use the first time but after using it several times all found it not difficult with the majority classifying it as quite or very easy. Two participants had problems using the software on different platforms and so were restricted on where they could access the course (Q2.1.P.4.7, 10).This did not stop them from participating but was limiting and went against the objective of flexible delivery. Another participant did not have sound on any of three computers and thus decided not to continue (Q2.1.P.4.11). This problem reflects the state of computing at the time and would be unlikely to occur now.

Table 4-63 Summary data Questionnaires 2.1 & 2.2

	Pilot 1	Pilot 2	Pilot 3	Pilot 4
How did you find using the LessonLab software the first time?(Q2.1)				
Very difficult	2	0	3	2
A little difficult but not too bad	2	0	3	2
Okay	2	4	1	6
Quite easy	3	3	0	2
Very easy	2	1	2	0
How did you find using the LessonLab software after using it several times? (Q2.2)				
Very difficult	0	1	0	0
A little difficult but not too bad	2	2	2	0
Okay	0	0	3	2
Quite easy	3	4	1	7
Very easy	5	2	3	1

On the question of needing help (Table 4-64), seven of the twelve respondents (58%) indicated they did require assistance. Of these, the written comments associated with the question indicated that four were general technology problems – a firewall stopping video, an old operating system, problems downloading required software and an old version of Real player on the school computer (Q3.3b.P.4.1, 4, 5, 11); one had problems using two different platforms; and two had problems with the LessonLab software – one user was already registered in a different LessonLab portal and was unable to gain access to the portal containing the TIMSS Algebra course, and the other had minor navigation problems.

Table 4-64 Summary data Pilot 4 Q3.3b

Did you require help with the software or registration process from LessonLab or anyone else? (Q3.3b)	
Yes	6
No	5
Other	1

The need for such a high level of support during the initial set-up and registration process continued to concern the technology team. However it was expected that as more people in general accessed the internet and computers improved these problems would decrease. The team continued to work on the startup CD-ROMs, the helpdesk system, and the online help.

4.6.3 Content and pedagogy

The content and pedagogy of the course did not change significantly after Cycle 2 except for question 5 in *Getting your feet wet* task being turned into a forum, and the task, *Reflecting on your teaching*,being added to the *Reflections* topic.

4.6.3.1 Getting your feet wet forum

Changing the last question in the *Getting your feet wet* task to a forum was initially the suggestion of the totally online group in Cycle 3. They wanted the opportunity to discuss the four lesson segments they had watched and commented on in the preceding task questions, something that had occurred naturally in the face-to-face sessions of the other groups. One way of measuring the effectiveness of the change is to compare the number of responses and the codes generated within each between question 5 of the first three pilots and the forum of Pilot 4.

Table 4-65 Getting your feet wet Q5 and forum

	Pilot 1	Pilot 2	Pilot 3	Pilot 4
# Responding to GYFW task	11	10	7	20
# Completing Q5 or Forum	7	7	7	18
% Completing Q5 or forum	63%	70%	100%	90%
Total # codes	33	50	57	266
Mean codes/respondent	4.7	7.1	8.1	14.8
# of SD3 codes	8	20	36	54
# of SD1 & SD2 codes	22	17	7	28
% of all SD codes	91%	74%	75%	31%

Figures in the first three rows of Table 4-65 show the numbers of participants in each pilot who completed Q5 or the equivalent forum and these as a percentages of the number who responded to any part of the *Getting your feet wet* task. It is interesting to note that these figures were substantially higher for both the totally online groups, Pilots 3 and 4.

All responses were coded using the codes discussed previously in 4.3.3.1. Each assigned code corresponds to a different idea, reference or opinion in the response and hence the greater the number of codes assigned, the more substantial the response. The mean number of codes per respondent show that the forum used in Cycle 3, Pilot 4, generated 14.8 codes on average per respondent, while two of the other groups answering the equivalent question, generated less than half of this (4.7 and 7.1) and the third, Pilot 3, only just over half at 8.1.

Pilot 4 participants had been assigned randomly into two groups for the testing cycle to make them align more closely to the group sizes in Cycles 1 and 2. Ten participants in each group had responded to the questions in the *Getting your feet wet* task. In the first group nine participants contributed at least one comment to the forum, with one of these adding three comments. Nine discussion threads were started by this group – six had only one comment, one had two and the last one three. Three comments were added by the facilitator but none of the questions posed in these received a response. In the second group eight participants contributed with five adding one comment each, one adding two and one adding three. Five threads were started with, in order, 5, 4, 1, 2, 1 comments each. The facilitator did not add any comments. This group contained more comments agreeing or disagreeing with previous postings such as a discussion on whether or not the students were 'engaged' in the lesson.

In the responses the discussions included not only comparative references to the videos watched but also to the other resources included in the course, and in the case of the lesson graphs, also in the course guide.

> In three of the lesson graphs, the majority of the work was done individualy, while one of the lesson graphs had the students working together and swapping questions. (F.IE.P.4.5)

Even though this topic was the first where participants looked at teaching in other countries, already there is evidence of teachers thinking about their own teaching and new ideas. In the following quote the teacher thinks of manipulatives in a new way and notices the way problems are used in the lesson. In the second quote, the focus is on the way questions are used:

> Australia was one of the most interesting since it used manipulatives in a way I had not thought of to introduce a topic. I appreciated the problems given in each lesson as a way to develop an idea. (F.IE.P.4.6)

> There was one major teaching similarity to all four: once instruction started, the teachers pushed the students by questions and not giving them answers. (F.IE.P.4.1)

Many comments were made and written through all cycles linking back to a common teaching practice in the US of giving the method followed by repetitious practise. It appears in this forum again.

> No teacher did multiple examples and then had students practice the skill just demonstrated. (F.IE.P.4.8)

The next three comments come from one thread. An interesting point in the first comment is student responsibility being couched in terms of 'not' getting to the end. The response to this comment indicated the participant's discomfort with the explanation followed by the presumption that the students in the lesson must feel the same way. The reaction by the first participant is to link back to the findings of the TIMSS Study.

> It was very interesting to see the different expectations for behavior in the classrooms. I liked the Netherlands classroom however, because the ultimate responsibility of not getting to the end of the chapter seemed to lie with the student. (F.IE.P.4.18)

> In all the classrooms, it is clearly the student's responsibility to learn. But only in the Netherlands classroom did the teacher defer to the book to facilitate student learning. In the clip, the teacher never actually verbalized a complete explanation. As I listened, I felt confused, so I suspect that the students were also confused and making poor progress. (F.IE.P.4.16)
> But how do you account for the fact that this is a high achieving country? (F.IE.P.4.18)

The forum in the *Initial Explorations* topic was considered to work well and no modifications were thought necessary.

4.6.3.2 Reflections - Mathematical thinking

The changes from Cycle 2 for the task *Reflecting on mathematical thinking* occurred both within the task and in the topic *TIMSS Video Study Up Close*. In the task the emphasis moved from making connections to mathematical thinking, and in the topic examples of the change of intent of a problem were added.

In this cycle, 15 participants responded to this task within the course. On average, their responses generated 10.5 codes compared with 4.7 for Pilot 2 (n=6) and 9.3 for Pilot 3 (n=6) (see 4.5.3.4). Obvious differences included more comments on the pedagogy seen in the lesson (total of 26 comments compared with only one each for Pilots 2 and 3); more annotated references on student thinking (total 25, one for Pilot 2 and five for Pilot 3); and 37 links to the videos, own practice, or research (nine for Pilot 2 and fifteen for Pilot 3).

More participants in this cycle refered directly or indirectly to the change of intent, thus satisfying the main objective of the task. One participant opened her response by talking about the problem and how the students seem to understand the representation as a variable expression written on the board but then “The opportunity for learning that presents itself is tying in algebra with a real application, but the teacher does not use the opportunity. The teacher is more interested in changing the constant when students do not really have an idea of what the variable does. …” (T.RF.1.P.4.14) Another participant wrote “The teacher jumped directly into the abstract. She read students a problem and then immediately provided them with an algebraic expression. …” (T.RF.1.P.4.2)

4.6.3.2.1 **Refinements – Reflections: Reflecting on mathematical thinking**

While the participants in this cycle did seem to include more discussion on the US lesson segment, as in the previous cycle emphasis tended to be on the suggested changes. To encourage participants to do more analysis of the lesson the two parts of the original task were separated and the refined task consisted of two questions, the first focusing on the lesson segment and the second on possible changes.

Table 4-66 Reflections Task 1 Cycle 3

<table>
<tr><th colspan="2">T_R.1 Task: Reflecting on Mathematical Thinking</th></tr>
<tr><td>Cycle 3
Original</td><td>How can the implementation of a problem encourage students' mathematical thinking?
In this U.S. lesson the teacher presents a problem to the class:
"You have an after school job. You make seven dollars an hour. But this week, you're busy, you can only work two hours. But, next week you can work ten. So I am going to put up here on the board, seven dollars h."

After a few clarifications, the teacher asks the students the following question:

"Say that job that I have represented up here. You get a raise. You now make seven fifty an hour. How will that change?"
• Watch this segment of the lesson: (<u>00:00:27-00:03:30</u> TIMSS 1999 Video Study Mathematics - US Publi...)

Write a brief analysis of how this problem is taught in the classroom. How would you change the lesson?</td></tr>
<tr><td>Cycle 3
Refined</td><td>1. How can the implementation of a problem encourage students' mathematical thinking?
In this U.S. lesson the teacher presents a problem to the class:
"You have an after school job. You make seven dollars an hour. But this week, you're busy, you can only work two hours. But, next week you can work ten. So I am going to put up here on the board, seven dollars h."

After a few clarifications, the teacher asks the students the following question:

"Say that job that I have represented up here. You get a raise. You now make seven fifty an hour. How will that change?"
• Watch this segment of the lesson: (00:00:27-00:03:06 TIMSS 1999 Video Study Mathematics - US Publi...)
Because the students are asked to reason about the functions of the different parts of the results, this problem encourages them to construct relationships between mathematical procedures, concepts and facts, thus this is a high-level problem.
• Watch how the lesson unfolds: (<u>00:02:55-00:03:30</u> TIMSS 1999 Video Study Mathematics - US Publi...)
Write a brief analysis of how this problem is taught in the classroom. What opportunities are created for students to learn?

2. How would you change the lesson?
If you could change something to improve students' learning opportunities, what would you change and why?</td></tr>
</table>

4.6.3.3 Reflections - Your teaching

This was the first time participants had a formal means to share ways they thought their teaching may change as a result of completing the course (0). The task consisted of three questions that moved from a discussion on possible changes through to how these would be applied and then, if the changes had been implemented, provided the opportunity to report back to the group.

Fourteen participants responded to this task with five reporting back after trying the lessons and another reporting on general changes made to her everyday teaching as a result of the course. This number surprised the development team as the pilot was conducted over a very short timeframe and several of the participants were in teacher professional development rather than directly in the classroom.

The range of ideas in the responses to the first question on changes to increase student thinking was extensive. Many participants focused on the types of problems they would use talking about complexity and multi-steps that would enable a variety of entry levels and solution strategies. The presentation of the problems particularly using visual models and a variety of representations to cater for different learning styles was high on the list. Many participants planned to use more manipulatives in their lessons. Others talked about making their lessons more student centered with students taking the lead in solving problems and presenting solutions. Along this line, one participant felt she always gave tools/methods to students before they needed them rather than, as in the case of the Hong Kong lesson, letting them get to a point where the students recognized that they needed something more to solve a problem. For others class management was recognized as an issue with a tendency to try to fit too much into a lesson, becoming sidetracked, and losing the focus of the lesson. The variety of lessons in the course had obviously stimulated many ideas and reflections on the participants own classrooms.

As in question 1, when asked specifically how they would apply these changes in question 2, the responses were detailed and diverse. Some participants gave specifics about their lessons and topics –using “paper strips like the Swiss lesson to solve a problem on a taxi cab ride” (T.RF.2.2.P.4.2); using “dice and playing cards for counting and probability” (T.RF.2.2.P.4.4); “duplicate the Japan lesson for inequalities so will need to think how I can get visual materials to represent the problem” (T.RF.2.2.P.4.5); and, using “similar pedagogy of the Japan lesson, have students explore the areas of rectangles with a given perimeter to lead to quadratic equations” (T.RF.2.2.P.4.13). Others concentrated more on general pedagogical ideas such as working backwards in a statistics class by giving students a mean and median and having them create a data set for the measures (T.RF.2.2.P.4.11); taking any lesson and making it more student centered (T.RF.2.2.P.4.3); and engaging students in discovery instead of a demonstration of the method followed by practise (T.RF.2.2.P.4.9).

Of the six participants who did have a chance to try their ideas, many reported success, some were surprised at the outcome and some recognized there were some problems still. The implementation of the lesson mentioned in the previous paragraph on working backwards with the statistics the teacher reported "… In half the time I expected, the students generalized the concepts of mean, median and mode. … Students were successful at more complex and difficult problems" (T.RF.2.3.P.4.11). Another implementation resulted in some classroom management issues with the challenge of keeping students on task with group-work but acknowledging that where this happened there were great benefits (T.RF.2.3.P.4.9). One participant at first said she had not had time to implement the changes but now planned every lesson asking "What can I change for the students to learn more?" The response then went on to describe a lesson where students explored similar triangles and came up with their own hypotheses on the relationship between the lengths of the sides in sets of such triangles (T.RF.2.3.P.4.13)

One participant reacted quite strongly to the first question of the task "How can I change my lessons to increase student understanding?" The response: "Interesting… why are you assuming that my lessons aren't designed to foster mathematical thinking? … " (T.RF.2.1.P.4.1). After discussing his teaching and comparing his students with those in the US segment, he continued "You would be better off asking about American educational theory/policy and what I saw in those videos." In question 2 on applying the changes he started "What changes? As much as I didn't like the implications or tone of the first question in this set, I'm not really trying to be negative about any of this. There are always ways that one can improve what's going on …" This participant is demonstrating signs of reaching the final stage, Stage 5: 'Development', of Salmon's five step model as discussed in 2.5.6 (Salmon, 2000). At this point participants become responsible for their own learning and will often start to question or challenge both the materials and facilitator.

4.6.3.4 TIMSS 1999 Video Study Up Close

The topic *TIMSS 1999 Video Study Up Close* as mentioned previously (3.2.3.6.3) discussed how the study was conducted, illustrated selected findings from the study, and included a list of resources pertaining to the research. The development team deliberately did not add tasks or forums to this topic considering it instead as a source of information that individuals or groups could explore in their own ways. However at one of the first facilitator training sessions, the participants, who had all completed the course previously, were adamant that they wanted a forum at the end of the topic. The development team discussed this and agreed to make this refinement.

4.6.3.4.1 Refinements - TIMSS 1999 Video Study Up Close

The following forum was added to the course after all cycles of testing had been completed and therefore was not part of the testing cycle.

Table 4-67 TIMSS 1999 Video Study Up Close Forum

F_TVS.1 Forum TIMSS 1999 Video Study Up Close	
Cycle 3	**None**
Post Cycle 3	**FORUM: What did you find interesting or surprising in the research?** You may also want to include questions you have as a result of reading the TIMSS 1999 Video Study Up Close material.

4.6.3.5 Summary of content and pedagogy Cycle 3

As discussed previously in 4.4.3.8 and 4.5.3.5, Question 5 in Questionnaire 2 asked participants to rate each section of the course in terms of interest and usefulness (Q2.5). Five levels of ratings were provided: 5=Extremely; 4=Very; 3=Undecided; 2=Somewhat; and 1=Not at all. Table 4-68 below shows mean values of each measure by course topic for each pilot group. In the following tables and discussions, Pilots 1, 2 and 3 have been included for comparative purposes.

