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Video-based Supplemental Instruction: creating opportunities for at-risk students undertaking Engineering Mathematics

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Video-based Supplemental Instruction: creating opportunities for at-risk students undertaking Engineering Mathematics

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INTRODUCTION

Since its introduction at the University of Western Sydney (UWS), Australia in 2007, the Peer Assisted Study Sessions (PASS) program has proved a very effective and popular methodology for increasing retention and enhancing student engagement. PASS is based on Supplemental Instruction (SI) which is an international program that provides peer led, interactive study sessions in subjects with relatively high failure rates or which are considered challenging by students (Martin, 2008). Video-based Supplemental Instruction (VSI), which is an offshoot of SI (Martin & Blanc, 1994) provides a more intensive and integrated learning experience based on collaborative processing of pre-recorded lectures for students who lack the prerequisite knowledge to successfully complete subjects. These attributes aptly describe a significant proportion of the students enrolled each semester in a core Engineering Mathematics subject, many of whom fail the subject one or more times. Although the PASS program was offered in this subject, attendance tended to be low, particularly among students who had previously attempted the subject. Therefore, staff from the Student Learning Unit and the Mathematics and Engineering Departments decided to pilot a VSI program as a way of addressing student engagement and progression. This paper provides a case study that details the processes of implementing this pilot in the first semester of 2011. It focuses particularly on the positive outcomes for the attendees who had all previously failed this demanding first year subject. We draw on a range of qualitative and quantitative research data which includes participating students' comments and their results. We recognise the limitations of this study due to the small number of participants and acknowledge that the results are not directly transferable to different contexts. However, we suggest that it offers a pertinent case study which will contribute to the research into VSI as an effective learning modality.

Supplemental Instruction

Supplemental Instruction (SI) has become an integrated component of many students' learning experiences since its inception in the USA in the 1970's (Hurley, Jacobs & Gilbert, 2006a). Essentially, SI can be typified as peer led study groups where the peer, who has successfully completed the subject, provides collaborative learning activities and models effective study habits. Attendance at SI is voluntary and sessions are usually held outside regular class times. The success of this program, which runs in well over 1000 institutions across 29 countries is due largely to its strong theoretical underpinnings which were synthesised into this model by Dr Deanna Martin when charged with developing a learning program for high risk classes (Hurley et al., 2006a). Also, because SI targets traditionally difficult classes, rather than targeting particular students it avoids remedial stigmatisation and is relevant to all students no matter which grade they hope to achieve. Research consistently shows that students who regularly attend SI sessions tend to attain both higher marks on average and improved progression rates than those who choose not to attend (Hurley et al., 2008).

Video-based Supplemental Instruction

Supplemental Instruction was well underway at the University of Missouri-Kansas City (UMKC) in the 1990's when the need arose to provide non-remedial academic support for a new cohort of students (Martin & Blanc, 1994). These students did not necessarily have the requisite skills for competent independent study as is expected among university students. Consequently the VSI model was devised as a means of assisting 'marginally prepared' students (Martin & Blanc, 1994). VSI is differentiated from SI as it provides integrated support for students who would benefit from SI attendance but who may not choose to take up the opportunity. By actually enrolling in the regular subject but participating in the VSI mode of delivery students actively commit to their learning experience (Hurley, Patterson & Wilcox, 2006b). The founders of VSI describe it as 'an interactive information processing and delivery system that helps academically at-risk students master rigorous course content as they concurrently develop and refine reasoning and learning skills' (Martin & Blanc, 2001, p.12).

The core approach to VSI is based on pedagogies of collaborative learning and student comprehension that emphasise the importance of pre and post learning (Wilcox & Jacobs, 2010). The primary learning tool in VSI, as the name implies, is a pre-recorded lecture. The four main components of VSI are described as preview, process, review and polish. These entail previewing the vocabulary and the content prior to viewing the lecture, processing the lecture by either the students or facilitator stopping the video at any point for clarification or more opportunity to practice, and then reviewing the concepts within the lecture (Hurley et al., 2008). The facilitator is usually a graduate student or member of staff who models exemplary learning behaviours both in terms of study techniques and processing content. They create learning activities around difficult concepts that require collaborative learning among the VSI students. The forms these activities take are dependent on the content area but may include formulating questions and problem solving. An important feature of VSI is that the students' face to face class time is substantially more than in the regular mode of the subject. Additionally, the class sizes are small to enable the establishment of a dynamic learning community which can encourage students to be more responsible for their learning than in a passive environment such as a lecture (Hurley et al. 2006b). VSI creates an environment where students can process the lecture material in an in-depth and reflective manner (Hurley et al., 2008). Evaluation of VSI programs has consistently shown that participation in VSI can increase course grades as well as retention. Although VSI students tend to start with lower entry marks they tend to receive less below average or failing grades and withdraw less than non-VSI students (Hurley et al., 2006b).

