Title	Trainee teachers' reaction to the use of multiple intelligences in the mathematics classroom
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Source	*AARE Conference, Fremantle, Australia, 2-6 December 2001*

TRAINEE TEACHERS' REACTION

TO THE USE OF

MULTIPLE INTELLIGENCES IN THE MATHEMATICS CLASSROOM

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SINGAPORE

As the educational system in Singapore shifts from an efficiency driven approach to one that is ability driven, there is now a more urgent need to look at individual students' learning style. The concept of multiple intelligences, as proposed by Howard Gardner, fits in well as a framework for such a consideration. Since teachers are found to teach the way they were taught, this study looks at the reaction of trainee teachers' reaction to the use of musical intelligence in learning activities for lower primary mathematics. In this study, the teachers were brought through the steps of such a lesson as part of their pre-service training. A short video clip of the session will be used to illustrate participatory level of the teachers in such a session.

INTRODUCTION

As a young nation, the education system for Singapore in the sixties and seventies is one of survival-driven – looking at what Singapore needed and delivering it. As the nation develops, the late seventies and early eighties witness an effort to hone the efficiency of the education system and to reduce educational wastage. The education system of the eighties and nineties is an efficiency-driven one – looking at what the nation want to achieve, and determining the best way of achieving this with optimal use of resources.

As we moved into the new millennium, intellectual capital, which refers to the application of knowledge and human ingenuity, has increasingly become the basis for competitive advantage of companies and nations. As an example, for every $100 output of refined petroleum products, perhaps $90 comes from crude oil and only $10 from "value added". This value refers to the returns to the workers who work in refineries and the investors who own the refineries. In comparison, for every $100 output of computer software, only a very small proportion ($5-$10) goes towards manufactured products like the box in which the software comes in and the other $90-$95 goes to the people who wrote, marketed and sold the software.

It is, thus, no surprise that the Ministry of Education (Singapore) announced in 1999 (The Straits Times, 10 July 1999) that Singapore will 'move towards ability-driven education to help individual recognize and make use of his talents and abilities'. In other words, education must focus on the individual student's needs, much the same way as manufacturing is moving towards customization, and the media producing personalized information on the internet.

LEARNING STYLES AND MULTIPLE INTELLIGENCES

"To be successful in our classrooms, we need to be more aware of how our students learn", as noted by Synder (1999), in her investigation of the relationship between learning styles and multiple intelligences and academic achievement of

high school students. Carl Jung (1927), the father of learning-style, noted the differences in the way students perceived, made decisions, and interacted. Since then, educators have become more aware of the research of cognitive and educational psychologists in the area of individual differences and learning styles. Gardner (1983) and Gardner & Hatch (1989), in their effort to rethink the theory of measurable intelligence embodied in intelligence testing, studied the work of cognitive and educational psychologists and developed their theories of multiple intelligences. Synder (1999) pointed out that learning styles are concerned with the differences in the process of learning and multiple intelligences centre on the content and products of learning. Silver, Strong, and Perini (1997) believe that by integrating the theories, the classroom teacher will be provided with some very practical suggestions that will prove to benefit the students. While Guild (1997) suggests that teachers that are concerned with learning styles and multiple intelligences "bring an approach and attitude to their teaching of focusing on how students learn and the unique qualities of each student".

MULTIPLE INTELLIGENCES AND MATHEMATICS CLASSROOM

Since his seminal book, Frames of Mind (1983), Gardner encourages people to expand their definitions of intelligence, examine their attitudes toward learning, and expand their beliefs about the way children learn. Many mathematics educators have been utilizing Gardner's theories and incorporating them into the mathematics classrooms. Martin (1996, 2000) publishes two books with collections of interesting ideas in applying multiple intelligences in the mathematics classrooms. The works by Adams (2001) and Willis and Johnson (2001) are samples of two recent studies to examine the role of multiple intelligences in the learning of mathematics among children. As Martin (2000, p.4) pointed out, through the use of Gardner's Multiple Intelligences theory in mathematics classroom, "educators can support the strengths and shore up the weaknesses of their students".

THE MATHEMATICS CLASSROOM AND THE TEACHER

Enactment of multiple intelligences type of mathematics classroom "requires major changes of the teacher, who must adopt new approaches to teaching, including a new role as facilitator instead of instructor, as well as acquisition of new knowledge" (Ernest, 1989). On the other hand, Carter and Norwood (1997), pointed out that "teachers construct understanding of mathematics and the teaching and learning of mathematics in accordance with their existing beliefs and understandings build by their experiences", often during their student years (Ernest, 1989). Emaneka (1995) drew attention to the fact that "mathematical beliefs do not develop overnight. They develop slowly, over a long period of time involving many mathematics encounters and experiences. Most students' primary source of mathematical experiences is the mathematics classroom". In fact, Owens (1987) and Sowder (1986) stated that many of these beliefs will be the same ones these teachers held as students because beliefs do not change quickly or readily. The problem then arises (Erickson, 1993) as we are "at a time when the mathematics we are recommended to teach, and the way that we are asked to teach it is different from what most mathematics teachers have experienced themselves".