Table 4-68 Questionnaire 2.5

Q2.5 Please indicate the extent to which you found each course section:								
Measure	**Interesting (Mean)**				**Usefulness (Mean)**			
Pilots	**1 n=11**	**2 n=8**	**3 n=9**	**4 n=11**	**1 n=11**	**2 n=8**	**3 n=9**	**4 n=11**
Introduction	4.0	3.4	2.8	**3.7**	3.7	3.7	2.8	**3.5**
Initial exploration	4.1	3.0	3.2	**4.0**	3.9	3.6	3.3	**3.7**
TIMSS Video Up Close	4.0	3.7	3.6	**4.2**	3.7	3.7	3.3	**4.0**
Case 1 – Japan	4.7	4.9	4.9	**4.7**	4.4	4.3	4.7	**4.6**
Case 2 – Hong Kong	4.0	4.9	4.5	**4.5**	3.8	4.0	4.3	**4.5**
Case 3 - Switzerland	4.3	3.4	2.8	**4.1**	4.0	3.1	3.0	**3.9**
Reflections				**3.4**				**4.6**

The means for all topics were higher than average on both variables for Pilot 4. The ratings on the three cases were high with Japan and Hong Kong being close to the top end of the scale (extremely) and Switzerland close to rating 4 (very). This was pleasing for the content and pedagogy team as in the previous cycle this case had rated considerably lower close to the undecided point. Two responses did focus on the Swiss case studies and these may give an indication as to why this case did not generally rate as highly. “Switz bit long few places hard to follow” (Q2.5.P.4.1) and “I was enjoying the course immensely until the last video. I really felt let down after the previous two lessons.”(Q2.5.P.4.9). Overall the ratings were more even over all topics. It is interesting to note that the *Reflections* topic was rated as average for interest but close to extremely useful.

Question 7 in Questionnaire 2 asked participants to rate three critical aspects of the course as: 5=Extremely helpful; 4=Very helpful; 3=Undecided; 2=Somewhat helpful; or 1=Not at all helpful (Q2.7). Table 4-69 below shows mean values for each aspect for each pilot group. The modes and medians (not shown in table) for each factor were 4, ‘very helpful’, for all pilot groups.

Table 4-69 Questionnaire 2.7

Q2.7 Indicate the extent to which the tasks and forums helped you				
Group	**Pilot 1 n=11**	**Pilot 2 n=8**	**Pilot 3 n=9**	**Pilot 4 n=11**
In understanding the content of the course	4.2	4.1	3.6	**3.9**
In learning a framework for the analysis of classroom practice	3.9	3.8	3.6	**3.5**
In applying the content to real classroom situations	4.1	3.5	3.8	**3.7**

These statistics continue to support the observation from the first two cycles (4.4.3.8 and 4.5.3.5) that the tasks and forums within the cases, and the repetition of cases, is supporting participants to develop their analytical skills and transfer them to their practice. In this cycle the measure for learning a framework for analysis of the classroom practice is closer to the measure for Pilot 3 both of which are slightly lower than Pilots 1 and 2. Only one participant added a comment to this question and it makes a valuable point about the limitations of this question “Should ask separately thought forums not done well at all” (Q2.7.P.4.7). The question was originally asked in the first cycle when forums were not included and was modified to include forums when they were added to the course. In hindsight, more might have been gleaned if the questions had been asked of both interactive tools individually.

Table 4-70 below shows responses in each group to the question on whether or not participants learned anything new about mathematics.

Table 4-70 Questionnaire 2.9

Q2.9 Did you learn anything new about mathematics?				
Group	**Pilot 1 n=11**	**Pilot 2 n=8**	**Pilot 3 n=8**	**Pilot 4 n=11**
Yes	10	4	7	6
No	1	4	1	4

Sixty percent of respondents in Pilot 4 indicated they did learn something new about mathematics. The written comments again often include reference to the teaching methodology rather than specific mathematics. For example "I never really thought about how powerful algebraic thinking can become through the use of simple models" (Q2.9.P.4.4) and "I learned how to create physical representations of variables contained in an expression." (Q2.9.P.4.10).

4.6.4 Implementation

Apart from conducting this cycle of testing and refinement, the main focus for the implementation group was evaluating the facilitation process and the latest course guide.

4.6.4.1 Course Guide

This cycle was the first to have participants use the course guide from the start. Its contents were designed, tested and modified before and during Cycles 1 and 2. Questionnaire 3 included specific questions about the guide. The first question required a simple yes or no "Did you read the course guide?" (Q3.4a). Ten of the twelve did use the guide and, of the other two, one indicated in the optional comments that he had skimmed parts of it (Q3.4b.P.4.1). The next question then asked participants to rate each section of the guide for usefulness (Table 4-71).

Table 4-71 Usefulness of Course Guide

4b. If yes, please indicate the usefulness of the following sections and pages. (Q3.4b)	
5 = Extremely 4 = Very 3 = Undecided 2 = Somewhat 1 = Not at all	
Sections	**Mean (n=9)**
Introduction	3.8
Getting Started	4.3
Navigating the Course	4.0
Beginning the Course	4.1
Viewing and Analyzing the Case Studies	4.0
Spaces for Note taking	3.3
Pages	
Course Planner	3.6
Task and Forum Checklist	2.9
Lesson Graphs	4.0
TIMSS Resource Pages	3.0

The mean values in the above table indicated that most content scored close to a very useful (4) rating. Three were closer to the "undecided" measure – space for note taking, task and forum checklist, and TIMSS resource page. The surprising one for the implementation team was the checklist as this had been a request from the previous cycle (4.5.4.3.1). The TIMSS resource page contained links to pertinent books, reports and websites and was considered a valuable resource even though it was not scored highly by this group, so it remained. Additional comments by participants did not include any suggestions for extra material that the team decided to adopt. One suggested adding the analysis of content to the guide (Q3.4c.P.4.6). This had been debated previously within the group but the final decision was that this should only be online as its placement was critical to the overall design of the cases and that it could always be printed. The course guide was not changed after this cycle.

4.6.4.2 Facilitation

As this was the first time a facilitator had worked with a totally online group, the third questionnaire for this cycle included an evaluation on the facilitation. As discussed previously in 3.2.5.4.4, the implementation team was responsible for designing the facilitation training, materials and tools ready for the next phase of the proposed usage of the course – at a district level with local facilitators.

As mentioned previously (4.6), this was the first time the facilitator, an experienced mathematics teacher professional developer, had worked online. Tools had been developed in the software for the facilitator such as group emailing and, in the forum interface, the capability to add general comments at the top of the page and having the facilitator name and role appear in bold within the forum discussion.

The experience of taking a facilitated online course was also new for most participants in the group. When asked about this, ten of the twelve had not, two had. The responses to the question "What was your experience with the facilitation process in the course" (Q3.5b) elicited two "positive" responses (Q3.5b.P.4.7) and "Fine – you can work on it in your own time" (Q3.5b.P.4.2). The other responses ranged from very negative "Very disappointing. I only heard from facilitator 3 times – welcome to course; don't forget to save responses; reminder course closing" (Q3.5b.P.4.1) to indications that this was not an important issue and did not affect their experience "I wasn't sure it was always useful to me – at times I felt as if I knew as much or more" (Q3.5b.P.4.8) and "I'm not sure, email was nice" (Q3.5b.P.4.12).

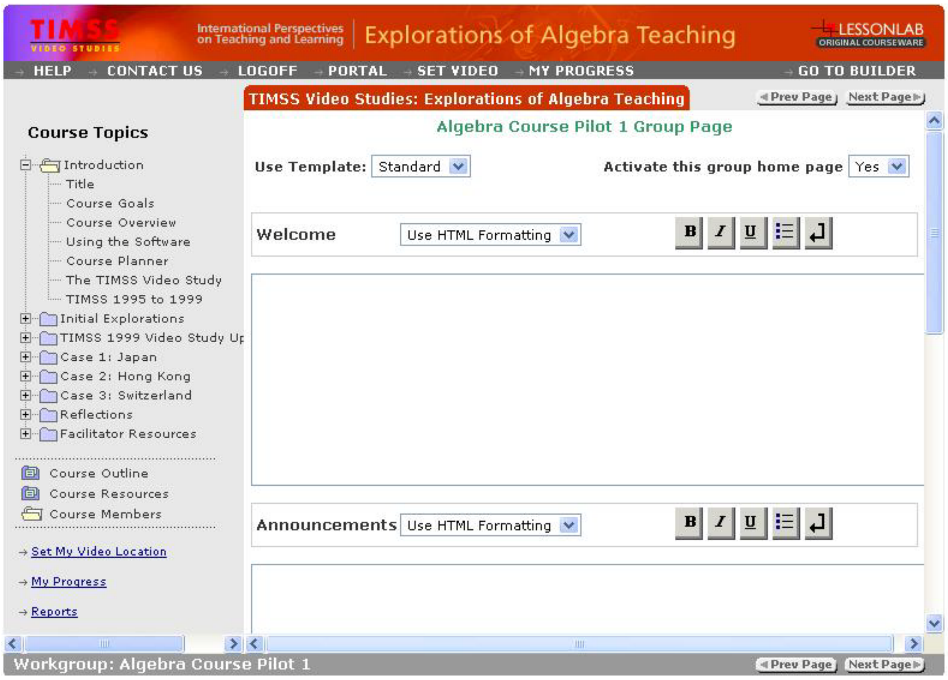
The next questions for participants were "What types of facilitation would you find helpful in this course?" (Q3.5c) and "Where and when would this facilitation be most beneficial? (Q3.5d). Despite the responses to the previous question, the facilitator was seen as crucial by many and the major points on the facilitator's role were to stretch participants thinking through thought provoking questions, to provide feedback one-to-one, and to provide more focus and direction within forums.

These responses were considered carefully when the implementation team designed the training and materials for facilitators. They also suggested extra software features and resources for facilitators and worked with the technology team to develop these.

4.6.4.2.1 **Refinements - Facilitator homepage**

In a response to one of the questions on the last questionnaire, one participant wrote "… I don't know anything about her either. Is she a teacher?" (Q3.5b.P.4.3). The implementation team agreed that this should be possible within the course and suggested ideas to the technology team on ways the facilitators could 'personalize' the course. The technology team designed and programmed a facilitator home page at the front of the course that was activated and managed totally by facilitators. Later a share page was added.

The home page contained an area for uploading a picture and contact details of the facilitator and another for displaying notes such as meeting times, work to be completed and other group information. The share page enables the facilitator and group members to enter notes or upload files, forums or electronic lesson plans for the group. The pages in builder (Figure 4-15) and course (Figure 4-16) modes are shown below.



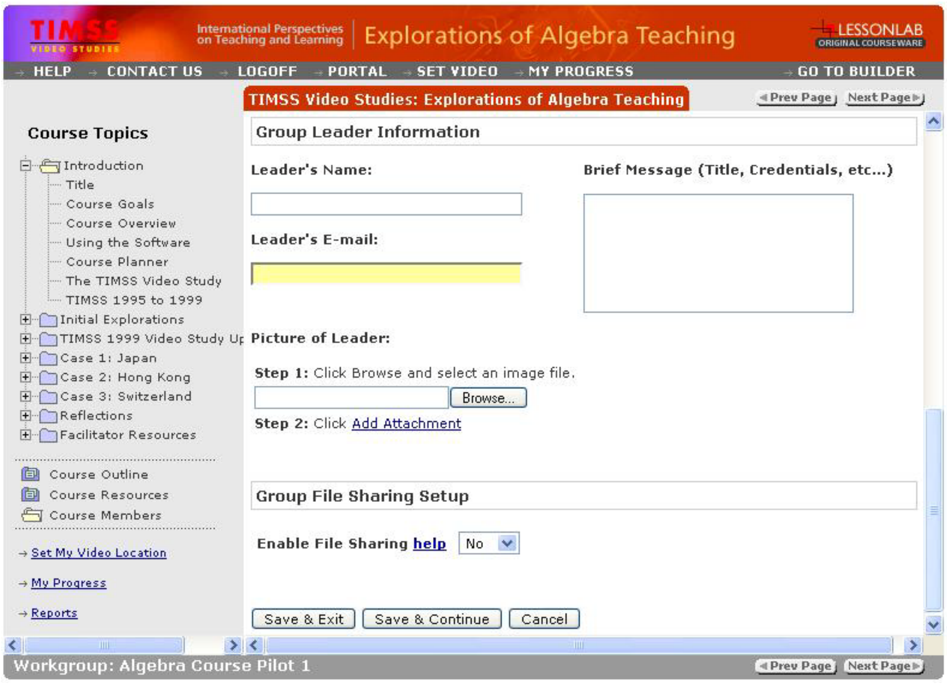


Figure 4-15 Facilitator homepages builder mode

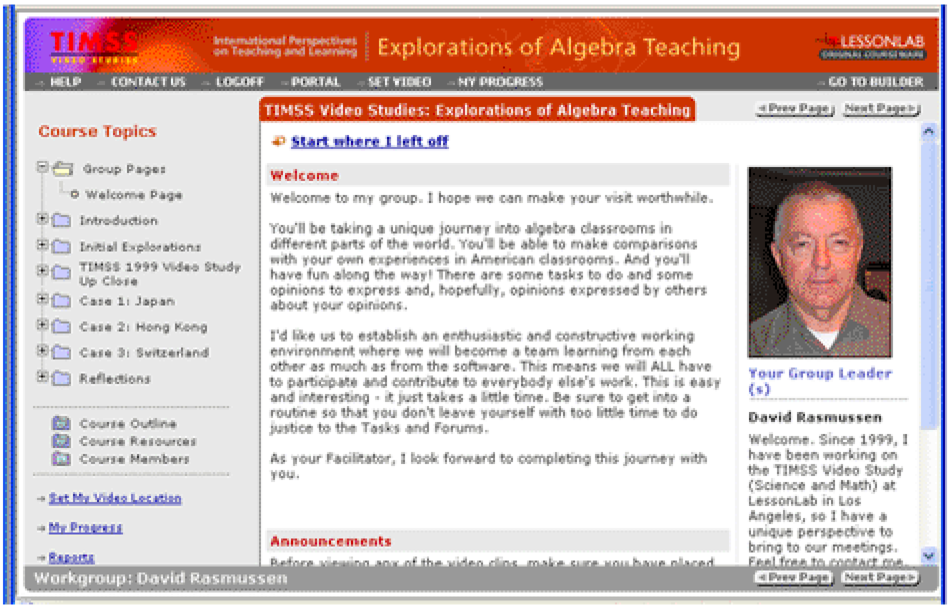


Figure 4-16 Facilitator Home Page viewer mode

4.6.4.2.2 **Refinements - Facilitator training**

The facilitation training and materials followed the cycles of design-based research overlapping with that of the course. The training consisted of an in-depth coverage of the course content; modeled facilitation; and practice in basic technology skills. It also dealt with basic requirements such as ordering the course for a group, distributing materials and checking the work of participants who had enrolled in (and paid for) a continuing education unit (CEU) from UCLA. As discussed previously, the facilitator for the initial implementations was trained through Cycles 1 and 2 and then facilitated Cycle 3. From this the original training was modified and prepared for further cycles of testing and refinement. Two of these were held several months after this research had been completed before the facilitator training was made available to a wider group

.

The training concentrated on the role of the facilitator as knowledgeable guide, rather than as expert. Guidelines for online and face-to-face facilitation were provided along with tips such as how to encourage participation and moderate forums, and different models for delivery of the course with different blends of online and face-to-face sessions were discussed. The facilitator guide, discussed below in 4.6.4.2.4 and the online resources (4.6.4.2.3) provided support to the facilitators after they had completed their training.

4.6.4.2.3 Refinements - Facilitator online resources

One of the LessonLab software features was that access to topics and pages could be opened to all users or just to facilitators or leaders. This enabled an online resource page to be created for facilitators within the course. As the software was dynamic, resources could be added, removed or details edited as required by the builders of the course. Figure 4-17 below shows a section of the resource page containing links for ordering the course for a group and another for downloading a tracking spreadsheet.