Mathematics in Engineering

The current situation facing Mathematics in higher education across the Western world presents serious challenges for staff and students alike. Students attending university are increasingly coming from a diverse range of mathematical backgrounds, many of which do not prepare them adequately for the level of mathematics they are undertaking at University level (Henderson & Broadbridge, 2007). Pell and Croft (2008) note that this lack of preparedness is causing problems across the tertiary sector, with Engineering students being one of the significantly affected groups. They suggest that consequences for students who do not have the necessary skills to achieve in mathematical subjects in their degree include 'disillusionment, failure, withdrawal and loss of self-esteem; for staff there is increased pressure and lack of job satisfaction' (2008, p.167). Not only are their skill sets below the required level, but many of these students have not developed the skills necessary for the level of independent study expected of them at university (Ryland & Coady, 2009).

Supplemental Instruction has been shown to be effective in assisting students in both mathematics and engineering (Malm, Bryngfors & Morner, 2011; Cheng & Walters, 2009; Kieran & O'Neill, 2009; Mahdi, 2006; Murray, 2006). Studies have shown that SI can enhance Engineering students learning experiences by helping them to engage with the content and in the process to build learning communities (Blat et al., 2001; Lin &

Woolston, 2008). SI has also run successfully in developmental mathematics programs (Rutschow & Schneider, 2011; Wright, Wright & Lamb, 2002). It can be difficult to isolate SI/PASS as the sole predictor of student success as there are many different determining variables. However, studies which have controlled factors such as the voluntary nature of SI tend to show that SI is a positive contributing factor to student success (Parkinson, 2009).

Two studies which analysed VSI programs offered to students in Engineering and Mathematics are particularly relevant to the UWS case study. In 1996, VSI was piloted for students at risk, in a first year engineering subject with high failure rates at an Australian university (Hands, Reid & Younger, 1997, p. 331). Evaluation of the program showed that the average improvement in marks was 15 percent and students felt that they had been able to address the problems that had hampered their progress in their first iteration of studying the subject. These problems included 'motivation, conceptual understanding, poor background knowledge, the structuring of the content and language difficulties' (Hands, Reid & Younger, 1997, p. 331). Koch and Snyder (1999) analysed the impact of VSI on a group of students at a South African University who lacked the requisite mathematics for their studies. Notably, it was found that students who attended VSI and studied consistently throughout the semester improved their outcomes. In summary, given the success of VSI in relatively comparable situations, the authors of this paper determined that that it would be a beneficial intervention, particularly for students with a minimum level of mathematical preparation.

VSI Pilot

We have used the descriptor of vPASS for our VSI program, however for the purposes of consistency we will continue to use the term VSI throughout this paper, with the exception of comments from participating students who use the term vPASS. The Engineering Mathematics subject chosen to pilot VSI is a core subject for all Engineering courses at the University and failure to pass it can impede or halt students' progression in their degree. It is a particularly difficult subject for students who enter University without adequate mathematics preparation and has a consistently high failure rate, which includes a considerable proportion of students who fail subsequent attempts of the subject. The subject coordinator records the lectures which, along with online quizzes, incomplete lecture notes and tutorial exercises, are provided to students via the subject Blackboard site and thus are available for use in VSI. While many support mechanisms are in place for students, all are voluntary and uptake is limited.

Students face difficulty with this subject for a number of reasons, including lack of preparedness and lack of confidence or positive attitude towards mathematics and or study in general. There is also a tendency to fall behind as the subject progresses and students are therefore unable to complete assessments and the exam. The assessment items and their weighting for this subject are: three tests spread across the semester worth 40%, weekly online quizzes worth 10% and a final exam worth 50%. Of the 332 students enrolled in the Engineering Mathematics subject, 66 had previously failed the subject one or more times. These students were invited to participate in the VSI delivery of the subject. Twelve of the 66 students chose to enrol in the VSI mode which entailed completing the same assessment items as students in the regular mode, but attending VSI classes instead of regular lectures and tutorials. Table 1 outlines student enrolment and assessment items in the Engineering Mathematics subject.

