

Teachers' understandings of the role of learning activities

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This study investigated teachers' understandings of the role of learning activities in secondary school mathematics. A qualitative study involving interviews and questionnaires was conducted in government and non-government schools. Most teachers in the study were supportive of the use of learning activities in the classroom for both teaching and learning purposes but were aware of constraints of time, adequate resources and curriculum requirements.

Selected Literature Review

In the changing face of school mathematics, the *National Statement* (AEC, 1991) and *The Cockcroft Report* (1982) envision that students develop within their capabilities, the mathematical skills and understanding required for adult life, employment and further study and training. Hence, mathematics can no longer be regarded as a 'chalk-and-talk' subject from the perspective of the teacher or as a 'pencil-and-paper' subject from the perspective of the student. The *National Statement* and *The Professional Standards for Teaching Mathematics* (NCTM, 1989) acknowledge the increasing diversity of clientele in schools, in terms of their abilities and personal experiences. These documents acknowledge that not every student will have the same interests and capabilities in mathematics, as some students will enjoy mathematics more than others, or a particular student may enjoy some aspects of mathematics but not others. To ensure that students leave school with a positive attitude towards mathematics, these policy and curriculum documents advocate that students must be exposed to a wide range of learning activities in mathematics.

There are several different ways in which the concept of 'activity' could be interpreted. 'Activity' can be understood as a concept within Activity Theory. In this particular theory of learning, mathematical understanding arises from the engagement in mathematising experiences with others and becoming a legitimate participant within a community where mathematical activity is accepted as part of competent membership (Lave and Wenger, 1991). In a mathematical learning activity in the classroom, learners become part of a community of practice interacting to help each other understand mathematical principles (Bishop, 1988). Activity could also be understood as a concrete experience used to illustrate a concept, or it could be a game which is associated with drill and practice. One of the purposes of this study, was to determine where teachers were located with respect to these different interpretations of activity.

There are a range of 'learning activities' that exist in mathematics education. These can range from independently completing a "fun" worksheet or playing commercially-prepared or teacher-made instructional games with peers in order to reinforce one's understanding of a concept, to getting physically involved in a whole class group activity to learn a new concept or skill. Bishop (1988) lists six activity-types commonly used for the teaching and learning of mathematical concepts. These are: Counting, Locating, Measuring, Designing, Playing and Explaining. Guided by policy and curriculum documents, Lovitt and Clarke (1988) have listed types of activities that may be worthwhile learning experiences. In the associated resource package are activities that students are able to become involved in: physical activities, creating a visual representation, participating in group investigations, problem-solving and making mathematical models. Sometimes, students also have the opportunity to write journal entries or stories to describe mathematical representations. Stephens, Lovitt, Clarke and Romberg (1989) contend that the specific classroom activities collected and documented by RIME (Reality In

Mathematics Education) and MCTP (Mathematics Curriculum and Teaching Program) represent “snapshot images of a quality learning environment” (Stephens, Lovitt, Clarke, and Romberg, 1989, p.229). The collection of activities in these activity packages forms a “gallery of the art of good mathematics teaching”, and serves as a vehicle which “illustrate[s] new understandings and reshaped practice.”

Mathematical learning is now viewed as a process that involves both active construction and enculturation. Cobb (1994) asserted that sociocultural and constructivist theories both highlight the crucial role that activity plays in mathematical learning and development. However, unlike the constructivists who give priority to students’ sensory motor and conceptual activity, socio-cultural theorists typically link activity to participation in culturally organised practices; that is, activities being performed in groups. Ernest (1994) outlines some principles of social constructivism which provide a useful framework for the study to be reported in this paper. As students construct knowledge by learning together in a social mode, they are communicating their progressive understanding of mathematical topics by describing in their own language what the topics mean to them and how they apply their interests and personal experiences.

Teachers’ beliefs (Cooney, 1985; Thompson, 1984) about mathematics and learning have a powerful influence on how they teach the subject. In turn, teachers’ views of mathematics are shaped to a very large extent by their own mathematical experiences as students (Dorfler and McLone, 1986). These views may also be influenced by content policies, teachers’ own content knowledge bases and their interest levels (Porter et al, 1988). Although the Queensland Years 1 to 10 Mathematics Syllabus (Department of Education, 1986) has advocates the use of activity-based lessons, many teachers do not feel secure about this arrangement, and feel that in such lessons, their authority is more apt to be challenged. Richards (1991) and Porter et al (1988) believe that this is because their years of teaching in a more traditional teacher-centred classroom provided them with a sense of security and comfort, in which they knew the questions that would be asked and the answers they would provide to these questions. In an activity-based lesson, teachers need to take on a different role. Rather than transmitting knowledge to students, teachers are required to facilitate students’ investigation and construction of concepts. This is a more open environment, where the teacher may have less control over student behaviour and the kinds of things that students learn. Therefore, teachers may be reluctant to take on an activity-based approach to teaching.