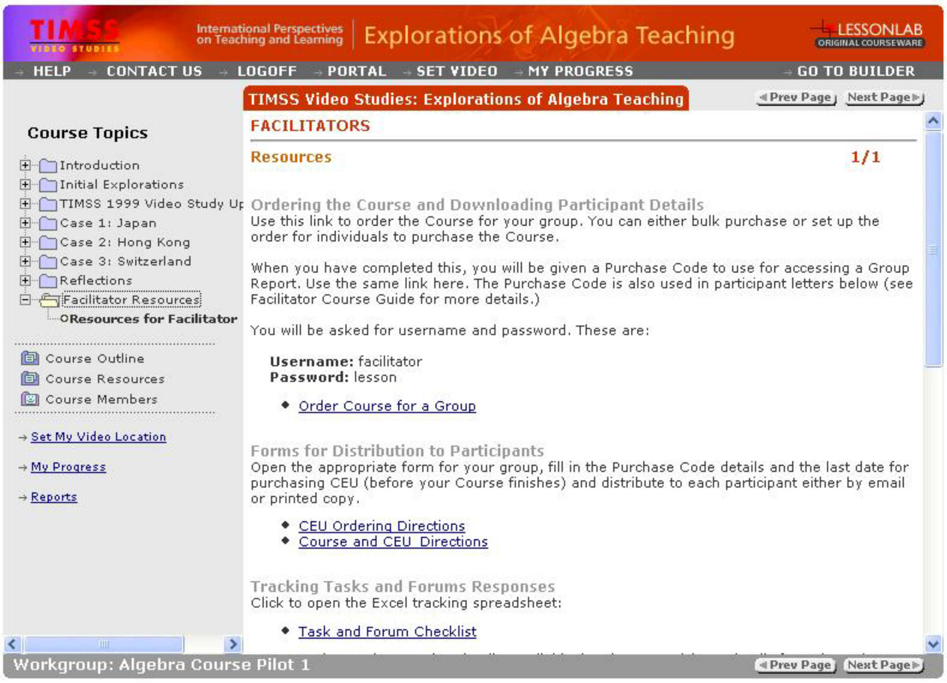
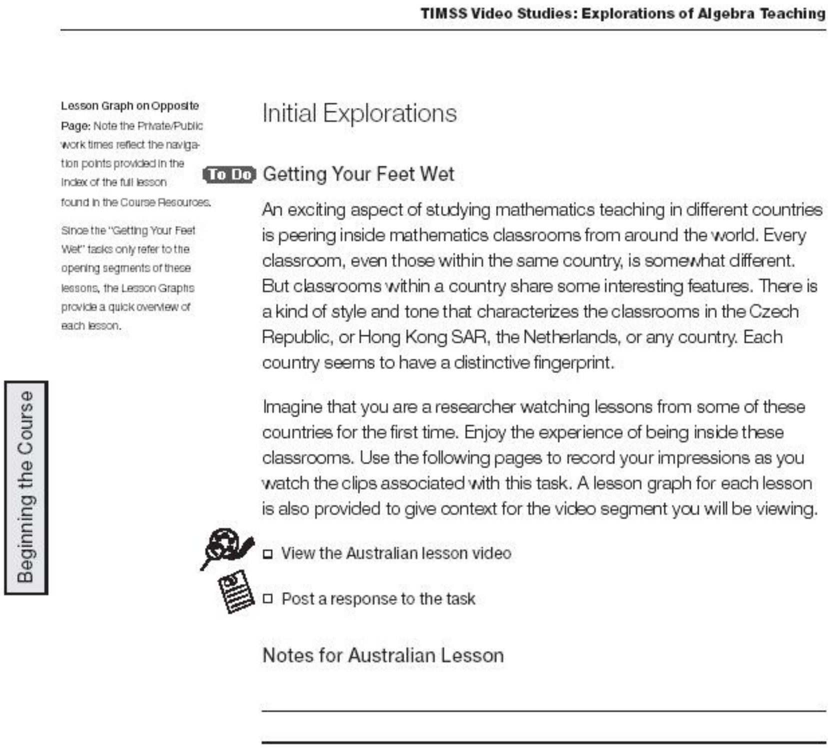


Figure 4-17 Facilitator resources page

4.6.4.2.4 **Refinements - Facilitator guide**

The printed guide designed for the facilitators incorporated an annotated user guide, suggested implementation strategies, and other resources.



TIMSS Video Studies: Explorations of Algebra Teaching

Lesson Graph on Opposite Page: Note the Private/Public work times reflect the naviga-tion points provided in the Index of the full lesson found in the Course Resources.

Since the "Getting Your Feet Wet" tasks only refer to the opening segments of these lessons, the Lesson Graphs provide a quick overview of each lesson.

Beginning the Course

Initial Explorations

To Do Getting Your Feet Wet

An exciting aspect of studying mathematics teaching in different countries is peering inside mathematics classrooms from around the world. Every classroom, even those within the same country, is somewhat different. But classrooms within a country share some interesting features. There is a kind of style and tone that characterizes the classrooms in the Czech Republic, or Hong Kong SAR, the Netherlands, or any country. Each country seems to have a distinctive fingerprint.

Imagine that you are a researcher watching lessons from some of these countries for the first time. Enjoy the experience of being inside these classrooms. Use the following pages to record your impressions as you watch the clips associated with this task. A lesson graph for each lesson is also provided to give context for the video segment you will be viewing.

- ☐ View the Australian lesson video
- ☐ Post a response to the task

Notes for Australian Lesson

Figure 4-18 Facilitator Guide: Initial Explorations

Figure 4-18 above shows a portion of a page on the *Initial Exploration* topic from the facilitator guide. The body text and notes section were identical in the user course guide. The notes at the side provided hints for the facilitator for this segment. The icons of the videotape and the notepad alert the facilitator to interactive points in the course (these were not included in the user guides).

Extra pages such as in Figure 4-19 above, that are not in the course guide, were coloured grey. The caution and evaluation points and extension ideas shown above were preceded by the goals of the session and some focus questions.

TIMSS Video Studies: Explorations of Algebra Teaching

Extension Ideas: (Cont.)

- If you were preparing to teach the Hong Kong lesson in your classroom, what types of questions would you pose to students and how would the questions elicit mathematical thinking among students?
- Imagine teaching this lesson to your students; explain how you would assess students' understanding of the mathematics in the lesson. Explain how your assessment of the students would be similar or different from what you saw and read about in the Hong Kong lesson.

Caution/Evaluation Points:

- Be aware that people may focus on the more procedural aspects of this lesson as compared to the Japanese lesson. Be prepared to push in the whole group discussion for a deeper analysis of the design of this lesson and its careful attention to the distinction between an identity and an equation and the importance that proof plays in determining an identity. Also push for people to look at how symbolic notation is developed across the course of the lesson.
- Take note of what mathematics teachers bring to the concept of identity and the distinction between identity and equations.
- Watch for how the group talks with each other and push people to provide evidence for any claims they make—using the lesson graph to help point to where in the lesson they are referring. Ask for rationale for their claims and ask for alternative perspectives and points of view using the lesson graphs and/or video times to refer to specific points in the lesson.

Case Studies

Figure 4-19 Facilitator Guide: Hong Kong case study

The page shown below, Figure 4-20, included a checklist to guide facilitators as their groups moved through the case study using either online or face-to-face modes.

TIMSS Video Studies: Explorations of Algebra Teaching

Case Studies

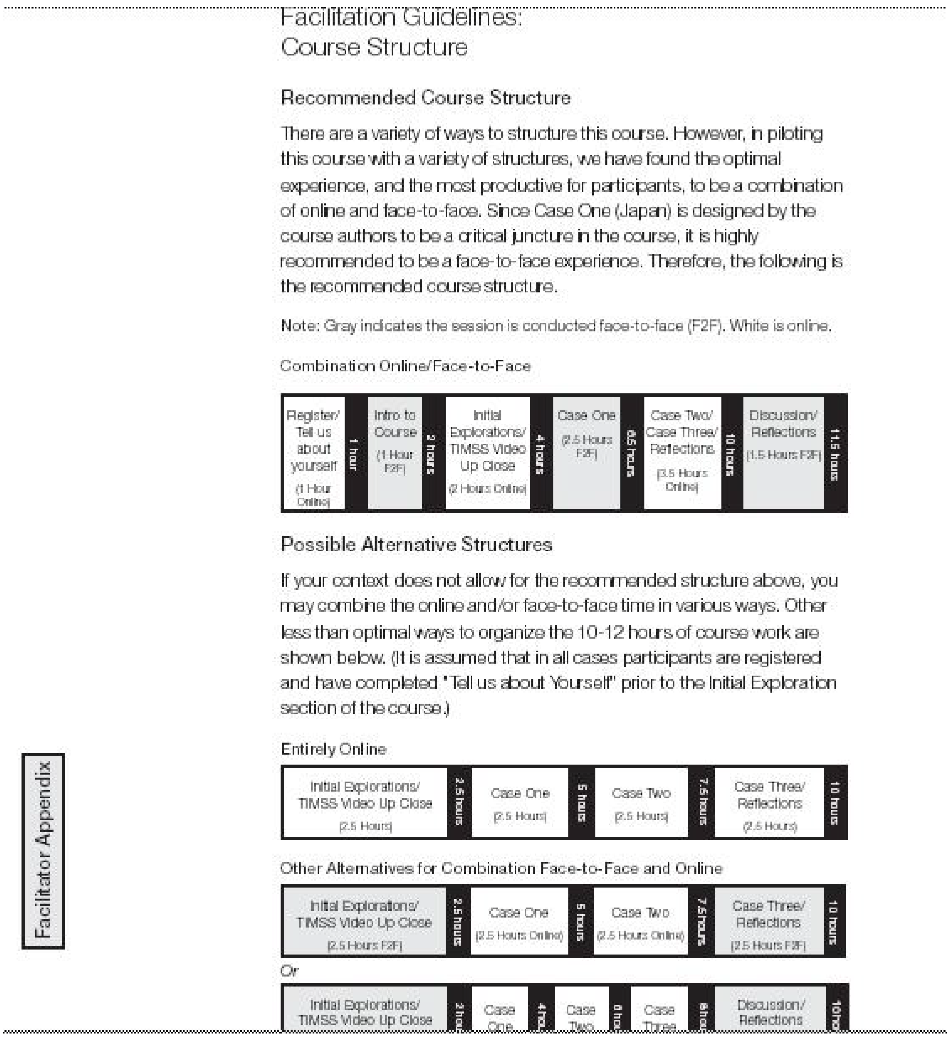
Online Facilitation Checklist	Face-to-Face Facilitation Checklist

☐ Read responses to task from participants—*Introduction to the Problem: Hong Kong*
  ☐ Respond to task using the email feature (*Members List* button or *Course Members* link), asking questions to promote discussion. Think about what messages should go to all members and what should be private. Keep copies of all responses.
☐ Read responses to task from participants—*Exploration: Hong Kong SAR*
  ☐ Respond to task postings, asking questions to promote dialog. Copy yourself on all responses.
☐ Read responses to task from participants—*Analysis: How the Hong Kong Lesson Unfolds*
  ☐ Respond to task postings, asking questions to promote dialog. Copy yourself on all responses.
☐ Moderate the forum: *The styles of teaching you have seen in the lessons so far are quite different. Why? For example, is the teaching style dependent on the content?*
	☐ Link to the previous session
	☐ Mathematics Task—Solve the problem individually, then share solutions
	☐ Lesson Analysis
	  • Explore lesson: TASK
	  • Read math content online
	  • Analysis: TASK
	  • Group discussion on Hong Kong lesson:
	    • *How are the Japanese and Hong Kong lessons similar/different?*
	    • *Why these differences? For example, is the teaching style dependent on the content?*
	    • *How does this relate to the TIMSS Video Study findings?*
	☐ Summing Up
	☐ Preview the next session

Notes

Figure 4-20 Facilitator checklist for online and face-to-face delivery

Facilitators were supplied with a variety of implementation models to provide flexibility. One blended model was recommended as a result of the pilot sessions and the design of the course. However, other structures may work better in some situations so a variety of these were presented (Figure 4-21).


Facilitation Guidelines:
Course Structure

Recommended Course Structure

There are a variety of ways to structure this course. However, in piloting this course with a variety of structures, we have found the optimal experience, and the most productive for participants, to be a combination of online and face-to-face. Since Case One (Japan) is designed by the course authors to be a critical juncture in the course, it is highly recommended to be a face-to-face experience. Therefore, the following is the recommended course structure.

Note: Gray indicates the session is conducted face-to-face (F2F). White is online.

Combination Online/Face-to-Face

Possible Alternative Structures

If your context does not allow for the recommended structure above, you may combine the online and/or face-to-face time in various ways. Other less than optimal ways to organize the 10-12 hours of course work are shown below. (It is assumed that in all cases participants are registered and have completed "Tell us about Yourself" prior to the Initial Exploration section of the course.)

Entirely Online

Other Alternatives for Combination Face-to-Face and Online

Or

Facilitator Appendix

Figure 4-21 Facilitation guidelines for flexible delivery

A sample agenda with times, activities, materials and notes was provided in the facilitator guide for the recommended course structure (Figure 4-22).

The following is an example of an agenda, including facilitation notes, for the recommended course structure, a combination of online and face-to-face.

Register/ Tell us about yourself (1 Hour Online)	1 hour	Intro to Course (1 hour F2F)	2 hours	Initial Explorations/ TIMSS Video Up Close (2 Hours Online)	4 hours	Case One (2.5 Hours F2F)	6.5 hours	Case Two/ Case Three/ Reflections (3.5 Hours Online)	10 hours	Discussion/ Reflections (1.5 Hours F2F)	11.5 hours

Session 1: Registration/Tell Us About Yourself (Approx. 1 hour online)

Time	Activity	Materials	Notes
Approx. 1 hour	Introduction • Participants register online. • Participants go through the Introduction pages of the online course, familiarizing themselves with the software. • Participants post a short bio for themselves in the *Tell Us about Yourself* section. • Participants read a brief introduction and background of TIMSS.	Course Guide for each participant Technical instructions are available in section 2 of the Course Guide (pages 9-20); Information on the Task and Forum Checklist is on pages 24-25.	Send out course materials, including Content Key, preferably at least two weeks before the first face-to-face session. Note: If you had your participants order the course directly, this will have been done by LessonLab. When participants complete the "Tell Us about Yourself" section, send out an email to the entire group to welcome that person to the course.

Facilitator Appendix

Session 2: Introduction (1 hour face-to-face)

Time	Activity	Materials	Notes
15 min	Welcome; introductions – names, grade level and ask: • *What brought you to this experience?* • *What do you hope to gain by participating?* (Continued on next page)	TIMSS presentation if desired	

Figure 4-22 Facilitation guidelines - sample agenda

4.6.5 Evaluation – General Cycle 3

Questionnaire 2, question 4 asks "How would you rate your overall experience with this course?" Of the eleven participants who answered this question in Cycle 3, 7 responded 'very good', 3 'good' and 1 'okay'. Several comments focused on the experience of viewing the videos including: "I enjoyed watching the videos very much …" (Q2.4.P.4.4) and "… I learned a lot from viewing the teachers and analyzing pedagogy" (Q2.4.P.4.6). The experience of completing the course totally online drew the following negative reaction: "Disappointed with the overall lack of interaction with other participants and facilitator. Thought it was just taking a course in isolation – lost a lot of potential value." (Q2.4.P.4.1). However, other comments were more positive on this aspect: “I think this was a very non-threatening experience. …” (Q2.4.P.4.7) and “This is an excellent way to learn.” (Q2.4.P.4.10)

In question 8 “What did you find most useful about the course?” four participants included watching the videos in their answers. Other themes to emerge here included the expert input or in-depth analysis; the task questions that focused participants viewing of the lessons; seeing new strategies of teaching; and the opportunities to explore mathematical concepts. Individual comments were made about the advantage of having access to the course 24/7; being able to replay the videos at will; the consistency within the cases; and that the proposed materials costs only would make the course accessible to all.

As with the other cycles, all respondents to this questionnaire in this cycle indicated they would recommend the course to a friend (Q2.12). Nine indicated that they would take a similar course if it were offered (Q2.15), one participant was undecided.

4.6.6 Summary of refinements from Cycle 3

Table 4-72 below shows all refinements from Cycle 3. Once the refinements were implemented the course was considered ready for publishing at the same time that the findings from the 1999 TIMSS Video Study (Mathematics) were released by the US Department of Education, National Center for Education Statistics (Hiebert et al., 2003).