Table 1: Student enrolment and assessment items

Engineering Mathematics Subject: 332 students		
Regular Mode 320 students	includes 54 students who previously failed the subject:	VSI mode 12 students: all previously failed the subject
Assessment Items: • Weekly online quizzes 10% • Class tests 1,2 & 3 40% • Final Exam 50%		

Eleven of the twelve students enrolled in the VSI mode are male and one was female. Seven of the students are the first in their family to attend University, five come from Non English speaking backgrounds and three are identified as coming from low socio economic backgrounds. Such demographics are similar to that of their peers studying the regular mode of the subject. Half of the VSI students had entered University via entry scores near the minimum entry level, seven students had failed the subject twice and, five had failed it once. A number of the students had also failed other subjects and consequently their Grade Point Averages were heavily weighted at the lower end of the scale with ten of the twelve students classified as 'at risk' of failing to progress in their course. Interestingly, six of the students identified in the pre-semester survey said they 'liked mathematics' and five indicated that they 'don't mind maths'.

Prior to the pilot of this program, two UWS academic staff members attended a customised VSI training in the USA so that we were sufficiently skilled to offer a quality program. The individually tailored training highlighted the importance of facilitating learning as a teaching methodology, rather than reteaching when conducting a VSI session (Martin & Blanc, 1994). The emphasis is on collaboration between students as integral to student learning and utilising the recorded lecture as the source of content wherever possible. Although the VSI facilitator, in this pilot, is a university staff member she was not responsible for any assessment and authority for the subject rested with the subject coordinator. Students in the VSI class were treated in the same way as all other students registered in the mathematics subject with respect to all assessment items. This included the supervision of class tests by a member of the teaching team for the subject, not the VSI facilitator.

COMPONENTS OF A VSI SESSION

Each week, the VSI group met for eight hours distributed over three days. The VSI facilitator blended the recorded lectures, from both the previous and current semesters, with the material provided to all Engineering mathematics students on their Blackboard site.

Preview

The Engineering Mathematics subject covers seven main topics. Before each topic the VSI facilitator organised a preview session which comprised combinations of vocabulary, notation and revision of concepts and skills required for the new topic. The most common approach was to ask students to look over a prepared worksheet before working in pairs or small groups to complete the activities. Each VSI session began with students previewing and deconstructing the topic. In previous attempts at the subject, students reported that when trying tutorial questions at home they spent considerable time just deciding how to start. Student D observed, “we used to go home and spend hours trying to figure out what it was about ... it would take an hour or two at home what you’ve achieved here in a few minutes”. Such comments reinforce the sentiment that preview sessions were vital in ensuring students could cope with the new material to be presented in lectures.

Process

During the VSI sessions, the recorded lectures were projected onto a screen in the classroom and students could indicate whenever they wanted the lecture paused. The facilitator had also pre-determined places to pause the recordings to check for student understanding. As well, the recording was frequently stopped so the students, in groups, could attempt questions presented in the lecture before viewing the solution. This opportunity enabled students to become aware of decisions required in answering the question as they had to attempt to grasp the content themselves before viewing the explanations. Extra questions were also attempted during these breaks in the viewing of the video. When students were asked about the types of learning activities they found helpful during VSI they frequently commented on the benefits of pausing the lecture, timely practice of questions, and group work. Student A commented, “Stopping the lecture, discussing, then doing the questions relevant to what was just explained in the lecture... this definitely contributes to the ease of learning and greater understanding”.

Review

The beginning of a review process occurred when students attempted questions during pauses in the lecture. During this time students were encouraged to start or add to a summary page for the topic. Initially the construction of summary notes was modelled by the facilitator writing notes about the topic onto a flip chart so that students could then add to it to create a summary for the whole class. Students were encouraged to use these as a basis for their own weekly summary notes which they reported to be a helpful learning activity. The review of lecture content was built into the process as described above, but further individual review also occurred when students were given questions to complete for homework.