Purpose of the Study

This study is an investigation of teachers’ understandings of the role of learning activities in secondary school mathematics, and examines the three key questions listed below:

- What views do teachers have of activity-related teaching methods in mathematics ?
- What are teachers’ views on the nature of student learning activities in mathematics ?
- What curricular issues do teachers associate with learning activities ?

It must be noted that the investigation did not endeavour to ask “What are learning activities ?”, but instead, to find out about teachers’ understandings of the role of learning activities in secondary school mathematics. In the context of the transformation of mathematics education from an expositional model to a more investigative one, teachers were asked to disclose their views of learning activities, what they thought these comprised, and what they believed should be taken into consideration when planning for a learning activity. Information was also sought on the reason for teachers’ attitudes about the role of learning activities in the secondary mathematics classroom. The study

endeavoured to seek an insight into individual teachers' views on various aspects of learning activities.

Methodology and Scope

The direction that this study took with regard to its questions and methodology was representative of interpretative social science and hence, the study used a combination of qualitative and quantitative research methods. Although qualitative methods were predominantly used, quantitative methods were also used to analyse questionnaire data. The centre of interest in this study was not collecting large volumes of data, but organising and making sense of the variety of thoughts and experiences, that were gathered.

The research study was carried out in two main stages of investigation: an initial study and a subsequent study (see Table 1). The findings that arose from the initial study were taken into consideration for the second phase of the investigation. While the aims of the initial study was to find out what secondary school mathematics teachers considered to be an 'activity' and whether these 'activities' were an effective learning and teaching tool, the subsequent study aimed to examine teachers' understandings of the role of learning activities in secondary school mathematics. In the initial study, the participants were mathematics teachers from selected non-government schools. However, in the subsequent study, the participants were teachers from both government and non-government schools. With regard to data collection methods, a questionnaire and a semi-structured interview were the main research instruments in both phases. In both phases, all of the teachers that agreed to participate were required to complete a questionnaire. For the interviews, however, a subset of the teachers were selected, based on their responses to the questionnaire. Interviews were audio-taped for the purpose of obtaining an accurate transcript. Qualitative and quantitative data analysis methods were used to present, describe, analyse and interpret the results from the questionnaire. For the interview, on the other hand, qualitative data analysis methods were used to present, analyse and interpret the data.

Table 1 **Structure of the study**

Stage of data collection	Aims of Research	Data collection methods	Data analysis methods
Initial Study	To find out: <ul style="list-style-type: none"> · What secondary school mathematics teachers considered to be an 'activity'; and · Whether these activities were an effective learning and teaching tool 	<ul style="list-style-type: none"> · Initial Study questionnaire · Semi-structured interview (audio-taped and transcribed) 	<ul style="list-style-type: none"> · Quantitative and Qualitative · Qualitative
Subsequent Study	To examine teachers' understandings of the role of learning activities in secondary school mathematics	<ul style="list-style-type: none"> · Subsequent Study questionnaire · Semi-structured interview 	<ul style="list-style-type: none"> · Quantitative and Qualitative · Qualitative

Participants

As the study was an examination of the central topic, teachers' understandings of the role of learning activities in secondary school mathematics, this paper focused on the results emerging from this phase in the investigation. For the subsequent study, 12

government and 12 non-government schools were approached. It was anticipated that about 2 teachers from each school would participate. Of the schools selected, 7 government and 4 non-government schools agreed. From these 11 schools, 26 teachers (18 government and 8 non-government) agreed to be participants in the questionnaire. Of these 26 participants, 7 agreed to participate in the interview. Only 1 of these 7 teachers were from a non-government school. Teachers were coded using a special coding system. The first letter of the code was either G or N to indicate whether they were from a government or a non-government school. The second letter of the code indicated the order in which the schools agreed to participate. The number was based on the serial number of the questionnaire which they wrote their responses in. The questionnaire documents For example, Teacher GA2 was given her code because she was from a government school, her school was the first government school to agree to participate, and she was the second teacher who filled in the questionnaire. Through gathering the data on their demographic characteristics, it can be seen that the participating teachers varied greatly in the length of their teaching experiences. There were teachers who had less than 10 years of experience, teachers who had up to 25 years, and teachers who had over 25 years. However, it must be understood that the length of teaching experience does not always affect teachers' perceptions about learning activities, as these perceptions could have been reshaped by in-service and professional development programs.