Table 4-72 Refinements from Cycle 3

Distribution of materials	Course materials to be distributed by courier after being ordered online.
Introduction	Design and add page *Using the software*
Introduction	Add task *Tell us about yourself*
TIMSS Video Study Up Close	Add forum to discuss findings
Reflections	Change task *Reflecting on mathematical thinking* Split the large question into two parts the first talking about the lesson segment and the second suggesting changes
Facilitation	*Facilitator Home page* added at start of course
Facilitation	Facilitation training redesigned ready for testing
Facilitation	Topic *Facilitator Resources* added to end of course. Accessed only by facilitators and contains pertinent information
Facilitation	Facilitator course guide prepared ready for facilitator testing and refinement cycles

4.7 Summary of Stage 3 of the design-based research

At the end of this stage the course was ready to be released for general use by mathematics educators. In its final form, as shown below, the course had seven topics, thirteen online tasks and five forums.

- Introduction
    - Tell us about yourself (Task)
- Initial Explorations
    - Getting your feet wet (Task)
    - What are the major similarities and differences …?(Forum)
- TIMSS 1999 Video Study Up Close
    - What did you find interesting or surprising in the research? (Forum)
- Case 1: Japan
    - Content
        - Introduction to the problem: Japan (Task)
    - Exploration
        - Exploration: Japan (Task)
    - Focus on content
    - Analysis
        - Analysis: How the Japanese lesson unfolds (Task)
        - How did the teacher engage the students in serious mathematical thinking? (Forum)
    - Viewpoints on the lesson
- Case 2: Hong Kong
- Case 3: Switzerland
- Reflections
    - Reflecting on mathematical thinking (Task)
    - Reflecting on your teaching (Task)

The task and forum responses and general feedback from the many participants in the three cycles during Stage 3 of the research was evidence for the development teams that the course worked on many levels. The response from one participant in the last cycle to the last question in the last task reflects that the overall objective of the course had been met:

> I know I am trying some of the things I saw on the video, to deepen understanding of what's going on. I tried using the inequality lesson and was amazed at how much the kids became engaged-the story really caught their attention from the start. When I allowed them to work the problem, they wanted verification if they were right-I wouldn't give it-just encouraged them to explain why they thought they had an answer. I actually saw the first two methods and the equality one. The first was done by a student who is extremely low performing. When I finally got her up, the other kids were surprised at her response and gave her their attention. When we shifted to practice-she actually wanted to try...It was interesting because this happened all day with various classes. The unexpected was the involvement of low end and the opportunity to allow them to shine in front of their peers. (T.RF.2.3.P.4.5)

Chapter 5 Conclusions

5.1 Introduction

The discussion in this chapter will focus on the last stage of the design-based research (Figure 5-1). At this point, as described in 1.3.4, the solution is considered ready to be used. Reflection on the stages preceding this one will enable the researcher to produce a set of design principles to inform future practice. These principles are the crux of the main question of this research: *What are the design principles for developing online professional learning to disseminate the outcomes of educational research that will inform teachers' practice?*

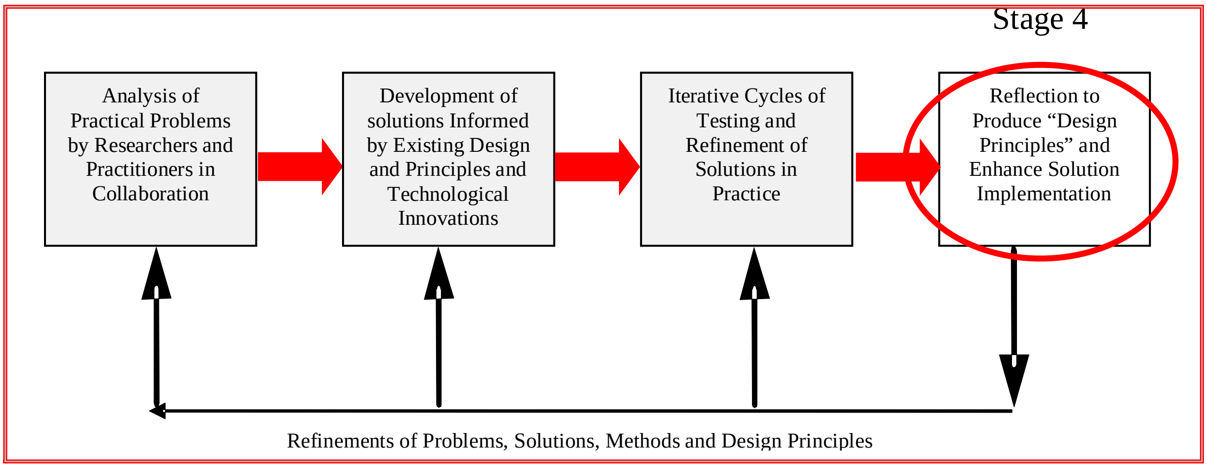


Figure 5-1 Design-based research Stage 4 (Reeves 2006)

The sub-questions for this research are:

- What is the impact on teachers' mathematical knowledge and practices of an online professional learning resource that focuses on analyzing culturally diverse mathematics lessons from high-achieving countries?
- What is the impact on teachers' understanding of educational research and its application to practice, of an online course designed around the findings and lesson videos of a major mathematics education research project?
- What structures support flexible delivery methods of an online, interactive course for teacher professional learning?

These will be discussed using findings from this research; data from an online questionnaire attached to the course once it was publically available; and current literature.

Limitations of the findings will be included in the discussions addressing in particular technology advances since this research was conducted.

5.2 Design principles

As with design-based research Stages 2 and 3 discussed previously, the design principles generally fall into the categories of technology, content and pedagogy, and implementation.

5.2.1 Technology

This was the first course developed using the LessonLab online course software and so the experiences and refinements from this design-based research were critical to the success of not only this course but the many that would follow. The course software had been preceded by LessonLab Viewer, a platform for single lessons with videos, resources, tasks and forums and many technical aspects had been refined during that stage (see 3.2.4.4.1.1and 3.2.4.4.1.2). However the groups using the lesson viewer software were generally in face-to-face settings in computer laboratories for the initial setting-up and registration processes. With this course, the plan was that individuals would buy the course materials online and then, after receiving the materials and a registration code, would set-up their computers, register and take the course individually and remotely online. It was planned that groups would take the course in flexible delivery methods but only after facilitators had been trained.

5.2.1.1 Setting-up

At the time of the development of the LessonLab software, Real Player was the only software that enabled video to be used cross-platform. This resulted in limitations on the host browsers with different browsers required for the different platforms (see 3.2.4.4.1.2). This was an on-going problem for technical support at LessonLab with many individual end-users lacking the skills, understanding and/or confidence to check and install the necessary third-party software. While sessions conducted in computer laboratories usually had the support of a laboratory manager, it was still necessary to provide guidelines for basic requirements. The problem with essential software not being available in the computer laboratory, even though the basic check had been conducted by the computer manager, was discussed in 4.4.2.1 and in 4.5.2.1.2. Thus the first technology design principle related to the setting-up of computers ready for the course software.

5.2.1.1.1 **Design principle 1: Setting-up**

Support end-users to access technology by:

1. Providing automated system and software checks at registration or login
2. Providing third-party software or site links on CD-ROM or DVD
3. Providing protocols and guidelines for using the software in computer laboratories.

5.2.1.2 Technical support

During the process of setting-up, registering onto the LessonLab portal and using the software, participants often needed help. In the face-to-face sessions this was provided directly by the facilitator and/or researcher. However when the participants worked remotely, even if they had been through the registration process face-to-face, this help was more critical, as discussed for example in 4.5.2.1.2. Help needs to be provided in a timely fashion and available in a number of forms to suit different users at different points in the process. Throughout the testing cycles, problems and feedback from participants and the implementation team were provided to the technology team who then worked on a variety of support structures. These included the help desk, online, and printed help. Updating all of these was an ongoing task due to problems such as changes in the third-party or course software.

5.2.1.2.1 **Design principle 2: Support**

Support end-users in an online environment through:

1. Help desk
    a. Establishing protocols and procedures for handling requests for help including collating and reporting aspects such as the responses, times taken and outcomes.
    b. Providing timely responses through phone or email.
    c. Keeping abreast of software or system updates.
2. Online help
    a. Providing linked online help in an easily accessible form.
    b. Including a list of FAQs to succinctly cover a diverse range of points.
    c. Keeping the information up-to-date.
3. Printed help
    a. Providing a printed course guide with details on the system requirements, registration and logon procedures.

b. Including basic information such as navigation and working with interactive components.

The two design principles above (5.2.1.1.1 and 5.2.1.2.1) support participants through Salmon's first stage of 'access and motivation' (see 2.5.6). If they become frustrated at this stage of their journey, then participants are liable to struggle to keep up with the group and the experience of working through the course may be marred by negative reactions.

5.2.1.3 Online support

As well as scaffolding the initial access to the course it was also important to provide clear navigation and tools for users to move through the course and track their progress (see 4.5.2.3 and 4.5.2.4). Navigation was provided at different levels in the course. At the top level, topics could be accessed from a list on the left-hand side of the screen with a list of the topic's content pages being revealed when the topic was clicked thus enabling access to individual pages. Within the course, previous and next page links were provided at the top and bottom of each screen. *Start where I left off* and *My progress* tools worked at an individual level.

5.2.1.3.1 Design principle 3: Scaffold online

Scaffold end-users online by:

1. Providing clear navigation at different levels in the courseware.
2. Providing tools for tracking progress.

5.2.1.4 Video

The central component of the course is videotaped lessons. Experience through the development and use of LessonLab Viewer showed that end-users could react quite strongly to the quality of the video to the point where it distracted from the lesson and task at hand. However the streaming of video at the time of this research was limited to a lower quality compression rate. To cater for this, higher quality video was provided on a CD-ROM and the course online software could access this locally while pulling all other data such as transcripts from the internet.

The policy on using videotaped lessons at LessonLab was that the whole lesson would be used and not edited segments. However, as discussed in 4.4.2.3, the decision was made that where time spent viewing an isolated segment was critical, this policy needed to be rethought and it was agreed that an edited segment would be used and the full lesson would be provided in the course resources. Where a number of segments from the one lesson were to be used, time links from the whole lesson would be embedded in the course pages or task questions rather than edited segments.

5.2.1.4.1 **Design principle 4: Video (technology)**

The use of videotaped lessons in the course would be enhanced by:

1. Providing two standards of video, one for streaming and a higher quality one on CD-ROM for local use.
2. Providing video clips when time is critical and only a small segment of a lesson is to be watched. Time links from the whole lesson should be used when several segments are referenced. Where clips are used, the whole lesson should be made available as a resource.

5.2.1.5 Comments on design principles technology

At the time when this software was developed, the only viable option for streaming video of the length of the TIMSS public-release videos cross-platform was using RealMedia format software. The use of RealMedia Player in turn dictated browser suitability for each platform (Netscape for the Mac OS and Internet Explorer for Windows). Adding to these limitations were the versions of operating systems, browsers and players. Major updates by third-party providers could cause problems with the LessonLab software. For example when Mac OS X first became available, users were required to revert to MAC Classic to continue using the software until the technology team could update and test the program (a very difficult task since the software always needed to work with the new and ‘old’ third-party software). This, of course, meant that the automated checks for system and third-party software also needed to be updated in both the online and CD-ROM versions.

Some years after this research, it became possible to use QuickTime video format across both platforms and this became the preferred format at LessonLab since the quality was generally better and a wider variety of internet browsers could be used. This meant all the video in any pre-existing programs had to be re-formatted to suit QuickTime – a lengthy process. However, it was not a simple task to just change the video format used, a new version of the course had to be built - eventually a QuickTime version of the *TIMSS Video Studies: Explorations of Algebra Teaching* course was created.

As new browsers were developed for the internet such as Firefox and Safari the technology team adapted the courseware to be compatible with these. The development of Flash Player brought a new level of streaming and cross platform capabilities to the software making it far easier to access and use.

Generally the developments within the internet environment; the greater broadband width available for accessing the internet as opposed to the dial-up modems used by many of the pilot participants; and the greater online experience of teachers since the time of this research make some of the design principles less pertinent today. However at the time they were critical for a successful online experience and did inform the practice at LessonLab for many years following the research. Other design principles such as those supporting the end-user and the availability of unedited lessons, are just as pertinent today as when they were devised.

5.2.2 Content and pedagogy

The guiding principles used in the development of the solutions in Stage 2 of the design-based research were generally found to have worked well for the overall objectives of the research to disseminate the findings of the TIMSS Video Studies in a way that would inform practice. Thus they are central to the design principles emerging from the research. Other design principles have been added as a result of observations and refinements made during the testing cycle.

5.2.2.1 Research

The TIMSS Video Studies research was central to the course. It informed both the content and the pedagogy employed in the course design. Findings from the research were selected to be central to the course and lessons were selected from the public-release set from the study.

The methods used by the TIMSS Video researchers were simulated in the course. For example, participants viewed and explored the lessons before analyzing them at a deeper level. The exploratory process was first used in the topic *Initial Explorations* (3.2.3.6.2) before participants read about the study and its findings in the topic *TIMSS 1999 Video Study Up Close* (3.2.3.6.3). The discussion in this topic linked aspects of the research method and findings, to the interactive task completed in the previous topic.

5.2.2.1.1 **Design principle 5: Research**

Support the understanding of research and its findings by:

1. Providing experience of the research process. Before reading about the research participants learn about the research process by doing research.
2. Providing links back to the research findings as appropriate in the course.
3. Providing links from the research findings back to practice when appropriate.

5.2.2.2 Video

Video was central to all research and professional development conducted at LessonLab and to this course. In the course the videos were selected from the set of TIMSS Video Studies public-release lessons. The videos opened the way for participants to move “beyond their own personal and educational experience” by providing “productive disequilibrium” and a “new terrain for learning” (Ball & Cohen, 1999, p.15).

It was expected that for many participants this would be their first opportunity to examine videotapes of lessons as well as ones from different countries. Reactions to the videos could be affected by many aspects including the quality of the video and audio, the need to read subtitles in videos from non-English speaking countries and, deal with educational and cultural differences. Technical considerations around quality and accessibility were discussed above in 5.2.1.4. Scaffolding the viewing experience in the course was via small segments of a variety of lessons used in the *Initial Explorations* topic (3.2.3.6.2). This also linked to the following topic about the TIMSS Video Studies research and findings, providing first hand experience of what the findings looked like in practice. Using the opening segments of four diverse video lessons paved the way for the cultural aspects to become less of a focus and the lesson content and pedagogy more prominent in the cases to follow. The viewing of the segments was so successful in the first testing cycle that many participants viewed far more of the lessons than intended by the development team resulting in the need for video clips to replace the complete lessons at this point (see 4.4.2.3 and 5.2.1.4.1).

5.2.2.2.1 **Design principle 6: Video (content and pedagogy)**

Scaffold the viewing of culturally diverse lesson videos by:

1. Providing an opportunity for participants to view and comment on video segments taken from a variety of lessons.
2. Providing the opportunity to question teaching goals in the segments.

3. Providing opportunities to discuss similarities and differences identified in the diverse segments and in participant's own practice.

5.2.2.3 Content knowledge

The content and pedagogy team agreed with the literature (2.5.1 and 2.5.2.1) that an understanding of the subject content being covered in a lesson was an essential part of what teachers should know and was critical for analysing lessons. Therefore this was the first element of each case study. It was generally expected that the mathematics, year 8 level, would be familiar to participants although some concepts may have been presented in a different way. In Questionnaire 2 in response to the question "Did you learn anything new about mathematics?" a total of 27 (73%) of the 37 responders from the four pilots answered yes (Q2.9). This figure supports subject content understanding as an essential component of this online course and hence it is included as a design principle.

5.2.2.3.1 Design principle 7: Content knowledge

An understanding of subject content is a basic requirement for analyzing lessons and can be developed by:

1. Participants working through the mathematics of the lesson before viewing the lesson.
2. Allowing participants to experience possible mathematical misunderstandings as appropriate.
3. Scaffold participants to look at the mathematics from different perspectives through activities and/or expert commentary.