Polish

At the end of a topic, when the group prepared for class tests, the summary notes made throughout the topic were used and modified to answer questions that could be expected in the assessment activity. Questions used in this revision session came from sample class tests provided by the lecturer, tutorial questions not yet answered and questions students sourced themselves. Often students brought in the class tests from their previous study of the subject. The final revision at the end of the semester involved bringing together each of the topic summaries to make links and assist in determining how to answer questions likely to appear in the final examination. Strategies for completing the examination were also discussed at this time.

METHOD

In order to conduct a comprehensive evaluation of the VSI pilot that considers students’ results as well as their experiences, we have used mixed methods research utilising both qualitative and quantitative data collection methods (Johnson & Onwuegbuzie, 2004). Pertinent aspects of this data have been selected for the purposes of this case study. Both VSI students and students studying the unit in the regular mode were surveyed at the beginning and end of semester. Eleven VSI students completed the first survey and ten VSI students completed the second survey. Of the regular cohort 174 students completed the initial survey and 105 students completed the final survey. There were a majority of common questions between the two surveys but VSI related questions were included specifically for the VSI students. The surveys were designed to gain insight into students’ mathematical backgrounds, attitudes towards learning and mathematics and perspectives on participation in the VSI mode of the program. Additionally, VSI students were invited to attend two focus groups during the semester with six students attending each time. The survey data was analysed using SPSS where practicable, and themes were identified in the open-ended responses from the surveys and the focus groups. Furthermore, by recording her reflections about the sessions each week the VSI facilitator provided important research data that adds an extra dimension to the study. Her notes have informed the discussion section of this paper.

In terms of quantitative data, a number of comparisons were made between VSI students' previous marks and their VSI results, as well as comparisons with their peers in the regular mode of the subject. Individual VSI student results from the three class tests were compared with their corresponding test results from their previous attempts at this subject. The average of each VSI student's class tests was also compared with the average of their previous performance in class tests. A further comparison was made between each VSI student's final results from their previous attempts at the subject and their results as VSI attendees. Additionally, the average results of VSI students class tests were compared with the results of the regular group for the same assessment items. The VSI students' final results were also specifically compared with the students in the regular class who like them, had previously failed the unit. It needs to be noted that there are limitations to interpretation when analysing and comparing the results of a small sample size. In the VSI class of twelve students, one student's result has a greater impact on a percentage result for the class than the result of one student in the regular class of over 200. To ensure explicit reporting of results, a graph depicting the individual VSI student scores for class tests and final results has been included below.

RESULTS

VSI students have shown that they were able to perform very well in the class tests both in comparison with their previous attempts at the subject and in comparison with the students attending the regular mode of the subject. Statistical analysis of VSI students' performance on each of the class tests was undertaken using paired t–tests. This analysis compared each student's result in a class test when studying in VSI mode with their result when they previously studied the subject. The results, shown in Table 2, indicate a significant improvement in each of the tests for these students. For Class Test One the results showed a significant difference at the 5% level, $p \leq 0.05$ but for Class Tests Two and Three the results when studying in VSI mode showed an even greater significant difference with p values ≤ 0.01.

Table 2: Each VSI students' result in class tests compared to their result when they previously studied the subject (N=12)

Class test	P value
Class test 1	$p = 0.0134$
Class test 2	$p = 0.0023$
Class test 3	$p = 0.0003$

A visual representation of the comparison between VSI students' previous results for the class test component of the subject and results in the VSI mode is shown in Figure 1. These results for each student, seen in Figure 1, show that all students in the VSI class improved their average class test results. The average of the three class tests for the twelve VSI students was 59.2% which represents an increase of 71% from their previous average of 34.6%.

A comparison of class test results between the students attending VSI (n=12) and those students attending the regular mode is represented in Figure 2. Initially, in the first test the average for VSI students was below that of the regular group; however in the second and third class tests the VSI class outperformed the regular group.