Results

Both the questionnaire and interview data were analysed in terms of the three key topics for this study. Teachers' actual responses to the questionnaire and interviews were used throughout the analysis to illustrate or reinforce the findings.

Teachers' views of activity related teaching methods.

From the questionnaire data, it was found that a significant proportion of the teachers believed that activities which were cognitive-active in nature (i.e. such activities that required students to think and participate actively) were more effective as teaching strategies. Teachers' believed that their teaching was more effective when they got students to: engage in problems and activities; solve a problem independently; or discuss a concept and apply it to real life. Consequently, most teachers had a positive view of learning activities. Teachers, however, had different ideas about using learning activities. Teacher GC2 believed that teachers had different 'understandings' about activities, as "there were some teachers who will not go any further than using one of those worksheets with the codes at the bottom, and that's their learning activities". Her personal preference was to develop students' thinking skills with the use of student-constructed questions. She found this to be particularly useful for students, as it gave them the opportunity to work at different levels.

Teachers also found that when they used learning activities, they were able to recognise that effective learning was taking place. Teacher GA2, who encouraged students to write about their mathematics, explained how she recognised effective learning taking place in her classroom. She attributed the efforts of students to her approach to teaching.

Because I tend to take....mathematical and scientific words, and get the kids to write it in their own words, like "Maths is the stuff that you find one object" or "My Math"...[W]hen the kids talk about them, because the year 8's tend to be "I", they're egocentric like...little kids... "My maths is how much there is inside my body, or the things that make up my body", and they might use some different other term in it in the exam, and that one word would throw the whole thing, and the kids would say, "Oh, is that what you wanted me

to"...you know, [or] "I know how to do that. Why don't they say it that way?"

What is particularly interesting about teachers GC2 and GA2 is their emphasis on student-centred activities. In the former case (GC2), the students are placed in the traditional teachers' role of devising questions and problems to solve; in the latter case (GA2), the teacher facilitates student engagement in writing about mathematics. These "activities" do not involve manipulation of concrete materials, but they do require deeper engagement by students in reflecting on how to think mathematically. In the case of GA2, she encouraged to talk and write about their mathematics, and when they did, she found that they were learning and constructing their own mathematical knowledge.

Teachers' views on Student Learning Activities.

Most teachers were supportive of activities which had an investigative nature. Such activities included physical involvement and group investigations and problem-solving. They also perceived 'hands-on' activities to be effective for students as these activities involved mathematical modelling or creating visual representations. Teachers believed that these were worthwhile learning experiences for students, as it exposed them to various learning processes. Thus, the teachers supported Guild's (1989) view that "[w]hen teachers plan for a variety of ways for students to learn, more students can use individual strengths to be successful" (p.17). Speaking of their classrooms, GA2 and GF1 provided evidence supporting Guild's view:

So, you've got students who learn visually, they got to see it all. Students that learn by tactile, by moving stuff around. Students learn stuff by discussing it, because it was a class group discussion that also took place with the cards and dice and stuff. Um and then, we wrote it down. We took it straight from the concrete to the abstract and related it directly on the board, so nearly everyone....all the teaching styles were catered for. [GA2:32]

Some students learn by actually writing, they can't take it in by listening. So, if you're just explaining something, they're not going to learn from that, because they can't conceptualise. So then, you know, with a lot of things I do, I use the whiteboard or the blackboard, I use the overhead transparency a lot...At times I prepare worksheets, so they're doing again, so I guess it's the saying "Monkey-see, Monkey-do, Monkey-don't-do"....there's the students that can just listen and take it in; and there's the students who must do it to learn....so I try to make sure that I'm doing all those things. You're talking, you're putting up things visually through overhead transparencies and worksheets...[GF1:22]

Teachers GA2 and GF1 differed in their perspective on catering for learning styles. Teacher GA2 believed that through the many learning processes that she provided, students were able to construct their own mathematical knowledge. Teacher GF1 on the other hand, had a more managerial perspective. As her priority was to keep the class under her control, she used activities, in which she did most of the talking and presenting. This difference could be attributed to the different values and beliefs that they held about teaching.