5.2.2.4 Pedagogical content knowledge

As discussed previously in 2.5.2, pedagogical content knowledge is included in Shulman's list of minimum categories needed for a teacher knowledge base (Shulman, 1987, p.8). During the process of lesson exploration and analysis in the course, the participants have the opportunity to expand their pedagogical content knowledge. They bring to the experience their own pedagogical content knowledge and use this as they reflect on the videotaped lesson and share observations and ideas with their peers in the online tasks and forums and/or face-to-face discussions.

5.2.2.4.1 Design principle 8: Pedagogical content knowledge

Encourage the development of pedagogical content knowledge through:

1. Guided exploration and analysis of videotaped lessons.
2. Shared responses that include evidence from the videoed lessons and/or references to participants' own practice.
3. Discussions online through forums and in face-to-face settings where applicable about the content pedagogy of the lessons.

5.2.2.5 Case studies

Central to this online course is the case study. The case study consists of three main components – content, lesson exploration and lesson analysis. The philosophy of including the content component has been discussed above in 5.2.2.3. The lesson exploration is guided but provides the opportunity for participants to think about the lesson from a general perspective before they start the analysis. The analysis is guided by task questions and tends to focus on the bigger ideas of the lesson. Interwoven with these three components is supporting expert input on the content and lesson. This material is placed after the participants have had the opportunity to explore, construct and share their own ideas about the content and lesson, and is included mainly to provide different perspectives and to support the totally online and/or non-facilitated participant. A lesson graph provides a quick overview of the lesson.

The pattern within the case study was designed to provide a process for participants to follow that would assist them in developing their analytical skills. Opportunities within each component are provided for individual work and for reading other responses and sharing ideas through online forums. Wherever relevant, links are made to the research and to the participant's own practice. In this course three case studies are included with each following the same pattern and sharing similar online tasks. Each case has one lesson, each from a different country. At the end of each case, a forum is included that discusses the current case and links to previous cases.

5.2.2.5.1 **Design principle 9: Case studies**

Develop lesson analysis skills through case studies. Each case study provides:

1. A pattern of content examination, lesson exploration and lesson analysis.
2. Expert input on content and pedagogy of the lesson.
3. Diversity by including one lesson from a one country in the TIMSS Video Study.
4. Similar tasks to reinforce the process of lesson analysis.

5. A forum at the end of the case to facilitate reflections on the lesson.
6. Resources such as lesson graphs (both online and in the printed course guide) to provide a quick and convenient overview of the lesson.

5.2.2.6 Links to practice

During the development of the guiding principles it was recognized that the participants' teaching practice would both inform and be informed by the online course. To promote this two-way flow, links were provided at pertinent points to encourage participants to refer back to their practice by, for example, comparing aspects of the videoed lesson with their own experience. It was found that the positioning of the links was very important and generally worked best during or after the analysis stage rather than in the exploration as had been the case in cycle 1 (see 4.4.3.4.1).

More direct links were provided after Cycles 1 and 2 when the *Reflections* topic was added containing two tasks, one based on a US video clip (4.4.3.2.1 and 4.5.3.4.2) and the other on the participants own practice (4.5.3.4.3). The first task was designed to encourage participants to reflect on specific findings of the TIMSS Video Study (the classification of problem types) and then to apply the analytical skills developed during the cases. The inclusion of the US lesson provided a link back to a more familiar setting for participants. In the second task participants were encouraged to reflect on how their experience with the course, and in particular studying the public-release lessons within the cases, may change their own practice. They are then asked to share more specific ideas on how they plan to implement these changes and finally to report back after they have applied the changes.

The final reflection task was developed as a response to the voluntary sharing of such experiences by participants in the early cycles (4.4.4.1 and 4.4.4.2). The online tasks were provided to allow all users to share these experiences but it was expected that this may be the focus of follow-up or extended professional development programs with many of the blended implementations.

5.2.2.6.1 Design principle 10: Links to practice

Opportunities for teaching practice to both inform and be informed by professional development can be provided by:

1. Linking to teacher's own experience at appropriate points within the interactive components of the course.
2. Scaffolding the connections between the unfamiliar and familiar teaching experiences.
3. Encouraging reflection and sharing of ideas and then outcomes of changes to practice.

5.2.2.7 Knowledge construction

The course and, in particular, the cases were designed to scaffold participants to construct their own knowledge about the research, the lessons, the mathematics and lessons analysis skills. Questions within the interactive tasks and forums guided the process but the placement of these encouraged teachers to reflect and form their own opinions before sharing responses with their peers in the group or reading the input from content and pedagogy experts. By repeating the same process within each case their ideas and skills were consolidated. Being asked to link back to the research and to their own practice helped to reinforce the relevance of the course to their teaching.

5.2.2.7.1 Design principle 11: Knowledge construction

Encourage participants to construct their own knowledge by:

1. Providing questions that guide through the process of content understanding, lesson exploration and analysis.
2. Providing the opportunity for individual reflection and knowledge construction.
3. Providing the opportunity to reflect and share ideas and opinions with peers.
4. Providing expert information after the individual knowledge construction opportunities.
5. Providing the opportunity to consolidate and increase the knowledge constructed by applying it in similar cases.

5.2.2.8 Situated learning

One of the theoretical underpinnings informing the guiding principles of the development of solutions of the research was that of situated learning. Collins' definition of situated learning as "the notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life" (Collins, 1988, p.2) was discussed previously in 2.5.3.1 and 2.5.3.1.1. The acceptance of video as satisfying the authentic basis requirement of situated learning was also discussed in section 2.5.3.1.2. Examining again the list of critical characteristics for designers of situated learning environments developed by Herrington and Oliver (1995) in light of observations and data collected during the testing and refinement stage, the researcher can find evidence that all of the characteristics have been satisfied in the development of this online course. While the last critical characteristic in the list, "Provide for integrated assessment of learning within the tasks" (J. Herrington & Oliver, 1995, p.3), may not at first seem relevant to this course, in fact after implementation, successful completion of all tasks was used as the measure to satisfy the requirements for the optional continuing education unit (CEU) from UCLA (4.6.4.2.2).

One measure of whether or not the course provides situated learning is to show evidence that the outcome for participants has indeed been "…useful in real life". While participants in the testing cycles were not directly asked this, a more focused question was included about the course tasks and forums (Q2.7). The mean values of the findings from the four pilot groups are shown here in Table 5-1.

Table 5-1 Questionnaire 2 Q7 Mean values Pilots 1-4

7. Please indicate the extent to which the tasks and forums helped you in the following areas.				
5 = Extremely helpful 4 = Very helpful 3 = Undecided 2 = Somewhat helpful 1 = Not at all helpful				
In understanding the content of the course	4.2	4.1	3.6	3.9
In learning a framework for the analysis of classroom practice	3.9	3.8	3.6	3.5
In applying the content to real classroom situations	4.1	3.5	3.8	3.7

The means for the three questions for the four pilot groups are, in general, close to the '4=very helpful' measure. The last two questions focus on analysis skills and transfer to practice and provide a clear indication that the participants consider that the activities within the course were useful in their practice.

5.2.2.8.1 **Design principle 12: Situated learning**

Provide authentic activities to maximize the relevance to practice. These activities should be guided by the nine characteristics of situated learning devised by Herrington and Oliver (1995, p.3), in particular by:

1. Providing authentic contexts
2. Including expert input
3. Providing multiple perspectives
4. Supporting collaborative construction of knowledge

5. Promoting reflection and articulation
6. Providing scaffolding

5.2.3 Implementation

One of the overriding objectives in designing this vehicle to disseminate the research and its findings to practitioners in a way that would inform practice was that it would support flexible delivery. For this reason, the cycles of testing employed a number of different implementations that were also tested and refined. The design principles resulting from this process were used to inform and guide the development of future online courses and their implementations at LessonLab. The principles include support strategies for both individuals and groups for both online and blended implementations.

5.2.3.1 Flexible delivery

As mentioned previously (3.2.5.1), it was always intended that the online course being developed for this research would suit a variety of implementation models. The online course was standalone and could be taken by individuals with or without a facilitator. The course could be started at anytime and the user would be assigned to a group at the time of registration. When the groups became too unwieldy due to size or time lapsed since its inception, a new group would be started. This method brought together participants from a wide geographical area with varied qualifications and experience, able to share ideas remotely through the task responses and forum discussions.

After facilitators had successfully completed the training program (3.2.5.4.4 and 4.6.4.2.2), the course was available for groups with facilitators deciding the implementation method. Most of these groups used a blended model, mixing online work with face-to-face sessions. Many used it as an introduction to long-term ongoing professional development focusing, for example, on the final task, *Reflecting on your thinking.*

5.2.3.1.1 **Design principle 13: Flexible delivery**

Make the delivery mode flexible by:

1. Providing a standalone online course.
2. Providing suitable levels of technical support (help desk, printed and online) and course materials and resources.

3. Providing opportunities for participants to form a community of learners through sharing and discussing ideas via interactive components such as forums.
4. Providing the option of using an online facilitator.
5. Providing facilitation for the blended implementations.
6. Providing the means to customise the blended implementations.

5.2.3.2 Scaffolding

Scaffolding participants in many ways was a major focus of all development teams and its significance can further be seen as it is a design principle of each area technology, content and pedagogy, and implementation. In implementation, it involves strategies to support users in the online environment to become comfortable and successful online users thus maximizing their learning potential.

One of the guiding principles was to scaffold users through the five stages to becoming competent online learners as identified by Salmon (2000) (see 2.5.6). This is a strong component of this design principle. Strategies to support it were developed in the design stage and then modified while others were added during the testing and refinement cycles. For example, the task, *Tell us about yourself*, was embedded in an information page on using the software early in the first (*Introduction*) topic. It scaffolded through Salmon's first two stages 'Access and motivation' and 'Online socialization' by making users familiar with the software, encouraging a community of learners through the sharing of information, and making participants aware that their completed task responses would be available to the group online.

5.2.3.2.1 **Design principle 14: Scaffolding**

Scaffold users to maximize their online learning opportunities by:

1. Using Salmon's (2000) five-stages to successful online learning, to identify opportunities to advance online learning.
2. Providing easily-navigated pathways through the online learning environment.
3. Providing an overview of the pathways both online and in the course guide.
4. Promoting the use of the online tracking tools (Design principle 3, 5.2.1.3.1).
5. Providing a task and forum checklist online and in the printed course guide.

5.2.3.3 Course guide

What to include in the printed course guide was the topic of many discussions during the design and testing stages. It was agreed that the guide was essential especially given that at the time the use of online courses incorporating video in professional development was minimal. Feedback during the testing cycle reinforced the value to the participants of the guide with indications that different participants found different sections of it most useful (4.5.4.2 and 4.6.4.1 and Table 4-71).

In this implementation the course guide contained an overview of the development and objectives of the course, a discussion on the TIMSS Studies, system requirements and how to get started and navigate the software, a course planner, a task and forum checklist, spaces for note taking for the tasks and forums, and resources such as the lesson graphs and links to TIMSS related sites. The guide also included the CD-ROM that contained the start-up program, third-party software and the higher quality video.

5.2.3.3.1 **Design principle 15: Course guide**

Support participants in the online environment by:

1. Providing a course guide containing essential information, printed resources and any additional materials required such as CD-ROMS or DVDs.

5.2.3.4 Facilitation

Participants choosing to take the course totally online had the option of joining a facilitated or non-facilitated group. The facilitator's role was to stretch participants thinking through thought provoking questions and comments especially in the online forums. After suitably qualified teacher professional developers had completed the online course they were eligible to complete facilitator training after which they could enroll and facilitator their own group.

As describe previously in 4.6.4.2, the implementation development team planned, tested and refined the facilitator training and developed online and print resources including an extended facilitator guide that incorporated an annotated version of the participants' course guide. The technology team developed facilitator homepages that enabled the online course to be personalized by the facilitator for each of their groups.

Within the guide and training, facilitators were provided with many flexible implementation models and provided with extra resources and extension ideas so that they could extend or modify the course to suit local requirements. Within the software facilitators could add global comments at the top level of forums, and any comments they added to forums had their name in bold, rather than the normal font used for participants.

5.2.3.4.1 **Design principle 16: Facilitation**

Facilitation can improve the professional development experience for participants and can implement a blended model that suits local needs. For this to occur, facilitators should be:

1. Suitably qualified professional developers who have completed the online course.
2. Trained specifically to facilitate the online course.
3. Competent to select, plan and deliver a blended model that suits local needs.
4. Provided with a facilitator guide centered around the participants’ course guide with hints for each topic, extra resources on course content, extension ideas for use during implementation, facilitation tips and a variety of implementation models.
5. Provided with a range of resources and online tools such as:
    a. An online home page to personalize the course and to display pertinent group information.
    b. An online group page for uploading and sharing resources such as lesson plans, files and web links.
    c. Forums they can create for group discussions.
    d. An online resource folder available only to facilitators to hold information and resources such as ordering and tracking templates.
6. Supported by technology and implementation team members.

5.2.4 Summary of design principles

Table 5-2 below contains a summary of the design principles that evolved from the design-based research conducted in the development of the online course *TIMSS Video Studies: Explorations of Algebra Teaching*.

Table 5-2 Design principles – technology, content & pedagogy, implementation

Design principles	
Technology	
1. Setting-up	Automate system checks Provide third-party software Devise lab protocols
2. Support end-users	Help desk Online help Printed help
3. Scaffold online	Online navigation Online tracking tools
4. Video (technology)	Two standards – local & streamed If video clips used, provide whole lesson
Content and pedagogy	
5. Research	Learn by doing Link to research Link research to practice
6. Video (content and pedagogy)	Diversity Question teaching goals Identify similarities and differences
7. Content knowledge	Work the mathematics Experience mathematical misunderstandings Scaffold different perspectives
8. Pedagogical content knowledge	Guided exploration and analysis of lessons Include video evidence and references to practice Share through online discussions
9. Case studies	Pattern of content and lesson exploration and analysis Expert input on content and pedagogy Diversity Online tasks to guide Forums for reflection Resources such as lesson graphs
10. Links to practice	Compare current practice with case lessons Scaffold between familiar and unfamiliar Reflect and share changes
11. Knowledge construction	Guiding questions Individual reflection Sharing and discussing Expert input Consolidate and increase by application
12. Situated learning	Authentic activities and contexts Expert input Multiple perspectives Collaborative construction of knowledge Reflection and articulation Scaffolding

Implementation	
13. Flexible delivery	Standalone online Technical support and resources Community of learners Optional online facilitation Blended implementations with facilitation Customise blended models
14. Scaffolding	Salmon (2000) – 5 stages to successful online learning Easily-navigated pathways Overview of the pathways Use online tools Task and forum checklists
15. Course guide	Printed essential information and additional materials

16. Facilitation	Suitably qualified professional developers
	Completed the online course
	Trained for the online course
	Deliver a variety of blended models to suit local needs
	Facilitator guide
	Resources and tools
	    Home page
	    Sharing page
	    Group forums
	    Own resource folder
	Support provided

The design principles were used to inform the development of many more online teacher professional development courses at LessonLab. In particular the pattern of hands-on content experience and lesson exploration followed by lesson analysis, the bases of the cases used in this course, were found to be very effective. The inclusion of expert input on the content and lesson was also a standard part of courses with this being in the form of text as in this course, or delivered as a video presentation. Linking to practice was always seen as an integral part of the online courses, a two-way flow with the teacher's own knowledge and experience contributing to responses and discussions in the interactive tasks and forums, and then insights gained from these flowing back to their practice.

The delivery of courses remained flexible but, in general, implementations tended to be blended with facilitators trained and/or supplied by LessonLab. Few courses were made freely available to individuals as this one was. Courses continued to be developed in collaboration with a variety of educational organizations for a specific application using client identified lessons videotaped by LessonLab or supplied by the client. Some implementations involved teachers also videotaping their own lessons and sharing these with their peers through the online software.

The ease of accessing and setting-up the software continued to be high priority for the technology group. As mentioned in 5.2.1.5, changes to the third-party software generally resulted in changes to the course software but almost always required changes to the automatic checking system. At the time of this research that was included on the CD-ROM but eventually it was done over the internet when users registered and logged onto the portal, minimizing the modifications of the CD-ROMS. Up-to-date online help and the ongoing tracking of help desk calls streamlined technical assistance and informed modifications made to the software and to the training of facilitators.