Figure 1: Comparison of VSI students' average class test results

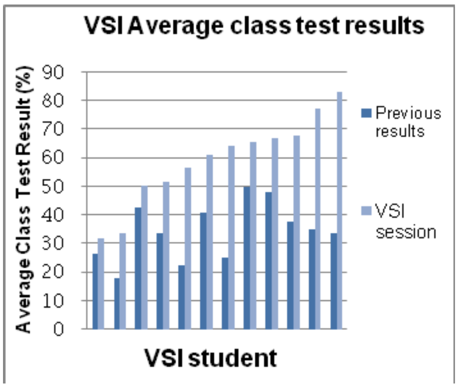
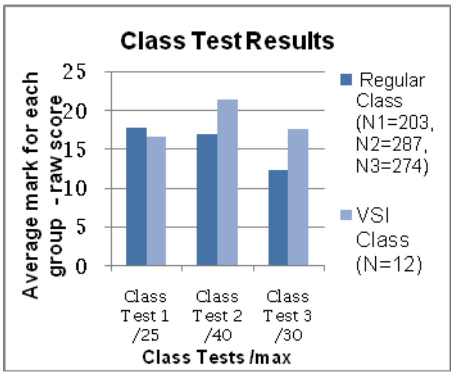
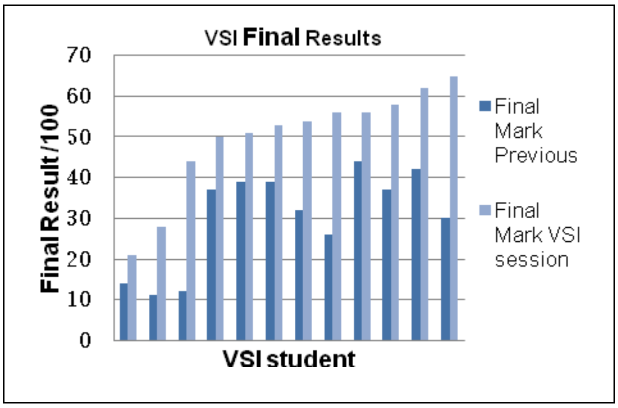


Figure 2: Comparison of class test results between regular class and VSI class



Overall final results, including the class tests and final exam, showed improvements for all students, as seen in Figure 3. The average final result for the VSI class was 49.8 out of 100 (n=12), with nine of the twelve students receiving a passing grade, and one of these a credit grade. This result means 75% of the VSI class passed and their average mark increased by 65% from the previous average mark of 30.3 (out of 100). The paired t-test showed this difference to be statistically significant ($p \leq 0.00001$).

Figure 3: Comparison of previous and current final results for VSI students



The results for the VSI class compare favourably with those of the regular class where the average mark was 46.1 out of 100 (n=320) with 37% of the class passing. Table 3 details final results for groups and subgroups of the engineering mathematics unit. All VSI students completed the subject compared with only 88% of students in the regular mode. When the students who did not sit the final paper are excluded, 42% of the regular group passed the subject. A comparison of students with a similar profile to those in the VSI class was made by looking at the results of the 54 students in the regular group who had previously failed the subject. Only seven of the 54 (13%) passed the subject which is substantially below the 75% attained by the VSI class. A t-test comparison of these results shows a significant difference ($p \leq 0.00001$) between the VSI students and those in the regular class who had previously failed.

Table 3: Final results for the Engineering mathematics unit

Group	Mean $\bar{x}$	Pass Rate (Percentage)
VSI class (n=12)	49.8	75%
Regular mode class (n=320)	46.1	37%
Regular mode class without those who did not sit the final exam (n=282)	52.3	42%
Students in the regular mode who repeated the subject (n=54)	23.3	13%

Student Feedback

The main themes that emerged from analysis of student feedback were an increase in confidence and understanding of content, positive attitudes towards learning and mathematics in particular, and improved study habits and learning strategies. The following comments from the end of semester focus group demonstrate increased confidence. "I enjoyed the discussion, understanding, the ease of asking questions, learning and the best it gave me is confidence" (Student A). Student B noted: "I was able to get a better understanding of the basics which allowed me to get a better grasp of the harder material and this second chance, especially being enrolled in vPASS, has helped me gain a greater perspective on the concepts". Students found they were able to grasp content that they had not understand during previous attempts at the subject: "Look at differentiation now, I find it really easy and before I used to just look at it and just have no idea where to start at all. She [vPASS facilitator] also teaches how to process a question a lot more, like first look for the techniques" (Student C). Students also discussed that they would take many of the skills and strategies they had been taught and modelled, such as the practice of making summary notes each week and studying together, into other subjects.