Curricula issues associated with learning activities.

Many curricula issues arose throughout the questionnaire and the interviews. The more pertinent issues, related to learning activities included preparation and planning, accessibility of resources, discipline and coverage of mathematical content materials. Many teachers considered that being prepared was an important characteristic for an activity. To them, being 'prepared' meant knowing what resources were available, ensuring that the environment was controlled, and ensuring that instructions for the activity were simple

enough to be understood. In the questionnaire, teacher GE1 offered a valuable comment on the organisation and preparation for the activities:

To get the ideas, then the resources, takes a little time, and is sometimes a little daunting, however, it is almost ALWAYS very much worth the initial extra time and effort.

Accessibility of resources was an important issue, because teachers' knowledge of these determined their choice of activities. In addition to the planning and preparation issue, one teacher raised an issue about coverage of content materials. The teacher claimed that with syllabus constraints there isn't always the time to conduct activities for every topic, especially in the senior school. Teacher NE1 reinforces this with the comment below:

"...the only restriction in the senior school is purely time. We have certain restrictions by which we have to work, and therefore, we have to make sure that we cover what we have to cover, and there is time to do learning activities, but not all the time. We have to be careful that we're not harming the kids' chances of progressing into university at the expense of just basically learning [NE1:66]

The discipline of students was also another important issue. "Strong discipline" was a priority with some teachers. In the questionnaire, teacher GB1 made a comment that:

Experience has taught me that strong discipline, good classroom management skills, setting parameters, expectations and rules etc, are necessary if learning activities other than the formal lesson are to be attempted.

This was supported by a comment made by GG2 in the interviews:

I cite the case of a few years ago of a teacher. He was first year out. He had wonderful activities planned for the students, wonderful hands-on things for students to do outside the classroom....but unfortunately, in this particular instance, he was not able to manage the students, so they were an absolute disaster...he probably needed to start off in a more formal setting, a bit ..more towards the chalk-and-talk...more of a teacher-dominated style of lesson first of all, until he was actually able to manage the students. He let the students go, and it was really "hell for leather"... he was well-prepared, but he wasn't able to manage a group of students efficiently or effectively. [GG2:32-36]

Based on his knowledge of this case, Teacher GG2, who himself was a very experienced teacher, believed that if activities weren't controlled properly, they were ineffective. Consequently, he recommended that beginning teachers establish a way of managing student behaviour before integrating learning activities into their teaching repertoire.

The teachers who participated in the study were in favour of using activities for dual reasons. As a teaching strategy, activities enabled teachers to determine whether learning was taking place. As a learning experience, activities exposed students to various learning styles. Teachers, however, had different ideas about how learning activities to be used. Other pertinent issues that were raised were accessibility of resources and strong discipline, which implies that teachers need to be effective classroom managers. The findings also implied that teachers be thoroughly prepared before conducting activities. This means that they need to know what resources are available at the school; the student group they are preparing for; and the year level for which the activity is targeted. These implications, however, are based purely on the participating teachers' views of learning activities. Although separate views on learning activities and classroom management were supported by the literature, views on the role of classroom management in mathematical learning activities have not yet been supported nor contradicted in the literature.

Recommendations for Future Research

With an opportunity for future research, this area of interest (teachers' understandings of the role of learning activities) could be investigated in alternative ways. To achieve greater consistency within the results, a more extensive examination of the teachers in Queensland schools would be useful, if schools across the state (rural and urban schools) were examined as opposed to schools in the Brisbane metropolitan area (government and non-government schools). Alternatively, observations of teachers carrying out learning activities would have been useful, as they would have supported or contradicted the claims that teachers made in the questionnaire and interviews.

With the availability of a longer time period, this area of interest could be investigated through a case study where two 'case' teachers are surveyed, interviewed and observed. Another alternative method would be to conduct an ethnographic study on a few teachers from government and non-government schools on their views of the effectiveness of learning activities. This would involve observing and interviewing these teachers and comparing what they say to what they do. Both approaches are useful because they would indicate whether teachers' understandings of learning activities have any relation to the way they conduct these learning activities.

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