5.3 Impact on teachers' mathematical knowledge and practices

The first sub-question for this research was: *What is the impact on teachers' mathematical knowledge and practices of an online professional learning resource that focuses on analyzing culturally diverse mathematics lessons from high-achieving countries?*

Evidence collected during the testing and refinement cycles indicates that participants believed they increased their mathematical knowledge. As discussed in 5.2.2.3 above, 73% of the 37 pilot participants who answered questionnaire 2 (Q2.9), claimed that they had learnt something new about mathematics. In optional comments to the question the focus seemed to be more on strategies for teaching it, indicating that there had been an impact on the teachers' pedagogical content knowledge. "I learned how to create physical representations of variables contained in an expression" (Q2.9.P4.10). "Strategies that incorporate advanced & concrete concepts in the same lesson." (Q2.9.P1.11). "Japan one problem 5 levels addressed, inequalities." (Q2.9.P3.2)

After the course had been published, individuals or groups could enroll to take the course at a time that suited them (p.57). An anonymous online survey (Zoomerang, 1999) was added to the end of the course for all users. Fifty-five percent of the first 266 participants to respond to the survey indicated that they had learnt something new about mathematics. Since the majority of participants are mathematics' educators and the lessons in the course focus on grade 8 mathematics, this may be quite surprising. Ninety percent of 260 respondents indicated they had learnt something new about teaching. These findings were clear indicators for the development team that the course had successfully expanded participants knowledge of both content and teaching (Ball & Cohen, 1999; Shulman, 1987).

In response to whether or not their teaching may change as a result of the course, eighty-two percent of the 266 respondents thought that it would somewhat (50%) or significantly (32%). Only one percent thought it would not change at all. This data supports the notion that the participants believed that the course had fulfilled the design principle of transference to participants' own practice. Nevertheless, it is recognized that various levels of transfer will ensue depending, not only on the quality of the course, but also on the school context in which new professional learning is implemented (A. Herrington, Herrington, Hoban, & Reid, 2009).

5.4 Educational research

The second sub-question for the research was: *What is the impact on teachers' understanding of educational research and its application to practice, of an online course designed around the findings and lesson videos of a major mathematics education research project?* In this case the biggest impact was created by teachers exploring and analyzing the content and pedagogy of the public-release lessons. While the research objectives and methods were discussed along with the findings in the topic *TIMSS Video Up Close*, it was the simulation of the research and the development of analytical skills using the lessons that were paramount in the course.

Table 5-3 Mean responses to the research topic Pilots 1-4

5. Please indicate the extent to which you found TIMSS Video Up Close interesting and useful				
5 = Extremely 4 = Very 3 = Undecided 2 = Somewhat 1 = Not at all				
Interesting	4.0	3.7	3.6	4.2
Useful	3.7	3.7	3.3	4.0

Table 5-3 above shows the mean ratings given by each pilot group to the question on how the interest level and usefulness of the topic discussing the TIMSS research. The level of interest scored slightly more highly than usefulness, but apart from Pilot 3's useful rating, all measures indicated that participants found the research very interesting and useful.

5.5 Flexible delivery

The third sub-question for the research was: *What structures support flexible delivery methods of an online, interactive course for teacher professional learning?*

This sub-question parallels design principle 13 that the course should support flexible delivery methods. As described previously, a variety of delivery modes were tested and refined during the cycles of Stage 3. One of the main requirements for all modes being successful was the scaffolding and support provided. Scaffolding was provided in each of the areas technology, content and pedagogy, and implementation to assist participants to become successful online learners whether they opt for totally online delivery or a blend of online and face-to-face. The scaffolding provided in this research is discussed in more detail in the design principles 3, 6, and 14.

Support for the online experience was largely provided by the technology and implementation teams. With the former it was important to provided timely support especially in the early stages of access to the technology. As discussed in design principles 1 and 2, support occurred in a variety of forms, both directly and indirectly. Facilitation was critical in supporting flexible delivery, especially for blended modes. The training and resources of facilitators as discussed in 4.6.4.2 and in the design principle 16 (5.2.3.4.1), provided the means to the course being adapted to suit local needs.

Evidence that the course caters for flexible delivery can be found in data collected from the online survey embedded on the last page of the published course. Of the first 266 respondents, 36% had completed the course totally online and facilitated, 11% had chosen the totally online non-facilitated option, and 53% participated in blended models of face-to-face meetings combined with online sessions.

5.6 Limitations of the study

As discussed in 3.2.2 the researcher was a member of all development teams that conducted this research and had overall responsibility at LessonLab for the project. While this provided excellent access to all aspects of the research, it did open the interpretation of it to the subjective views of the researcher. However, as the design and implementation stages of the research were conducted by teams from the stakeholders

(1.3.1), each with a history in educational research, individual influence was minimal during these stages. Decisions on the data to be collected, the format, type and means, were made at the team level. Further analysis of the data after the course had been launched and the focus of this thesis is the work of the researcher.

The data collected provided multiple perspectives from the designers, observers and participants. The researcher selected from this rich source to explain the journey through the design-based research and to justify the decisions made for the final product and design principles emerging. While the researcher acknowledges the subjectivity of this process, an overall objective has been to represent the "multiple perspectives of reality" (Merriam, 1998, p.22) evident through the research.

During Stages 2 and 3 of this design-based research many decisions were made based on the participants' experience with technology, the technology itself, the software, and the networks available both in schools and at home. As was shown in Tables 4-6, 4-7, 4-36, 4-37, 4-41, 4-42, 4-59 and 4-60, computer usage and connection to the internet varied across the groups. Most participants indicated they were regular users of computers but unfortunately the questionnaires did not elicit how participants used computers nor how often they accessed the internet. The types of internet connections varied widely indicating that video streaming would be difficult for many, such as those with only dial-up. Other challenges related to technology included service providers restricting access to third-party programs needed by the LessonLab software, the age of computers, and firewalls and other restrictions in school computer laborites (see 4.4.2.1, 4.5.2.1 and 4.5.2.1.2). Some of the refinements during Stage 3 of this research were due to such issues with the technology and user experience.

With the advances made in technology and internet connections since this research was conducted, and with end-users being far more computer technology savvy, many of the issues experienced at that time should not be evident. However, challenges of keeping software, such as that used in this research, working with hardware, operating systems, and third-party software that are continually evolving, is an on-going consideration (see 5.2.1.5). Despite these limitations, the researcher considers the technology design principles discussed in 5.2.1 to be valid.

5.7 Future research

As was discussed in 5.2.4 above the design principles from this research project did inform many of the online courses developed at LessonLab. One area for future research would be to see how these design principles may have evolved over time, with different objectives, different implementation models and changing technology.

During all testing cycles many of the teachers indicated that they had tried new ideas in their classrooms as a result of studying the public-release lessons (see 4.4.4.1, 4.5.3.4.3, and 4.6.3.3). This finding was confirmed by participants taking the course after it had been published with 82% of 266 respondents to the online survey expecting their teaching to change somewhat (50%) or significantly (32%) (see also 5.3). However, since these responses are self-assessments and made immediately after taking the course, it is in general an indication of intent or perceived changes. Research could be carried out to see if the teachers did actually change their teaching after the intervention. This could be through contacting the pilot participants for follow-up on perceived changes emanating from the course. Alternatively, more rigorous research could be conducted such as observing teachers before and after they had participated in the professional development.

Other research could address some of the following questions focusing on some of the design principles from the study. Do teachers who participate in the professional development then continue to translate research into practice? Do teachers apply the lesson analysis skills to their own teaching, and, if so, how? Do teachers work more collaboratively with their peers reflecting the community of practice aspects of the professional development? Do teachers focus more on their own mathematical knowledge when considering the content of a lesson? Would the model developed here work as well in other disciplines?

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Appendices

Appendix 1.1 Trends in International Mathematics and Science Studies

	TIMSS 1995	TIMSS 1999	TIMSS 2003	TIMSS 2007
Grades assessed	**4, 8, Final year of secondary school (12 in the United States)**	**8**	**4 and 8**	**4 and 8**
Component studies	**Benchmark Study, Video Study, Case Study, Curriculum Study**	**Benchmark Study, Video Study**	**None**	**None**
Participating countries	**42**	**38**	**46**	**63**

Source: Frequently Asked Questions, http://nces.ed.gov/timss/faq.asp, accessed February 19, 2007 (Institute of Education Sciences)

Appendices 3

Appendix 3.1 Consent forms: Pilots 1, 2 and 3

November 4, 2002

Re: Pilot - TIMSS-R Video Study Explorations of Algebra Teaching

Dear Participant,

LessonLab Inc. is working with Intel Foundation to develop a Course aimed at understanding and improving mathematics' teaching and learning. The Course uses Public Release lessons from the TIMSS-R Video Study due for release January 2003. The Course will be presented using LessonLab's (www.lesssonlab.com) proprietary software. This software is delivered in a secure web based environment that only registered users can access.

You have been invited to participate in a pilot for this Course. To do this, we need your permission. We will be videotaping the pilot sessions, collecting all materials including task responses and giving questionnaires for the purpose of evaluation/research. Please review and sign the attached Consent Form prior to the first pilot session.

If you have any questions regarding videotaping, please contact: Gail Hood at LessonLab on 310 664 2340 (W) or 310 600 1597 (C)

Sincerely,

Gail Hood
LessonLab Inc.

Project ID: TIMSS-R Explorations of Algebra Pilot

PARTICIPANT RELEASE AND ASSIGNMENT FORM

I understand that Intel Foundation (the "Publisher") in conjunction with LessonLab Inc. (the "Producer"), would like to record my name, likeness and voice for use in an educational product for teachers. I understand that the recordings may include digitized video, videotape, DVD, film, still-images, photo, multimedia, audio and/or any other electronic or analog form (the "Videos"). I also understand that all materials including task, forum and questionnaire responses will be used for the purpose of product evaluation and educational research.

I grant to Publisher, as well as anyone to whom Publisher assigns, grants or licenses these same rights, permission to record the Videos of the pilot sessions. I understand that, once created, I am granting to Publisher all right, title and interest, including the copyright, in the Videos and any related transcription of the Videos, and that Publisher may use, edit, modify, license, transfer or dispose of these Videos, without limitation, in any language and media now known or hereafter developed, including in print publications, audio and video recordings and electronic uses, including the Internet. Similarly, my name, likeness and voice may be used to publicize, promote or advertise any product, work or other materials that relate to, supplement or contain the Videos.

I have not previously assigned any rights related to my name, likeness, voice and/or lesson plans and teaching methods to any other person or entity (such as a talent agency, a talent manager, an actors' or talent guild or any other entity who would be entitled to receive royalties for my performance in the creation of the Videos). Moreover, I have not previously assigned to any other person or entity the rights that I am now assigning to Publisher.

I release and discharge each of Publisher, and Producer, and their respective agents, employees, licensees, directors, officers, assigns and any end user viewing or using the Videos from any and all claims, losses, demands, damages, royalties, liabilities, costs and expenses, including reasonable attorneys' fees and expenses, which I may now have or may hereafter have by reason of the use of my name, likeness, voice, lesson plan or teaching method in connection with the Videos (including, but not limited to, any alleged violation of the right to privacy and/or any alleged claim for any distortion or illusionary effect resulting from the publication of any Video).

______________________ ____

DATE SIGNATURE

____

NAME (PRINT)

Project ID: TIMSS-R Explorations of Algebra Pilot

Appendix 3.2 Consent forms: Pilot 4

February 1, 2003

Re: Pilot 4 - TIMSS Video Studies: Explorations of Algebra Teaching

Dear Participant,

LessonLab Inc. is working with Intel Foundation to develop a Course aimed at understanding and improving mathematics' teaching and learning. The Course uses Public Release lessons from the TIMSS 1999 Video Study due for release early in 2003. The Course will be presented using LessonLab's (www.lesssonlab.com) proprietary software. This software is delivered in a secure web based environment that only registered users can access.

You have been invited to participate in a pilot for this Course. To do this, we need your permission. We will be collecting all materials including task and forum responses, giving questionnaires and conducting interviews for the purpose of evaluation/research. Please review and sign the attached Consent Form prior to being given access to the Course (February 7).

If you have any questions regarding the pilot, please contact: Gail Hood at LessonLab on (310) 664 2340 (W) or (310) 600 1597 (C).

Sincerely,

Gail Hood
LessonLab Inc.

PARTICIPANT RELEASE AND ASSIGNMENT FORM

I understand that Intel Foundation (the "Publisher") in conjunction with LessonLab Inc. (the "Producer"), is conducting a pilot to evaluate the TIMSS Video Studies: Explorations of Algebra Teaching Course they have developed as an educational product for teachers. I have agreed to be part of this pilot. I understand that my name and voice may be recorded during evaluative interviews. I also understand that all materials including task, forum and questionnaire responses and the Interviews and related transcripts (the "Pilot Materials") will be used for the purpose of product evaluation and educational research.

I grant to Publisher, as well as anyone to whom Publisher assigns, grants or licenses these same rights, permission to record the Interviews as part of the pilot. I understand that, once created, I am granting to Publisher all right, title and interest, including the copyright, for the Pilot Materials, and that Publisher may use, edit, modify, license, transfer or dispose of these Pilot Materials, without limitation, in any language and media now known or hereafter developed, including in print publications, audio and video recordings and electronic uses, including the Internet. Similarly, my name, and voice may be used to publicize, promote or advertise any product, work or other materials that relate to, supplement or contain the Pilot Materials.

I have not previously assigned any rights related to my name, likeness, voice and teaching methods to any other person or entity (such as a talent agency, a talent manager, an actors' or talent guild or any other entity who would be entitled to receive royalties for my performance in the creation of the Interviews). Moreover, I have not previously assigned to any other person or entity the rights that I am now assigning to Publisher.

I release and discharge each of Publisher, and Producer, and their respective agents, employees, licensees, directors, officers, assigns and any end user viewing or using the pilot materials from any and all claims, losses, demands, damages, royalties, liabilities, costs and expenses, including reasonable attorneys' fees and expenses, which I may now have or may hereafter have by reason of the use of my name, voice, or teaching method in connection with the Pilot (including, but not limited to, any alleged violation of the right to privacy and/or any alleged claim for any distortion or illusionary effect resulting from the publication of any Pilot Materials).

____________________	____
DATE	SIGNATURE
	____
	NAME (PRINT)

Appendices 4

Appendix 4.1 Questionnaire I – Demographics

TIMSS Video Studies – Explorations of Algebra Teaching *Participant Survey 1*

1. What is your gender? ☐ Male ☐ Female

2. How often do you use a computer?

At School/Work	**At Home**
☐ Rarely	☐ Rarely
☐ Once a week	☐ Once a week
☐ Every other day	☐ Every other day
☐ Once a day	☐ Once a day
☐ More than once a day	☐ More than once a day

3. What type of internet connection do you use?

☐ DSL/Cable Modem	☐ DSL/Cable Modem
☐ Dial-up	☐ Dial-up
☐ Ethernet	☐ Ethernet
☐ Not sure	☐ Not sure
☐ Don't have internet access	☐ Don't have internet access

4. What type of computer do you use?

☐ PC	☐ PC
☐ MAC	☐ MAC
☐ Both	☐ Both

5. How would you describe the student population at your school?

% of students with low Socio-Economic Status:

☐ 0-25%
☐ 25-50%
☐ 50-75%
☐ 75-100%

% of Eng. Lang. Learners: ________%

% of students participating in free or reduced lunch program: ________%

6. What is your credential status?

☐ I am a credentialed teacher
☐ I am an emergency credentialed teacher
☐ I am a non-credentialed teacher

7. What type and level of mathematics are you currently teaching?

____

____

____

8. Not counting this year, what is your mathematics teaching experience?

School Level	Grade Level	# of years
Elementary	_____	_____
Middle	_____	_____
High	_____	_____
College	_____	_____

9. What was the highest level of math you studied in:

High School ____

College ____

Graduate School____

10. What was your:	**Major**	**Minor**
College	______________	_________________
Graduate School	______________	_________________

11. How much and what type of professional development have you had in math teaching during the past five years?

____

____

____

____

____

Appendix 4.2 Questionnaire 2

TIMSS-R Video– Explorations of Algebra Teaching ***Participant Survey 2***

1. How did you find using the LessonLab Software <u>the first time</u>?

☐ Very difficult/frustrating ☐ A little difficult, but not too bad ☐ Okay ☐ Quite easy ☐ Very easy

COMMENTS: (Please continue on the back if necessary.)