The foregoing discussion is in particular applicable to the Singapore context. Shifting the education system from one of efficiency-driven to one of ability-driven is only part of the total education reform. To respond to the rapid change that is taking place round the globe, the school curriculum places greater emphasis on preparing students to be life-long learners, and to equip them with the necessary thinking and problem solving skills to handle the new challenge. As Alvin Toffler (The Straits Times, 2 Apr 2000), author of the bestsellers Future Shock, The Third Wave and Powershift, put it, "we need people who don't just memorise and repeat – the database can do that. We need people who can solve problems, think in terms of models". However, our teachers, both trainees and practicing teachers, belong to the era of either the survival- or efficiency-driven education system. They attended schools to learn 'ready-made' mathematics, and the teachers were the dispensers of knowledge, whereby chalk and talk was the norm of the approach adopted in the mathematics (in fact, all) classrooms.

Ernest (1989) noted "views of mathematics will … depend on the modes of instruction and types of experience through which mathematics is learned". As many teachers "teach as they were taught" (Ball, 1988, Frank, 1990), the beliefs teachers hold are passed on to their students who in turn, when they become teachers pass them on to their students. Since teacher education deals with the pedagogical aspect of mathematics, it is essential to examine how such courses should be drawn up to better prepare our teachers. Becker & Selter (1996) pointed out that learning that "teachers' courses need to be organized in a way that provides them with experience in learning that they will want their students

to experience".

METHODS

This study examines the reaction when a group of trainee teachers, whose experience in mathematics classrooms belonging to the survival- or efficiency-driven education systems, were introduced to the teaching of fractions using the multiple intelligences approach.

SAMPLE

The subjects belong to a convenient sample of students from an intact tutorial class in the National Institute of Education – the sole teacher certifying agency in Singapore. The 24 second year students are trainee teachers of a four-year Bachelor of Arts / Science course with Diploma in Education programme. The youngest in the group completed her pre-university course in 1998, while the oldest completed her pre-university course in 1976. There are 5 males and 19 female trainees. The session was conducted during the normal class time for their Curriculum Study for mathematics, i.e. the study of teaching and learning of mathematics. The duration of the session is 1 hour and 40 minutes. To minimize threats to validity due to the experimenter's effect, the tutor of the class himself conducted the session. However, there might be threats due to the Hawthorne effect as the session was video-taped for record purposes.

THE LESSON

The session was targeted to prepare the trainee teachers to introduce the concept of fraction to Primary Two students. As with their normal tutorial sessions, the trainee teachers were required to take on the role of Primary 2 students by going through the actual activity. At the same time, the trainee teachers were also to take on the role of the teacher as the tutor discussed the pedagogical issues relating to the lesson.

There were two main activities for the whole session.

First Activity:

In the first activity, the trainee teachers worked in groups of four (member A, B, C and D). Members A and B will take on the role of the Primary Two Pupils while C and D will be the observers. Five apples will be given to members A and B of each group. A and B were then to spend 2 minutes to decide how they could share the two apples without biting or cutting the apples. The decision arrived at must be agreed by both members. When the decision has been made, members A and B of one group would have to share with the class how their decision was arrived. They were then told that they have to give away one of the five apples to someone (for example, member C). Once again, the two must negotiate to arrive at an agreed decision. Members A and B of one group will then be requested to share with the class what transpired during the decision-making process. After this, the two members of each group will then put their apples together, and then decide how they will share out the apples between them. The process will repeat itself until members A and B of each group were left with one apple. A plastic knife (which could be used to cut the apple) will then be given to each group. Members A and B of each group were then told to share out the apple left between them, and they may use the knife provided only if they needed to. Once they have agreed on their decision, members A and B for each group will be required to share with the class how they shared the apple as well as how the decision was arrived at.

Second Activity

The second activity was essentially the same as the first, with the same four trainee teachers working in each group. However, now members A and B are observers while members C and D will take on the role of the Primary Two pupils. Furthermore, C and D would now act out according to the story as told in the lyrics of the song "The Apple Tree" (words by Dorothy Williams, music by Graham Wescott, in Hunt (1984)) (Figure 1).

