The ideal teacher: A curriculum framework for teachers of primary mathematics

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The ideal teacher: A curriculum framework for teachers of primary mathematics

Abstract
This paper suggests a curriculum framework for training prospective primary teachers of mathematics. Such a framework needs to be viewed in the context of the skills and understandings that are reflected in successful mathematics teachers.

Keywords
teachers, framework, ideal, teacher, primary, mathematics, curriculum

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curriculum framework
for the training of
primary mathematics
teachers

Introduction

To train the ideal primary school
teacher, a Professor of Education once
said, needed a minimum of twelve
years.

She argued, tongue in cheek, that
three years were needed for training
as a child psychologist; three more
years needed to be spent on the
history, philosophy and psychology
of education; three years on the
academic content of the primary
curriculum and a final three years
training in method acting could
usefully round it all off.

It is surely possible to spend a lifetime
arguing about and designing the
training of the ideal primary teacher—
and many an education lecturer has
done exactly that. Any description of
the ideal implies the need for an equally
ideal training program, and for that
matter an equally ideal primary school
teaching and learning program.

Without presuming to describe the
ideal, this paper suggests a curricu-
ulum framework for training
prospective primary teachers of
mathematics. Such a framework
needs to be viewed in the context of
the skills and understandings that
are reflected in successful math-
ematics teachers.

Such teachers must surely first of
all, be aware of, and be able to react
to, all the many and varied calls
made upon the profession. For a
start, they must be able to learn
from the training program to which
they have been exposed, using it to
build on their strengths and to rem-
edy their weaknesses.

Communicating with
students

Knowledge of one’s own strengths
and weaknesses must be matched
by sensitivity towards the strengths
and weaknesses in others. Primary
teachers cannot teach successfully
unless they are able to listen with
sensitivity and care to their stu-
dents, and act accordingly. Their
own use of language must enrich
the students’ linguistic experience.
All their actions must sustain and
enhance the children’s work, what-
ever their level of attainment.

Indeed, the skills of communication
which are needed in the primary
classroom are of the highest degree.
Simply knowing when to stimulate
and excite on one occasion, and
when to listen and react passively,
on another, is basic to the teaching
process.

They must also have the confidence
to be able to say ‘I’m not sure’, or ‘I
don’t know’, but to be able to add,
‘but I think we can find out’, know-
ing that solutions and ways forward
are not just to be found in books
kept on shelves, or from colleagues,
but also on occasion from the stu-
dents themselves (and not neces-
sarily from their correct answers
—sometimes the germ of a right idea
can be found in a wrong answer to
a question).

Those who underestimate the care
we need to take in planning teacher-
training curriculum fail to under-
stand that we are not talking about
an occasional need to use such
skills, but about a day-by-day, week-
by-week, term-by-term and year-
by-year activity.

Communicating with
colleagues

In the best of all possible worlds—apart
from expecting all primary teachers to
be able to work with children in the way
we have been suggesting—we might
assume that every primary school
teacher would also be capable of the
scholarly activity (and what is more,
have the time) needed to create his or
her own teaching program. In prac-
tice, we do not assume this is possi-
bile, and the help of others is provided
from outside the classroom, to develop
the primary curriculum. We must
therefore have teachers who can re-
act positively with these professional-
als, whose job it is to write the primary
school programs in English, math-
ematics, and science. We need teachers
who are able to debate and argue with
confidence, giving advice based on their
practical experience, so that the cur-
riculum can become a proper amalgam
of the needs of the children as seen from
outside the classroom with those needs
as seen from inside.

To successfully communicate with
students and colleagues, teachers
need to share common understand-
ings about mathematics, about how it is learnt and taught, and about
other significant issues that surround
the subject. The basis for these
understandings lie to a large extent in
the beliefs that teachers hold.

Beliefs about mathematics

What is meant when we talk about a
belief? The term belief is interpreted
in many ways. Mcleod (1988), in his
work on a theoretical model for affec-
tive issues in mathematics learn-
ing, describes the three factors:
emotions, attitudes, and beliefs.

Emotions may change rapidly and
be quite physiological in nature. For
example, students who become
frustrated and upset when working
on a problem may become very posi-
tive just minutes later when the prob-
lem is solved. Attitudes toward mathe-
ematics refer to feelings about math-
ematics teachers.
emetics that are relatively consistent. As an illustration, when students say that they dislike mathematics one day, they are likely to express the same attitude the next day.

Beliefs about mathematics are frequently based as much on cognitive factors as on feelings or affective responses. Beliefs about self may have more of an affective component, but in general, beliefs involve mainly cognitive aspects that are typically built up over a long period of time. Consider for example, the beliefs about the usefulness of mathematics, the nature of mathematics, the view of a problem and problem solving, and the conception of the learning and teaching of mathematics. Each is a belief which is not likely to change day-by-day and encompasses a strong cognitive component.

An instrumental belief

Brown, Cooney, and Jones (1990) describe the commonly held view that mathematics is cut-and-dried and the belief that the discipline is composed of many disparate and already prepared parts. This instrumental belief is embodied in the following response given by a teacher when asked about the nature of mathematics:

For me, mathematics is the basic operation of addition, multiplication, subtraction and division used as the fundamental building blocks to show definite relationships of numbers and symbols that can be extended into higher and more difficult levels of numeric and symbolic relationships.

The above quote is taken from data collected during a study by Becker and Pence (1988). In this project, 43 teachers from an inservice program were asked to discuss their views of 'what is mathematics'. A number of teachers took this question seriously and bravely discussed their own views. All of the quotes attributed to teachers come from this data source.