____

____

____

2. How did you find using the LessonLab Software after <u>using it a few times</u>?

☐ Very difficult/frustrating ☐ A little difficult, but not too bad ☐ Okay ☐ Quite easy ☐ Very easy

3. How many hours did it take you to complete the Course?

☐ Less than 8 ☐ 8 – 10 ☐ 10 – 12 ☐ 13 – 15 ☐ More than 15

COMMENTS:

____

____

____

4. How would you rate your overall experience with this Course?

☐ Very good ☐ Good ☐ Okay ☐ Poor ☐ Very poor

COMMENTS:

____

____

____

5. Please indicate the extent you found each Course section <u>interesting</u> and/or <u>useful</u>.

5 = Extremely **4** = Very **3** = Undecided **2** = Somewhat **1** = Not at all

<u>Interesting</u>	**<u>Useful</u>**
____ Introduction (TIMSS Video Study/TIMSS to TIMSS-R)	____ Introduction
____ Initial Exploration	____ Initial Exploration
____ TIMSS-R Video Up Close	____ TIMSS-R Video Up Close
____ Case 1 – Japan	____ Case 1 – Japan
____ Case 2 – Hong Kong	____ Case 2 – Hong Kong
____ Case 3 – Switzerland	____ Case 3 – Switzerland

COMMENTS:

____

____

6. How would you describe the goals of this Course to someone else?

____

____

____

7. Please indicate the extent the tasks and forums helped you in the following areas.

5 = Extremely helpful **4** = Very helpful **3** = Undecided **2** = Somewhat helpful **1** = Not at all helpful

____ In understanding the content of the course

____ In learning a framework for the analysis of classroom practice

____ In applying the content to real classroom situations

8. What did you find most useful about the Course?

____

____

____

9. Did you learn anything new about mathematics?

☐ Yes ☐ No

If yes, what were the main things you learned?

____

____

____

10. What other kinds of things did you learn from this Course?

____

____

____

11. How might this Course assist you in your teaching practice?

____

____

____

12. Would you recommend this Course to a friend?

☐ Yes ☐ No

COMMENTS:

____

____

____

13. Was there anything in the Course that surprised you?

☐ Yes ☐ No

If yes, what was that?

____

____

____

14. Is there something missing in this Course that you think would make it better?

☐ Yes ☐ No

If yes, what would you add?

____

____

____

15. If you were invited to take a similar course, would you take it?

☐ Yes ☐ No

COMMENTS:

____

____

____

16. Is there anything else you would like to add?

____

____

____

Thank you for your participation!

Appendix 4.3 Questionnaire 3

TIMSS-R Video– Explorations of Algebra Teaching ***Participant Survey 3***

1. During the past week you were expected to access the TIMSS-R Video– Explorations of Algebra Teaching course. Did you use the software at:

☐ Home ☐ School ☐ Both ☐ Other ______________________________

2. Using the LessonLab Software by yourself was

☐ Very difficult/frustrating ☐ A little difficult ☐ Okay ☐ Quite easy ☐ Very easy

COMMENTS: (Please continue on the back if necessary.)

____

____

____

3. Did you require help using the LessonLab software outside of the Pilot sessions?

LessonLab Tech Support: ☐ Yes ☐ No

Other ______________________________

COMMENTS: (Please describe frequency and type of help needed.)

____

____

____

4. How many hours did you spend on the Course outside of scheduled Pilot sessions?

Hours: ______
Percentage of time on assigned homework: ______

If you did additional activities, what were these?

☐ Reading/exploring Course text
☐ Finishing Tasks
☐ Reading other people's responses to tasks
☐ Viewing the Lessons
☐ Exploring Resources associated with lessons
☐ Reading Commentaries in lessons
☐ Other ______________________________

ADDITIONAL COMMENTS:

____

____

Appendix 4.4 Demographics Summary - Pilots 1-4

Demographics	Pilot 1	Pilot 2	Pilot 3	Pilot 4
1. Gender				
Male	5	5	3	10
Female	5	4	4	19
2. How often do you use a computer?				
At School				
Rarely	1	1	1	2
Once a week	1	0	0	0
Every other day	0	0	0	2
Once a day	0	1	1	0
More than once a day	10	8	5	24
At Home				
Rarely	2	0	0	0
Once a week	0	1	0	2
Every other day	2	0	3	5
Once a day	4	4	1	7
More than once a day	3	5	2	15
3. What type of internet connection do you use?				
At School				
DSL/Cable Modem	2	1	2	10
Dial-up	2	0	1	0
Ethernet	4	7	1	9
Not sure	2	2	3	6
Don’t have internet access	0	0	0	0
At Home				
DSL/Cable Modem	6	3	2	16
Dial-up	4	6	4	11
Ethernet	0	0	0	1
Not sure	1	1	0	0
Don’t have internet access	0	0	0	1
4. What type of computer do you use?				
At School				
PC	9	6	3	19
MAC	0	2	3	6
Both	2	2	1	3
At Home				
PC	9	8	3	24
MAC	1	1	2	3
Both	1	1	1	2

Demographics	Pilot 1	Pilot 2	Pilot 3	Pilot 4	
5. How would you describe the student population at your school?					
Ethnic Diversity					
High	6	3	6		
Middle	5	5	0		
Low	0	2	1		***S-E Status***
Socio-Economic Status				10	0-25%
High	1	0	0	7	25-50%
Middle	2	3	0	4	50-75%
Low	7	6	6	4	75-100%
% of Eng. Lang. Learners	56.3%	26.8%	35.7%	31.7%	% ELL
% of students free lunch	61.6%	42.0%	63.0%	33.7%	% Flunch
6. What is your credential status?					
Credentialed teacher	11	8	7	23	
Emergency credentialed teacher	0	2	0	0	
Non-credentialed teacher	0	0	0	0	
8. Not counting this year, what is your mathematics teaching experience?					
Grade Level/#Years				# / Mean	
Elementary				3 / 3.0	
Middle				19 / 9.8	
High				17./ 6.5	
College				4 / 8.4	

Other questions asked in demographics survey

7. What type and level of mathematics are you currently teaching?
9. What was the highest level of math you studied in:
10. What was your:
    - College Major
    - College Minor
    - Graduate School Major
    - Graduate School Minor
11. How much and what type of professional development have you had in math teaching during the past five years?

Appendix 4.5 Pilot 1-4 Questionnaire 2 Summary

Questionnaire 2	Pilot 1	Pilot 2	Pilot 3	Pilot 4
1. How did you find using the LessonLab Software <u>the first time</u>?				
Very difficult/frustrating	2	0	3	2
A little difficult, but not too bad	2	0	3	2
Okay	2	4	1	6
Quite easy	3	3	0	2
Very easy	2	1	2	0
2. How did you find using the LessonLab Software after using it a few times?				
Very difficult/frustrating	0	1	0	0
A little difficult, but not too bad	2	2	2	0
Okay	0	0	3	2
Quite easy	3	4	1	7
Very easy	5	2	3	1
3. How many hours did it take you to complete the Course?				
Less than 8	0	2	0	2
8 – 10	4	3	1	3
10 – 12	5	2	3	4
13 - 15	2	0	3	1
More than 15	0	0	1	2
4. How would you rate your overall experience with this Course?				
Very good	9	5	3	7
Good	2	3	5	3
Okay	0	0	0	1
Poor	0	0	1	0
Very poor	0	0	0	0
5. Please indicate the extent to which you found each Course section <u>interesting</u> and/or <u>useful</u>.				
5 = Extremely 4 = Very 3 = Undecided 2 = Somewhat 1 = Not at all				
<u>Interesting</u>				
Introduction	4.0	3.4	2.8	3.7
Initial Exploration	4.1	3.0	3.2	4.0
TIMSS-R Video Up Close	4.0	3.7	3.6	4.2
Case 1 – Japan	4.7	4.9	4.9	4.7
Case 2 – Hong Kong	4.0	4.9	4.5	4.5
Case 3 – Switzerland	4.3	3.4	2.8	4.1
Reflections				3.4
<u>Useful</u>				
Introduction	3.7	3.7	2.8	3.5
Initial Exploration	3.9	3.6	3.3	3.7
TIMSS-R Video Up Close	3.7	3.7	3.3	4.0
Case 1 – Japan	4.4	4.3	4.7	4.6
Case 2 – Hong Kong	3.8	4.0	4.3	4.5
Case 3 – Switzerland	4.0	3.1	3.0	3.9
Reflections				4.0

Questionnaire 2	Pilot 1	Pilot 2	Pilot 3	Pilot 4
7. Please indicate the extent to which the tasks and forums helped you in the following areas.				
5 = Extremely helpful 4 = Very helpful 3 = Undecided 2 = Somewhat helpful 1 = Not at all helpful				
In understanding the content of the course	4.2	4.1	3.6	3.9
In learning a framework for the analysis of classroom practice	3.9	3.8	3.6	3.5
In applying the content to real classroom situations	4.1	3.5	3.8	3.7
9. Did you learn anything new about mathematics?				
Yes	10	4	7	6
No	1	4	1	4
12. Would you recommend this Course to a friend?				
Yes	10	8	8	11
No	0	0	0	0
13. Was there anything in the Course that surprised you?				
Yes	7	3	4	7
No	3	5	4	4
14. Is there something missing in this Course that you think would make it better?				
Yes	4	4	6	10
No	6	2	1	2
15. If you were invited to take a similar course, would you take it?				
Yes	11	8	9	9
No	0	0	0	0
(Undecided)				1
Total # Respondents	**11**	**8**	**9**	**12**

Appendix 4.6 Pilot 1 Questionnaire 2 Comments

Note: Comments connect to questions in data summary, Appendix 4.5 *above.*
Number before each comment signifies participant (1-11)

1. How did you find using the LessonLab Software <u>the first time</u>?

3	At times I was unsure as to what section to do next.
5	Some problems with saving file
6	This was a rich learning experience. Thank You.

3.How many hours did it take you to complete the Course?

3	Class and short 1 ½ in homework.
10	9 hours in class 2 hours at home

4. How would you rate your overall experience with this Course?

3	Excited to try new strategies
5	Overall experience “good” assoc teaching methods.
6	I feel honored to be part of this study and learned a great deal. I now understand the things I’ve heard about Education in Japan.
7	It was very interesting & has made me reflect on my own teaching practices.
8	I enjoyed having the discussions.
10	Got some excellent ideas.
11	I appreciated the variety of teaching strategies modeled- and the students doing the talking and doing

5. Please indicate the extent to which you found each Course section interesting and/or useful.

1	I found these video’s of these countries very interesting. Mainly because of the view that other countries have on education. My students would not appear in those videos.
3	The manner in which the lessons were all similar in generality.
5	Overall Japan Course was very interesting and useful
10	Japan study was awesome.

6. How would you describe the goals of this Course to someone else?

1	A way to teach math.
2	The goal is to observe methods of teaching algebra in different countries in order to think “outside the box” and become a more effective teacher.
3	To help teacher see the differences between students-cultures yet similarities to “good teaching”
4	To introduce you to TIMSS and to give you an introduction to how others in other countries teach. To show you some method that work from other countries.
6	To look at math instruction in other countries, as a teacher to see quality interaction and engagement of learners.
7	To increase our awareness about teaching practices in other countries & how it differs from ours.
8	I would describe this course as away to see lessons being taught in other countries. What connections can be made between my teaching and other teaching around the world?
9	To help teachers learn from other teachers & their techniques & philosophy.
10	Discovering similarities in high achieving countries and how they teach algebra.
11	I would tell them this is an exploration of successful teaching styles from 3 different countries. In it you will learn the Japanese method which allows students to find multiple ways to solve one problem.

8. What did you find most useful about the Course?

2 Making the connections between the concrete to abstract.
3 To see concepts that I am attempting with my class with varying results to be validated through veteran teaching and to be given a visual presentation of the benefit of manipulative/concrete teaching.
4 Viewing other teachers "in action".
5 Using some of the materials in my classroom. Lesson plans different ways to solve one problem.
6 Along with the video course- interacting with other teachers & hearing their experiences
7 Seeing the different types of instructions in other countries.
8 Using of lessons approaches.
9 The Japanese instruction techniques.
10 How to teach several objectives in one class. Making connection from manip to actual problems.
11 Using multiple ways to solve problems. Go slowly to reach mastery before moving on to another concept

9. Did you learn anything new about mathematics?

1 Algebra from years passed.
2 The strategies for teaching the mathematics.
3 There are useful tools from concrete to abstract concepts.
4 Strategies about how to teach some math.
5 Hand outs with students/chalkboard demonstrations
6 Learning mathematics by having students solve, each in their own way, the share out
7 How to increase my students to participation /buy into their math education
8 The connections of concepts in on lesson.
10 See above
11 Strategies that incorporate advanced & concrete concepts in the same lesson.

10. What other kinds of things did you learn from this Course?

2 Presenting and facilitating solutions
3 Good teaching has many similarities in varying cultures.
4 How to teach some subjects a new way.
5 Check for understanding from students
7 Other tools that teachers from the pilot course use in instruction.
8 I am learning how to be a great teacher because the students deserve it.
9 Strategies of instruction- I'll try them.
10 See above
11 Students who talk and are engaged in their learning –learn to master.

11. How might this Course assist you in your teaching practice?

2 I will think daily about what I teach and what I want the students to learn.
3 This gives me the opportunity to see "good" teaching as a model. It is hard to observe good teaching while working.
4 To consider new ways to teach math.
5 Many different ways: 1. Demonstration of a problem solves in more than one way. 2. Students hands on. 3. Using material for math problems.
6 All of the above comments
7 I saw teachers that reminded me of my teaching style and didn't like what I saw. I am going to try other ways to bring math alive to my students.
8 New ideas in lessons.
9 I plan to use the strategies to help my students.
10 The kids can really understand that there are several ways to answer 1 question.

12. Would you recommend this Course to a friend?

1	Other teachers need to see what it is like to teach in other countries.
3	There is a lot to learn from different cultures.
5	Yes!
7	I think this was a valuable learning experience.
10	Great ideas to share.

13. Was there anything in the Course that surprised you?

1	The attitude of the students from other countries.
3	Netherlands very laid back individual style.
5	Japan lesson was great!
6	That so many approaches were found among countries.
8	The way teaching is the same as well as different, not just different.
9	I never realized so many countries taught these different ways.
10	Hong Kong speaking English.

14. Is there something missing in this Course that you think would make it better?

1	American teachers from parts of U.S.A.
2	A little more time between 1st & 2nd session. Other lessons from countries in the study.
5	Japan lesson was great!
10	See an American study.

15. If you were invited to take a similar course, would you take it?

2	Please invite me or contact me for other studies/courses.
3	Life long learner.
5	Yes! Lots to Learn!
7	Always willing to learn something new.
10	I love learning new ideas for teaching.

16. Is there anything else you would like to add?

1	I really appreciated the way in which I was given help. As slow as I am with computers I felt good. I was not made to feel badly.
2	Thanks for all of your time and preparation. Is there a place that I can go to get more details and resources from the original TIMSS.
3	Nope, fun course!
4	The snacks were good.
5	Thank you all for this great opportunity. ☺
6	Thank You! Excellent opportunity.
7	Great opportunity.
9	Perhaps (for those who don’t work well on computers) might can few the work on film.
10	I presented a proportion problem to my algebra class in a Japanese style. The kids loved it. Want to do it again.
11	All of it was said above. Thank you for the stipend & the camera.