Figure 1

The class was first lead to sing the song, so as the familiarize them with the tune and lyrics. Then for each of the verses, C will take on the role of 'me' while D will take on the role of 'you'. And, for the first three verses, the line 'Some for you, some for me', C and D were supposed to change the word 'some' to numbers that reflect how the two shared out the apples. Similarly, the lines 'One for you, one for me –' and 'One for you, none for me –' in verses four and five will be accordingly changed. For the last line of each verse – Eat one apple from the tree, C and D were to discuss and based on the agreement to give away one of the apples to either A or B, the observers. And, similar to First Activity, at each stage when a decision was agreed upon and acted on, a pair or all pairs (for the last decision made) would be asked to share with the class as to how the decision was arrived at. Each group will then be asked to sing a verse of their 'own' song to conclude the activity.

Feedback

At the end of each of the two activities, the trainee teachers were required to respond to the following questions:

- What thinking skills did you use during this activity?
- What have you learnt from this activity?

Furthermore, at the end of both activities, the trainee teachers were also asked to decide which approach (Approach 1 corresponding to First Activity, Approach 2 corresponding to Second Activity, while Combine Approach corresponds to an approach that combines both approaches taken First and Second Activity) better maximizes the understanding of mathematical concept and which approach better motivates pupils in their learning.

Notes

1. The activities basically brings pupils through the process of realizing that the whole number system is insufficient in handling all real life situation, thus there is a need to introduce another number system – the fractions.
2. First activity made use of several of Howard Gardner's multiple intelligences:

• Verbal Intelligence	-	Pupils' verbal intelligence was tapped as they engaged in verbal discussion during the negotiation process as well as when they shared their experiences with the class.
• Mathematical Intelligence	-	Pupils' mathematical intelligence played a part in using number bonds as they shared out the apples, as well as when the whole number system failed and they have to resort to the use of fractions.
• Bodily/Kinesthetic Intelligence	-	As pupils tried to cut the apples, the teacher tapped on pupils' bodily/kinesthetic intelligence.
• Interpersonal Intelligence	-	When the pupils work in pairs and engage in discussions to arrive at an agreed decision as to how the apples were to be shared between the two, the teacher was encouraging the use of interpersonal intelligence.
• Intrapersonal Intelligence	-	As pupils articulate how their agreed decision was reached, they become more self-reflective – being in touch with one's feelings and thoughts. This would tap on pupils' intrapersonal intelligence.

1. The Second Activity incorporated not only all the intelligences involved in First Activity, it also provide opportunity for the teacher to tap on pupils' musical intelligence as they made up and sang their 'own' song.
2. To guide the trainee teachers to identify the thinking skills used during the activity, the list of thinking skills suggested by the syllabus (Ministry of Education, 2000) was put up for them to refer to:
    - Classifying

- Comparing
- Sequencing
- Analysing Parts & Whole
- Identifying Patterns & Relationships
- Induction
- Deduction
- Spatial Visualization

RESULTS AND DISCUSSION

THINKING SKILLS

Of the 48 responses (24 for First Activity and 24 for Second Activity), 34 for 71% of the responses listed comparing as one of the thinking skills used, while 24 or 50% of the responses listed analyzing parts and whole as one of the thinking skills used. The rest of the responses constitute much less than 50% of the total response.

The reason that the thinking skill, analyzing parts and whole received one of the highest frequency of mention could be due to the fact that the topic concerned is fraction and the activities involved breaking a whole into parts through sharing. In fact, it is interesting, but yet puzzling, that it is only 50%. It is indeed more interesting to observe that comparing tops the list of thinking skills used in the activities. Although comparing is a skill that is required, it seems to be less obvious than analyzing parts and whole. One possible contributing factor could be the explicit strategy used in the whole session, which requires the trainee teachers to compare two different approaches. This would certainly supports the much championed belief that the teaching of thinking need to be made explicit.

LEARNING ACQUIRED FROM THE ACTIVITY

First Activity

Of the 24 responses for the First Activity, 10 or 42% of them indicate a better understanding of fractional parts with comments such as:

Learnt that not all things can be divided into equal parts.

That an approximate half is not half.

This reflects that the lesson engage the participants in meaningful mathematics activity. In fact, it is a common observation that beginning teacher tends to use inappropriate examples to develop the notion of fractions, which often led to misconception among the pupils.

Another 8 or 33 percent of the respondents indicated that the learning came from the negotiation to arrive at an agreed decision on how the apples should be shared. The following are sample responses:

Sharing equally between one another needs a lot of skills and agreement.

To divide equally for objects is not always fair for some people and not easy for participants. Negotiations play an important part.

This reflects the emphasis placed on interpersonal intelligence by this activity. It certainly brings comfort to those pupils who excel in this area, thus creating for these pupils a possible path for success in the learning of mathematics.

Second Activity

Though the two activities are rather similar except for the use of the songs, none of the responses for the Second Activity refers to a better understanding of fractional parts. This could be due to the fact that this activity follows immediately after the first, whereby the trainee teachers have already gained a better understanding of the concept. This certainly reflects well on care the trainee teachers took in responding to the questions.