Unlike their previous attempt at the unit students were overwhelmingly confident that they would pass the subject prior to their examinations. Students' comments at the pre-exam focus group, reflect this positive attitude towards their studies: "Due to my marks in the class tests and online quizzes all that is required is a pass mark in the final which I am confident I can achieve" (Student E) and "I do think I should pass, I have put a lot of time in more than last semester and my marks have shown that" (Student C) and "I'm very confident I will pass, I know all the content and understand it, except for going poorly in class test 3, I have done well this semester; [my] marks have practically doubled and I now have more confidence in my abilities" (Student F).
In terms of attitudes towards learning, Student D commented: "Everyone's got a lot more happier attitude. It's not like 'Oh classes'" and Student A exclaimed "We love vPASS". The idea that mathematics could be enjoyable also affected students' attitudes: "When you understand maths it becomes fun to work with, and therefore more motivation to keep on track, studying at home etc" (Student B).

Students also formed new friendships and established the pattern of studying together: "I'm pretty sure a lot of us will probably stay together for study group next semester" (Student E). VSI also enabled students to approach the subject from a more empowered and collegial place: "it [the VSI class] helped me to determine my weak and strong points and strategies" (Student F) and "working with others, induced understanding" (Student A). Student D commented "I have learnt a lot more in vPASS than in the lectures because of more student interaction".

Both the extended face to face study time and the small class size which are rare opportunities in higher education were recognised by the students as an important feature of VSI. They observed that this enabled them to work together more effectively as a group and to feel confident to participate more fully in their learning process. Comments included “The longer hours and smaller group allowed myself to ask more questions and understand a lot more content going into a class test” (Student G) and “It is really helpful to constantly get together with the same people, on the same track. The more time together the more beneficial revision” (Student E) and “Due to the extensive time spent with the other vPASS students people were able to feel comfortable and confident in class enabling them to ask questions and receive help from other students” (Student H). Student C pointed out that they felt much more confident to ask questions, and that they had greater control over their learning process. “I liked that you could ask any question and no harsh comments were said even if it was a ‘stupid’ question. Also that it is very interactive and everyone participates and that we can pause the lecture to go back and understand what is happening”.

DISCUSSION

We recognise that it is a privilege to create a relatively optimal learning environment for students who are deemed at risk of failure to progress. VSI has reinforced the pedagogical benefits of small group, collaborative study with increased time for face-to-face learning. Within the first week, the VSI facilitator identified a lack of preparedness among students even though they had attempted the subject once or twice before. Consequently, it was vital that the VSI facilitator did not assume prior knowledge because it was apparent that many of the students had not understood some of the basic pre-knowledge required for the subject. This was surprising as we had assumed prior to beginning VSI that the students would have retained some of the content from their previous attempt/s. Of course, we were aware that students who failed the subject had major gaps in understanding but the number and size of these gaps was startling. This tends to suggest how little the VSI students, in general, had used the learning materials available to them and how little time they had previously invested. As the literature suggests, their initial lack of preparedness during their first attempt in the subject would have been a major factor in their failure to achieve (Ryland & Coady, 2009; Pell & Croft, 2008; Henderson & Broadbridge, 2007). Also, many diverse factors impacted on the VSI students’ studies. A high proportion of them are the first in their family to attend university and several had family responsibilities outside university. One student found stress very difficult to deal with: “for class test 3, I was unprepared and stressed with other assessments and I did poorly though it was still a lot better than last year” (Student F). Each student brought their own complex set of circumstances and learning experiences to the group and these will always affect the dynamics within any VSI class. Students also formed new friendships which can be an important factor in student retention (James, Krause & Jennings, 2010).

Many of the VSI students exhibited traits of students who have not yet taken full responsibility for their own learning. James et al. (2010) found that ‘coming to class unprepared, skipping classes and accessing lecture notes on the web as a replacement for attendance together ... summarise patterns of students’ preparedness for class and their engagement in scheduled classes’ (p.43). These behaviours were typical of many of the VSI attendees and one of the purposes of VSI was to scaffold more engaged learning among the students. Early in the semester some students admitted to not checking their student emails and this behaviour continued across the semester despite constant reminders. For example, Student G remarked “I see my email box and go pfft.” Similarly most students did not regularly check the messages and discussions on the subject Blackboard site. The VSI facilitator tried to foster student independence by ensuring students did not become dependent on her passing on all important information and encouraging the group to share important information with each other. However, some students became aware that she would always check or prompt or play parts of the current lectures if there was anything important being discussed. The irregularity in student attendance and punctuality at VSI became apparent after the first couple of weeks of semester. It would seem that these students would also have regularly missed lectures in previous semesters and therefore valuable content. Students were sent an email discussing the impact of this behaviour on their learning and that of the group which resulted in some improvement. Despite best intentions students seemed to struggle with the early starting time: "The vPASS classes are fine, if anything, they are enjoyable to come to. Except for the early starts at 9am" (Student E).

