Teaching problem solving to mathematics student teachers in a Malaysian context

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Problem solving is viewed as an important component in mathematics teaching and learning in Malaysia. As part of my research project on student teachers' recontextualisation of problem solving, I would like to share how one mathematics teacher training program in Malaysia teaches problem solving to student teachers. The courses within the program which focus on problem solving are Methods for teaching mathematics, Laboratory in mathematics education, Microteaching and Operational Research. I am using a critical discourse analysis approach on the data, focusing on what counts as a problem, what problem solving processes are demonstrated and the values portrayed about the problems and problem solving processes. The similarities and differences in the ways the courses portray problem solving and its values are emphasised.

Keywords: Problem solving, values, processes

Introduction

In Malaysia, problem solving is considered to be an important element in its Secondary Mathematics Curriculum (2006). Teachers are called to pay attention to the development of problem solving skills among students. However, it has been documented by Karp (2010) that many student teachers face challenges in teaching problem solving to students. The importance of mathematics problem solving emphasised in the curriculum and these difficulties has led me to investigate how one mathematics education program in Malaysia prepares student teachers to teach problem solving in school.

The mathematics education program mentioned is a bachelor's degree designed as a collection type (Bernstein 1977) where students have to 'collect' and pass all subjects in the program curriculum outline. The subjects are taught from two different faculties; the Faculty of Education which teaches mathematics education courses and the Faculty of Mathematics which teaches mathematics courses. There is a disadvantage to this system because it causes difficulties in communicating the consistencies and relevance of the content and approaches of each course from the different faculties (Graham, Li and Buck 2000). As a result, the interrelationship between the subjects can be quite vague or closed (Bernstein 2000) and differing messages about problem solving may be observed. This is where I am interested to investigate whether similarities, difference and perhaps friction about mathematics problem solving messages can be observed between the courses from the Faculty of Education and Faculty of Mathematics.

Theoretical framework

In the mathematics education courses and mathematics courses, there are many discussions about teaching mathematics led by lecturers that student teachers

experience. I suggest viewing these discussions in the respective courses as a form of discourse according to Fairclough (2003). Fairclough (2003) defines discourse as a social activity where people construct meaning to the world through spoken and written language. Discourse is also viewed as ways of representing and valuing a particular world. I view the discussion of teaching mathematics in the courses as ways of speaking, writing and representing teaching mathematics which also includes problem solving. The discourse also represents what is being valued about teaching mathematics, especially focusing on problem solving.

Methodology

The courses selected for the data collection are taken by year two student teachers. The courses selected are Methods in teaching mathematics, Laboratory in mathematics education and Microteaching which are designed to help student teachers prepare to teach in school and are handled by the Faculty of Education. These year two students are taking one mathematics course handled by the Faculty of Mathematics which is Operational Research. Observations were conducted with these courses twice and an interview was conducted with the lecturers focusing on the messages they wish to emphasise through the course activities.

To determine the messages from the university setting about problem solving, I developed a set of questions which I impose on the data focusing on what counts as problem solving and the values portrayed about problem solving. The questions developed are 1a.) What are the problems displayed to the student teachers? 1b.) what are the values that are placed on the problems? 2a.) What are the problem solving processes that are demonstrated to the student teachers? and 2b.) What are the values that are placed on the problem solving process? To answer the question about the problem displayed and the problem solving processes demonstrated, I noted from the video recording the problems displayed and the problem solving processes demonstrated by the lecturers and students. To answer the questions about values, I search for value statements from both lecturers and student teachers about the problem and the problem solving processes. Below is an excerpt of the data analysis process.

Example of data analysis

The data analysis excerpt shows an exchange in Laboratory class where the lecturer was commenting on a student's problem and problem solving process. The task was to create a problem solvable with spread sheet. Several value-based comments about the problem and the problem solving process were given during the exchange. This is translated as part of the Laboratory class's messages about problem solving. The problem which the student had created is as follows:

> 'Suppose you are given two different options for a salary at a temporary job which lasts for 25 weeks. Choose the best option of the two different salary plans. Plan A: you can earn 2000 pounds per week, Plan B: you can earn 1 penny the first week, 2 pennies the next week, 4 pennies the next week and so on, doubling your salary each week.'