Since this activity uses a song, it is no wonder that 10 or 42% of the trainee teachers expressed that they have learnt that songs could be created to teach mathematics.

General Comments

It is interesting to note that the activities seemed to have provided some with a greater insight into their classmates, with comments such as:

Joanna is not fond of apple.

The participants have poor interpersonal and intrapersonal social skills. Very selfish. Indecisive.

C is an evil person, choosy and both of them have poor social skills.

Such comments provide opportunities to deal with character building.

APPROACH THAT MAXIMISES UNDERSTANDING OF MATHEMATICAL CONCEPT

Of the 24 responses, 6 or 25% selected Approach 1, 8 or 33% selected Approach 2, while 10 or 42% selected a Combined Approach.

Those who selected Approach 1 felt that the Approach is simpler and easier for pupils to grasp the concept, and that there is no distraction caused by the song. In fact, when the trainee teachers were asked for a verbal feedback at the end of the session, some have expressed concern that the song might serve more as a distraction. Some felt that the song might cause so much excitement that it is easier for the lesson to go off focus, and felt that it is important that the teacher should make a conscious effort to bring the pupils back to the learning of mathematics. However, those who chose Approach 2 did mention that the song also helps pupils to remember easily. Those who chose a Combined Approach were either concerned with the level of the pupils or perceive the two approaches as contributing the same level of conceptual understanding. For those who were concerned that the approaches or level dependent felt that Approach 1, which is more concrete and systematic, is more suitable for upper primary pupils. They felt that Approach 2, which involves singing, is more stimulating and might be more suitable for lower primary pupils.

APPROACH THAT BETTER MOTIVATES PUPILS IN THEIR LEARNING

Of the 24 responses, 3 or 13% selected Approach 1, 13 or 54% selects Approach 2, and 8 or 33% selects a Combined Approach.

Of the 3 who selected Approach 1, two mentioned that it is "more engaging, fun, allows more particpation". Both of these subjects were actively taking the role of the pupils during the First Activity, but both were the passive observers in the Second Activity, which might explain how the comments were arrived at. The third subject who chose Approach 1 claimed that "there is a rule (for Approach 1) which they can adhere to, i.e. share equally, or else they can't know how their sharing should be carried out". As this participants was the passive observer during the First Acitivity, he/she might have perceive a rule that was in the first place not in existence for the

activity.

Those who chose Approach 2 felt that singing activity is interesting and enjoyable, that pupils would probably like it, and that it enable pupils to relate to another content area which pupils might be interested in. In fact, one wrote that "as much as it distracts, it brings about motivation too", and this might explains for the large number of the trainee teachers who chose Approach 1 over Approach 2.

As in the preceding discussion on maximizing conceptual understanding, most of those who selected a Combined Approach felt that both approaches delivers the same level of motivation. It is interesting to note that one respondent pointed out that it "depends on the interest of the class, e.g. musically inclined kids will prefer Approach 2". In fact, during the verbal feedback conducted at the end of the lesson, one of the trainee teachers pointed out that Approach 2 might make some pupils who are not musically inclined to be rather upset. The reflected a heightened level of sensitivity to the individual needs of the pupils, contributed possibly by the trainee teachers themselves going through the activities. However, the large number of trainee teachers who chose Approach 2 and the Combined Approach tends to point towards a willingness of the trainee teachers in considering using musical intelligence in the teaching of mathematics when the needs arise. This is in particular an interesting observation as it is noted that in a verbal survey carried out at the end of the lesson, only one of the 24 trainee teachers has also been trained as a music teacher. Furthermore, only one out of the remaining 23 trainee teachers indicated to have an interest in singing or playing a musical instrument (he played the guitar). In other words, the feedback seems to point towards an willingness among this group of trainee teachers to consider instructional approaches that make use of intelligences which they themselves might not excel in.

CONCLUSION AND IMPLICATIONS

The size of the sample certainly does not allow any conclusive results to be drawn from this study. However, it did point towards possible positive outcomes from a teacher training programme that provide trainee teachers with activities that incorporate Howard Gardner's multiple intelligences:

- Trainee teachers are exposed to and made aware of possible alternative instructional approaches to supplement traditional ones so as to better cater to individual needs of pupils.
- Having been exposed to instructional approaches that uses multiple intelligences, it might help to sensitize teachers to the needs of the individual pupils.
- By exposing teachers to instructional approaches that incorporates various intelligences, it also helps teachers to be more confident of implementing instructional strategies that taps on a wider range of intelligences, including those that they may be weak in. This would certainly helpful in an ability-driven system, whereby we are trying to cater to the individual needs of the pupils.

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