Appendix 4.7 Pilot 1-3 Questionnaire 3 Summary

Questionnaire 3	Pilot 1	Pilot 2	Pilot 3
1. Did you use the software at:			
Home	4	4	4
School	1	0	1
Both	5	3	4
Other	0	1	0
2. Using the LessonLab Software by yourself was			
Very difficult/frustrating	3	1	3
A little difficult, but not too bad	1	1	2
Okay	2	2	1
Quite easy	3	2	1
Very easy	1	2	2
3. Did you require help using the LessonLab software outside of the Pilot sessions?			
LessonLab Tech Support			
Yes	5	3	4
No	3	5	5
Other		0	
4. How many hours did you spend on the Course outside of scheduled Pilot sessions?			
Hours*	2.1	8.1	15.1
% time on assigned homework*	80%	79%	66%
If you did additional activities, what were these?			
Reading/exploring Course text	2	4	6
Finishing Tasks	1	3	0
Reading other people's responses to tasks	1	4	5
Viewing the Lessons	3	3	2
Exploring Resources associated with lessons	3	2	2
Reading Commentaries in lessons	2	4	4
Other	1	2	2
Total # participants	**11**	**10**	**10**
Total # evaluation forms collected	**10**	**8**	**9**

Note: Figures are total for category except * which indicates mean value

Appendix 4.8 Pilots 1-3 Questionnaire 3 Comments

Note: Comments connect to questions in data summary, Appendix 4.7 above. Number before each comment signifies participant.

PILOT 1	
Question 2	
2	Real player G2 (part of Earthlink.net) kept trying to run the video disk and also off the website.
3	I tried helping other people in the class who asked me for help. I like the email function that can be used for this type of communication between class sessions.
4	Did not know that I had to download "real time player". Had colleague help me.
5	I had problem putting up the work using Java Script. I had to hold down ctrl key while pressing mouse.
6	I couldn't get the video on my computer. I did get the text.
8	The "NEXT" button is very light in color and was a bit difficult to find.
9	but even at school I had difficulty loading the video clips
Question 3	
2	Tried - no answer (answering machine)
6	I called about 10pm - left a message and my number (GH-no response)
9	I emailed for help
Question 4	
7	Tried but denied GH-reading other people's responses)
8	1 on CD 0.5 hour on developing lesson
3	Trying to figure out how to work
Additional Comments	
1	Although the computer part was frustrating I really enjoyed the class time and learning experience
2	Many hours of frustrating!
3	I would really appreciate participating in future programs (similar in nature) and am waiting for TIMSS-R to be released to the general public. This project and the original TIMSS has helped me with teaching strategies that are outside of my comfort zone. I also feel that the observations and analysis has helped me to focus on the process of quality mathematics teaching.
4	I really enjoyed the Japanese style lesson. I taught a lesson in this style and my class really enjoyed it as well. I videotaped my lesson for your use.
8	This was easier than I expected
10	Hong Kong 2 problems were interesting. 2x+4=x+6
PILOT 2	
Question 2	
1	I had some trouble navigating around because it wasn't always clear to me how to get to where I wanted to get. I could always get to the part that I wanted but not always directly.
2	At first, it was hard to navigate to the next task, but I eventually figured it out. The worst part was the sound sometimes would go out on my computer, but I just exited the program, logged out, logged back on and it worked.
3	I feel I have totally failed this project. I had major technical problems using home computer and computer borrowed for school.
5	That is once I got the hang of it and began to understand what it didn't do well or like to do.
6	After completing a section, it was necessary to close the window in order to continue
7	It was easy once I found a computer that it would work on.
8	I had a difficult time with the initial set up and using my dial up. However, the 2nd & third etc, were much better.

Question 3

1 Actually I called for help but found out I had a CD-rom problem & replaced the CD-rom everything worked

3 Spoke with Jim on Friday 12/13/02 to try to help get into the program.

6 There was a few minor glitches, but I was able to get through things without calling tech support.

7 Only to try to get the program to worrk at home or in my classroom, which it never did. With the computer that I worked on, I didn't need any help.

Additional Comments

2 I enjoyed exploring the lessons especially the Japan one. I thought the internet program was very well laid out.

3 Thanks for the opportunity. I hope to be more successful if another opportunity presents itself.

5 I enjoyed working with LessonLab materials. It provided some interesting moments for reflection about the nature of learning and the role of the teacher.

6 I very much liked the lesson graphs. I liked the format and the material presentation.

7 The lesson graphs were very helpful. I read them 1st, they helped me better understand and respond to the computer lessons. I enjoyed the experience!

8 I thoroughly enjoyed watching the lessons. I would have liked to have been able to hear audio, as I would have been able to understand more about the interaction in the classroom, both between teacher/students & students/students!

PILOT 3

Question 2

2 The software did not work with my Macintosh. I was having trouble with freezing up. The Real player was not working at all.

4 I believe some of the problem was my computer software.

5 I had more done than got recorded. Knocked off line. Did not realize parts missing until the end.

8 Every time I tried to pause, rewind, fast forward the video it caused my computer to malfunction. Poor video quality. Not knowing how to enlarge video. Not knowing my progress as soon as I logged on.

Question 3

2 I called 4 times. I also contacted my colleagues who did the program.

3 I felt the software was fairly user friendly.

4 Sometimes. I would miss a sequence and had to be reminded or helped on certain strategies.

8 Each time I logged on (6 different times) I had to call for tech support for an approximate total 15 hours.

Question 4

3 Making comments in my notebook.

8 Tech support + 20 hours with Earthlink

Additional Comments

1 This was a busy time of year for me to take the time for this, but I really enjoyed the opportunity to see teachers from other countries and their approach to teaching the same concepts that I teach.

2 I had the opportunity to read the text. I wasn't able to view the videos and get the enrichment that was provided by watching the video.

7 More teardown of why lessons work, why they don't work. Go beyonds just the methods.

8 Because of all the "tech problems I was frustrated. I spent many additional hours with Earthlink trying to get my internet server back.

Appendix 4.9 Pilot 4 Questionnaire 3 Summary

Questionnaire 3	Pilot 4
1. “Ordering” the Course.	
a. Was the order form clear to you?	
Not at all	0
Not quite	0
Okay	2
Quite clear	5
Very Clear	5
b. Were you comfortable/secure supplying the information over the Internet?	
Not at all	0
A little insecure	1
Okay	3
Quite comfortable	4
Very Secure	4
c. Did you receive confirmation of successfully ordering the Course?	
Immediately	10
Other	1
d. Do you purchase goods or book services over the Internet (online)?	
Never	1
Occasionally	10
Frequently	1
2. Receiving the materials.	
a. From the day you ordered the Course the materials arrived in approximately:	
1-3 days	3
4-7 days	4
>7days	5
b.The condition of the materials was:	
Very good	11
Good	1
Okay	0
Poor	0
Very poor	0
3. Accessing and Registration	
a. The instructions in the cover letter and in the Course Guide for getting online and registering on the LessonLab site were?	
Very good	4
Good	7
Okay	0
Poor	0
Very poor	0
b. Did you require help with the software or registration process from LessonLab or anyone else?	
LessonLab Tech Support:	0
Yes	6
No	5
Other	1

c. What type of computer did you use to do the Course and where?

<u>Home</u>	
Mac	1
PC	9
<u>School</u>	
Mac	1
PC	5
<u>Other</u>	
Mac	0
PC	0

4. The Course Guide.

a. Did you read the Course Guide?

Yes	10
No	2

b. If yes, please indicate the usefulness of the following sections and pages.

5 = Extremely 4 = Very 3 = Undecided 2 = Somewhat 1 = Not at all

Sections	
Introduction	3.8
Getting Started	4.3
Navigating the Course	4.0
Beginning the Course	4.1
Viewing and Analyzing the Case Studies	4.0
Spaces for Note taking	3.3
Pages	
Course Planner	3.6
Task and Forum Checklist	2.9
Lesson Graphs	4.0
TIMSS Resource Pages	3.0

5.Facilitation of the Course.

a. Have you ever taken a facilitated online course before this one?

Yes	2
No	10

Appendix 4.10 Pilot 4 Questionnaire 3 Comments

*Note: Comments connect to questions in data summary, Appendix 4.9 above.
Number before each comment signifies participant.*

PILOT 4 Comments	
1. "Ordering" the Course.	
a. Was the order form clear to you?	
10	I accidentally hit enter twice - creating two orders
b. Were you comfortable/secure supplying the information over the Internet?	
2	Took me a few minutes to get it straight
c. Did you receive confirmation of successfully ordering the Course?	
3	Quite quickly - but then could not enter the course right away.
12	I don't remember
d. Do you purchase goods or book services over the Internet (online)?	
2. Receiving the materials.	
a. From the day you ordered the Course the materials arrived in approximately:	
5	I think maybe sooner but it came on a Friday and didn't get put out until later in day
7	Large delay
12	I have slow mail service
b. The condition of the materials was:	
3. Accessing and Registration	
a. The instructions in the cover letter and in the Course Guide for getting online and registering on the LessonLab site were?	
b. Did you require help with the software or registration process from LessonLab or anyone else?	
1	Get video thru fire wall Tech support did not reply within 24-48 hrs. Had to call Gail. Once he replied he stayed with me till resolution
3	Once accessing the courses - once with question about accessing the graphs. Tech support was outstanding/prompt/ courteous and efficient.
4	I needed help a few times (maybe 3?) but all problems were due to my outdated operating system!
5	School computer technician. He had to renew Real player on my computer so I could use course.
7	At outset b/c PC @ home and MAC @ work did not allow some functions - PC setup was different from anticipated in manual
8	I was registered with LessonLab thru another portal and I couldn't get on that way. Once I registered, I had to wait until the following Monday to begin - I lost use of the weekend.
11	I did have trouble at first with downloading the program onto my computer.
c. What type of computer did you use to do the Course and where?	
10	I wanted to use a PC at home and work - depending on where I was.
4. The Course Guide.	
a. Did you read the Course Guide?	

1	Skimmed parts; more no than yes

b. If yes, please indicate the usefulness of the following sections and pages.

1	Just wanted to get started.
2	Lesson Graphs could be larger in print
8	I went to the TIMSS Resource page but couldn't find where the various graphs were, easily, to make copies to remind me.
10	None were helpful when I clicked when I didn't mean to.

c. Is there anything else you think should be included in the Course Guide?

2	Fine as is
5	Besides Progress Chart in total on pp. 24-25, why not break it down to where they would actually appear on case studies (notes).
6	It might be helpful to have the analysis of the content in the Course Guide.
7	No
8	snap shots of pages to see what students are working on?
10	A blackline for teachers that can be used if desired. Example: The Japanese problem and manipulatives. (So teachers don't have to make their own) or a blackline for transparency.
12	No

5. Facilitation of the Course.

a. Have you ever taken a facilitated online course before this one?

3	Have participated in online networks for professional development.

b. What was your experience with the facilitation process in this Course?

1	Very disappointing. I only heard fromfacilitator 3 times - welcome to course; don't forget to save responses; reminder course closing.
2	Fine - you can work on it at your own time
3	I had virtually (no pun intended) no contact with the facilitator (except extension of date email). As far as I could tell the facilitator posted one forum response? I don't know anything about her either. Is she a teacher?
4	I didn't feel it was a major part of the course, but this could be that I just didn't feel a personal need to participate too much in discussions
5	As mention before, I don't if was Distict's server or your program, but after clicking into an exploration (either just to watch or answer) and then leaving it for another part, I'd have to laeve the course completely in order to get to next step.
7	Positive
8	I wasn't sure it was always useful for me - at times I felt as if I knew as much or more…
10	I guess I enjoyed the Course and the Guide was extremely helpful.
12	I am not sure, email was nice

c. What types of facilitation would you find helpful in this Course?

1	I expected facilitator to reply to some of my comments to stretch my thinking, maybe reference me to another person's contrasting comments.
2	Same as provided
3	I think facilitator is crucial. The beauty of online work is that it should be easy to give participants feedback almost 1 to 1. I think this was really lacking i.e. I would respond to a question and have no idea if I had missed the point or not. I even made a that I was "lost" in a forum and heard nothing. I think you could add facilitation feedback at any point and that would help immensely (I also commented on this in my email feedback - sent previously).
4	The type of facilitation used would be helpful to anyone interested in participating in the forum discussions - I don't think any changes need to be made.

5	Is there possibly a way to increase volume on videos? Or for the video screen to be larger?
7	Chance to review my responses before posting it
8	Identifying the teacher behaviors and learning padagogy that made the lesson successful … sometimes before to watch for … ideas that could be useful in our classrooms assistance of writing problems to engage? Look at process teachers go thru to create lessons?
12	More focus and direction in the forums.
d. Where and when would this facilitation be most beneficial?	
1	Driving throughout Course. Thought facilitator would pose some thought provoking group dialogue questions and also enter into dialogue.
2	It is okay as is
5	At all points I could only sit for a few minutes having to concentrate to be close enough to see and listen.
7	Before posting a response
10	Would be most beneficial if people could access by area of interest/need. That way teachers can fit the module within their lesson plan.

Appendix 4.11 Codes for task and forums

Code	Definition	Examples	Notes
		Content (C)	
C.0	None		Generated after coding
C.1	Mathematical term/topic	fraction	Repetitions in each response not counted
C.2	Mathematical concept	Fraction method	No repetitions
C.3	C.1 or C.2 with explanation/commentary/		C.1 or C.2 may be implicit
C.4	Making connections to real world or other mathematics		
		Pedagogical Content Knowledge (P)	
P.0	None evident		
P.1	Observation of teaching pedagogy		Literal
P.2	P.1 with discussion		Explains noted pedagogy
A.1 A.2 A.3 A.4	Use of chalkboard Manipulatives – students Manipulatives – teacher Other – worksheet/text		
P.4	Pedagogical critique/value judgement		
P.5	Reaction to class event or observation	CZ grading publically/ Class is attentive	
		Student Thinking/Understanding (S)	
S.1	Reference to student(s)		Mention of student thinking, understanding or learning progress
S.2	S.1 with discussion		Adds discussion on above observation
		Link or Transfer to Practice (L)	
L.1	Seen (link)		Relates video to something they have observed or read about
L.2	Done/do/Could do/Couldn't do(link)		Relates video to own teaching
L.3	Pedagogical belief (link)		No evidence
L.4	Will try (transfer)		Plan to try idea in own teaching
L.5	Have tried L.4 (transfer)		Outcome of implementing idea
		Link to Research (R)	
R.1	Reference to research by participants		May be explicit or implicit
R.2	Research background facilitator		
R.3	Ref to public-release lessons (prl) outside of cases		
R.4	Ref to prl comparison of pedagogy		
		Video Evidence (V)	
V.1	Video marker only		
V.2	V.1 with explanation		Note this may also be without marker
		Distracters (D)	
D.1	Content		
D.2	Pedagogy		

Code	Definition	Examples	Notes
Similarities and Differences (SD)			
SD.1	Single observation		For use in tasks or forums where this is asked e.g.Getting Your Feet Wet or reaction in f2f sessions
SD.2	S.1 with discussion		
SD.3	Comparison between 2 or more cases, countries or lessons	Use * if a problem	This may also be used in other responses if reference made to another lesson in course.
Predictions			
I.1	Yes I did predict/ compare/ correct For Reflection Math alternative suggested	JP SW Exploration Q2	
I.2	No I did not predict/ compare or not correct For Reflection Math NO alternative suggested	JP SW Exploration Q2	
Participant Mathematics Solutions (M, M1-M5 for JP problem)			
M.1	Manipulatives or Trial & error	Simulate removing coins each day	As for student 1 JP Note answer: Day 15
M.2	Table	Table days/amount left	As for student 2 JP
M.3	Differences	Diff of 5 yen/day (180-110)/(10-5)=14	As for student 3 JP
M.4	Simultaneous equations	Find when equal and add 1	As for student 4 JP
M.5	Inequalities	180-10x<110-5x	As for student 5 JP
M.6	X=2 0=0 identity		For HK content question
M.7	Other	Graph,…	
*Flag incorrect answers with * next to code for method			
Technology (T)			
T.1	Internet		Connection, registering, 3rd-party software
T.2	Software		Multiple videos, Save feature
Feedback/Evaluation (F)			
F.1	Research		
F.2	Video		Reaction to using video
F.3	Online platform		
F.4	Mathematical personal challenge		
Extras			
NA	Not applicable/no response		
C.2*	Flag incorrect assumption/responses		Use for all codes
O	Other		Use for anything that looks interesting and doesn’t fit anywhere else