The exchange in Table 1 shows the student's problem being valued as a nice situation because the problem solver has to make a decision. Students' contexts are also being valued as an important characteristic of a solvable problem. The underlined words are the value based words and the key words of the exchange.

Table 1: data analysis extract

	Text	**Analysis**
lecturer:	This is a very nice situation. The company gives two different options, normally most companies do they give options or not? They don't.	**value word:** Nice **Value statement about problem:** nice situation because there is an option a decision is to be made. However, no comment on the context of the option.
	Ok, Ahmed, what is wrong with your problem statement? Penny is what currency?	**value word:** wrong
Student:	Penny is equivalent to cents in Malaysian currency.	
Lecturer:	Yes. But, we don't say penny, we say cents. Our students are not familiar with penny. So when you prepare a problem we have to use the students' contexts. So, make adjustments. When you refer to a source, make some adaptations.	**Obligatory verb:** have **Value statement about the problem:** make adaptation to a referred problem so it fits with students' contexts.

The Four Courses on Problem Solving

In the analysis of the data, the four courses observed had distinct activities involving problem solving. Methods for teaching mathematics focused on Polya's heuristic for problem solving through the example of a problem. The activity in Laboratory for mathematics education focused on student teachers creating a problem which can be solved using spreadsheets. A class discussion was conducted where the lecturer selected a student's work to be commented on. In Microteaching the student teacher was to teach straight lines using problem based learning to her peers. Afterwards, good practices about teaching using Problem Based Learning were discussed. In Operational Research (OR), the student teachers were starting a new topic which is Transportation Problem (TP). Table 2 depicts the problems displayed in the respective courses, while table 3 portrays the messages about problem solving from the university courses and the problems solving processes demonstrated. The underlined words are the values words and the themes being valued on.

Table 2: the problems displayed in the respective courses

	1a. What problems are being displayed to student teachers?		
Methods	When fixing a house, a contractor finds out he has paid this amount of money during the construction work: -Day 1: $530 to the carpenter and bricklayer -Day 2: $330 to the electrician and the carpenter -Day 3: $320 to the bricklayer and the painter -Day 4: $170 to the painter and loader -Day 5: $110 to the loader and the electrician -Day 6: $110 to the painter and the cleaner. How much money has he paid to each of the workers?		
Laboratory	Ahmed's problem is as shown in data analysis excerpt		
Microteaching	Mak Jemah's Cleaning Service RM 10 per house call Plus RM 20 per hour Work from 8am till 9pm	Shiro's Cleaning Services RM 30 per house call Plus RM 15 per hour Work from 9 am to 6pm	Super Spontan's Cleaning Services RM 22 per house call Plus RM 14 per hour Working hours: 7am until 11 am
	Task 1: Mrs Jati wants to call professional cleaners to clean her house. Based on the advertisements, which cleaning service is the cheapest for 3 hours of work? Which company has the same service cost if Mrs Jati wants her house to be cleaned from 1pm until 5 pm?		

<table>
<tr><td>Operational Research</td><td>Transportation Problem
Suppose an auto company has three plants in cities A, B and C and two major distribution centres DC1 and DC2. The capacities of the three plants during the next quarter are 1000, 1500 and 1200 cars. The transportation costs between the plants and the distribution centres is as follows: Transportation Cost from Plant to Distribution Centres
<table>
<tr><td>From/to</td><td>DC1</td><td>DC2</td></tr>
<tr><td>Plant A</td><td>80</td><td>215</td></tr>
<tr><td>Plant B</td><td>100</td><td>108</td></tr>
<tr><td>Plant C</td><td>102</td><td>68</td></tr>
</table>
The problem is to decide how many cars should be supplied from each plant to each distribution centre so the total transportation cost is minimized.</td></tr>
</table>

Table 3: the values about the problems and problem solving process and the demonstration of problem solving processes