A Platonist belief

Another view of mathematics is illustrated by the teacher who states that:

To me, mathematics is a set of theorems and postulates which are used to organize data, and to put some order into the physical aspects of the real world. Mathematics is often simplified into a set of algorithms which can be applied to real problems or abstract problems. This statement seems to correlate more closely to a Platonist view of mathematics as a static but unified body of knowledge. The mathematics is discovered, not created.

A problem solving belief

A third view of mathematics is reflected in this next quote by a primary school teacher:

Mathematics is a way of describing our universe and our world. Poets may use adjectives and historians use dates and artifacts to describe our environment. Mathematicians use numbers, form, patterns, and graphs to help us understand the world we live in. For me, mathematics has always been a process of discovery.

Here, there is a problem solving view of mathematics, one in which mathematics is a dynamic, continually expanding field of human creation and invention. Mathematics is a process of inquiry and discovery.

Implications of belief systems

Ernest (1988) suggests that there may be three general categories of beliefs about mathematics typified by these examples. To each of these conceptions of the nature of mathematics, Ernest maps a view of both the teaching and learning of mathematics. In the case in which mathematics is an accumulation of facts, rules and skills, the teacher's role is perceived as that of an instructor working to show or tell students the proper techniques in the clearest way possible, and helping the children to reach the 'correct' way of thinking about mathematics. For the Platonist, the view of the role of the teacher becomes that of an explainer of conceptual understanding of a unified knowledge. Finally, where mathematics is seen as a process of discovery, the role of the teacher becomes that of a facilitator helping the students become problem solvers.

Beliefs affect communication as well as classroom practices. The word problem, for example, does not mean the same thing to everyone. It may mean a routine word problem to one person, and to another it may mean the process of discovery. The following examples illustrate this variety in the meaning of problem:

• Steers sell for $25 a head and cows for $26 a head. A farmer has $1000 to spend and must spend it all on cattle. How many cows and how many steers could she buy?

• Steers sell for $25 a head and cows for $26 a head. A farmer bought 14 steers and 25 cows. How much did he spend?
Teacher

A curriculum framework

Thus recent research highlights the importance of the relationship between beliefs, communication and classroom practice (e.g. Thompson, 1984). With this relationship in mind it seems clear that we must seek ways to incorporate experiences in our teacher education courses that engender beliefs conducive to successful mathematics teaching.

A curriculum framework

Teacher training courses need to provide for the realities of the primary classroom: the vast range of student abilities and attitudes; the need to work with individuals, and small and large groups; familiarity with manipulatives and schemes of work, as well as more than an instrumental understanding of mathematical content. These courses also need to provide varied situations in which students encounter the major and significant issues that arise in teaching mathematics with the aim of developing belief systems that can accommodate new ideas and new approaches.

Table 1: DIMENSIONS AND ELEMENTS

<table>
<thead>
<tr>
<th>AGES</th>
<th>STRANDS</th>
<th>WORKING WITH CHILDREN</th>
<th>LEARNING OUTCOMES</th>
<th>TEACHING STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early childhood</td>
<td>Number + / - / x / - Number patterns and relations</td>
<td>Individuals Small groups Large groups</td>
<td>Content Conceptual structures Processes Cognitive Metacognitive Attitudes Feelings Beliefs Emotions</td>
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<td>K</td>
<td>Chance Statistics Graphs Space 2D, 3D Measurement Length Area Volume Capacity Mass Time Angle Temperature</td>
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<td>8 - adult</td>
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</table>

For some, the first would be a problem because it provides some room for exploration while for others the first could not possibly be a problem for exactly the same reasons. Thus in a conversation about mathematical problems, the difference in conceptions might never surface and thus similarly stated ideas may bear little similarity of meaning and no overlap in classroom practice.

Experiences within courses and with school children can be conceptualized as interactions of the various dimensions and the elements within each dimension. For example, an activity involving calculators from the upper primary number strand can provide the focus for a discussion on the issue of assessment. The Mathematics Curriculum and Teaching Program (Lovitt & Clarke, 1989) resource provides such a teaching episode that incorporates these three elements.

Similarly, teaching problem solving can be considered across strands and stages using a variety of materials and technologies. The focus of any series of teaching episodes will depend on pre-service teachers’ past experiences, knowledge, and attitudes, and will need to be considered in much the same way as teachers consider children’s development. As pre-service teachers gain in knowledge, experience and confidence, issues will be developed with an ever-increasing depth of awareness and understanding.

The dimensions that form the framework for considering the significant ideas of a primary mathematics education course are described as follows:

1. Ages. The chronological age of the children for whom the activities apply.
2. Strands. The content of the mathematics syllabus partitioned
into areas that are conceptually similar. For example, the space strand, which incorporates 2D and 3D knowledge.

3. Learning outcomes. This dimension describes qualitatively different outcomes that children learn, for example, the conceptual structures (understandings) of mathematical content and the processes of mathematical thinking and problem solving (Shuard, 1986).

4. Working with groups. Activities involving children are considered in relation to the size of the group.

5. Teaching strategies. Different teaching strategies that incorporate those identified in the Cockcroft report (DES, 1982).

6. Significant issues. This dimension includes issues that provide the basis for developing appropriate beliefs about, for example, how children learn.

7. Significant resources. This category includes both materials considered essential for the development of mathematical understanding of children and the professional development of teachers.

The interaction between various dimensions and elements can result in a teaching episode that is a rich and rewarding learning experience.

Conclusion

The beliefs that teachers hold about mathematics and how it is learnt will certainly be influenced by the approaches taken in mathematics education courses. The framework provides here allows us to step back and reflect upon the myriad connections that can occur.

Our task, then, is not to spend 12 years training students in an attempt to 'cover' all the possible routes of understanding resulting in the 'ideal teacher', but to choose pathways - and allow pathways to be chosen - that reflect both the nature of understanding and discovery, and provide teachers with an awareness, and a desire, for future growth.

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