At the beginning of the semester, all VSI students were asked to sign a Memorandum of Understanding that detailed both their and the VSI facilitator's responsibilities. We found it difficult to enforce the agreement that failure to adhere to these responsibilities could result in the student returning to the regular class. However, midway through the semester, we invited students whose attendance remained sporadic for informal discussions. These were very illuminating as we found out that some of the students had a range of family responsibilities before arriving at their 9am class, health issues and others were working long hours. We negotiated ways that they might address these situations and again saw some improvement in attendance. We discussed effective strategies with the students which included attending all VSI sessions, watching the lectures online if they missed a class, completing homework and tutorial exercises, spending time making notes or some other form of revision and forming or joining a study group with their VSI peers. In the future we would interview all students early in the semester to see how they are adjusting to the VSI mode of study and to encourage them to employ strategies appropriate to their particular circumstances. We would also use a more scaffolded approach to guide students towards developing 'good student' behaviours.

Perhaps the most significant concern is that although students were achieving better results across the semester and improving their 'in class' learning habits and study strategies, this did not necessarily translate into how they study outside class and prepare for their final exams. Although one of the aims of VSI is that students become 'interdependent and independent learners' (Hurley et al., 2006b, p. 49) this is not necessarily achievable over the duration of one semester. Possibly students felt that attending VSI was sufficient due to the extended class hours. Responses to questions concerning individual study time seemed to depend on the number of other subjects students were studying this semester. Most of the students stated that they studied for 1-2 hours each week outside VSI. The balance between university and work was also reported as impacting on their ability to spend any more time outside class time. Students are expected to spend ten hours per week on this subject so a minimum of two extra hours would be expected of students. As failure to pass this subject impedes student progression and can result in exclusion it was interesting that students still did not feel the need to put in more than the minimum suggested time. Comments such as "you can count this as a double subject because you're putting double the time in" (Student B) highlight that students already felt they were investing enough time by attending VSI and that they were attaining the maximum recommended study time rather than the minimum.

One of the important features of VSI is that students begin to develop the meta-cognitive skills of 'learning how to learn', which can then enable a much deeper learning experience (Wilson et al. 2011). Students grasped this to different degrees. Some of the students worked very consistently and although only receiving low passes across the semester, were always trying to understand the 'what and why' of the content rather than 'just doing' the steps. Students appear to face problems in retaining the material over a longer period and being able to distinguish which material and method is required when presented with several topics at the same time. Therefore it seems that the deeper learning approaches needed to consolidate understanding were still very much evolving for students as the semester drew to a close. Perhaps the students felt that they had studied enough because they had passed the class tests and did not recognise that they still needed to apply extra time and commitment to attain the next level of application which was required in the final examination. The students did not seem to fully recognise the importance of this, even though it was emphasised consistently in VSI. Perhaps the students had inflated or unrealistic confidence about passing the examination because they were doing so much better than previously. This suggests that in future semesters we need to model, all learning behaviours, even more explicitly, including simulating exam conditions with previous exam papers.

CONCLUSION

In applying the VSI model to our particular context we were able to provide a unique opportunity for students who had previously failed a very challenging subject. The VSI students brought their own complex set of circumstances to the learning environment and therefore each individual responded differently to the program. Overall, students found that working in a structured collaborative environment was beneficial in helping them to acquire confidence as learners, develop effective learning strategies and form friendships and study groups. They all improved their understanding of the content and consequently their results. We identified a tension that seems to exist between students acquiring and applying independent learning strategies and we need to explore ways that can assist students in these areas. Although VSI is a very resource intensive approach to student learning, if the skills and strategies that these students gained are taken into their future study and they are able to progress through their degree, it can be seen as a worthy investment. VSI appears to be an effective form of SI for at-risk students. In order to further establish the efficacy of VSI programs, future research may examine longitudinal changes in students' attitudes and outcomes.

AUTHORS

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