	Methods	**Laboratory**	**Microteaching**	**Operational Research**
1b.What values are placed on the problems?	-Problems are challenging and difficult. -Students should have the mathematical knowledge required.	-Nice problems involve decision making. -problems should relate to students' contexts.	-Problem solving is unusual. -Problem solving involves a real situation.	-It is a 'special problem' - Context does not matter, the process is more important.
2a. What problem solving processes are displayed to the student teachers?	-Giving time to students to try finding answer independently. -Indicating that the lecturer/teacher does not know the correct answer beforehand. -Emphasising different approaches to solve the problem.	-Process shown using spread sheet. -Emphasising differences between calculating manually and with spread sheet.	-Draw out information about the problem from students. -Draw out students' mathematics knowledge related with the problem. -Helping students in difficulty.	-Giving time to students to complete task before proceeding. -Demonstrate specific steps in solving the problem and students apply it in another problem. -Commenting on three different methods.
2b. What values are placed on the problem solving processes displayed?	-Teachers may also not know the correct answer beforehand. -A method that requires long and unclear procedures is undesired.	-Calculating manually this kind of problem is tedious and undesirable. -Use of tools simplifies the problem solving	-The teacher needs to assist students in order for them to understand what to do. -Activity should be sufficient with the time frame.	-Certain methods give better solution than others. -Students are expected to demonstrate the same methods on similar

	-Demonstrate knowledge of different methods to solve a problem. -The process of problem solving involves thinking of methods other than in the textbook.	process.	-Introduce the problems and activities so that it has a relationship throughout.	problems. -Give time to students to finish the task on their own and ask if they are ready to move on.

Discussion

Several similarities can be observed about problem solving from the courses of these two faculties. One is that, each of the situations portrayed are called problems and the methods for solving each of the problem are demonstrated by the problem poser.

In addition, the courses Methods, Laboratory and Operational Research talk about different methods to solve the same problem and discern it based on practicality. In Methods and Laboratory class, a method that calls for a procedure that is long, unclear and tedious is undesirable. In OR, one specific method is discerned as usually giving the optimal solution from other given methods. This seems to portray a parallel message that in teaching problem solving, different methods to solving a problem are to be acknowledged and discussed. However, the best method which is a short, clear method and gives the best solution is to be emphasised.

Another similarity observed was that ample time was given to students to work out the answer. During this time, the lecturers and the student teacher in Microteaching checked students' progress and helped students in difficulty. This demonstration emphasise a coherent message that each student has to experience the problem solving processes on their own and the teacher's task during this phase is to assist students.

Despite these similarities, there are also several difference portrayed across the courses about problem solving demonstrations. In OR, the lecturer does not imply that she has not prepared the content and procedures to be discussed. There is a clear transition between one topic area to the next, and the lecturer demonstrates that she is well versed in the subject area. This portrays a different message from Methods class where there are suggestions the teacher does not always know the answer beforehand, and appears slightly tentative about the problem solving process. Methods class also emphasises that not arriving at the answer immediately is alright. This seem to reveal contradictory messages that a teacher needs to be fully prepared and fluid with the problem solving process in order to demonstrate it successfully, with the message that it is fine to be hesitant, experiment and demonstrate this uncertain process to students.

Another large difference in values observed was the emphasis of thinking about methods other than in the textbook. In Methods class, solving problems by thinking of different and better ways other than in the textbook are highly valued. Whereas, in OR, the steps to solving the Transportation Problem is shown in a fixed step by step manner, and students are expected to demonstrate the same procedures in similar problems. The message seem to conflict that a problem solving process

involves thinking of ways beyond the textbook, or a problem solving process is a replication from the textbook.

Finally, there appears to be a limitation across the courses about the values of problems being related to real life. For instance, in Laboratory class, the problem presented value that the currency should be adapted to students' contexts. Also acknowledged, in a real context, an employee would usually not give options for payment of salaries. However, there is a lack of discussion on how this part of the problem would be relevant to real life. Furthermore, there is a mathematical imposition to the problems posed, where students are expected to solve the problem using particular mathematical strategies, even though in a real context, the problem might be solved in a different way. This is evident in Microteaching, where the problem could be solved without the use of knowledge on linear equations. However, students are instructed to employ this strategy to their problem solving processes.

Conclusion

This paper reports on the similarities and different messages about problem solving across courses in a mathematics education program. Although there are similarities in the messages, the analysis seems to suggest that there is a level of contradiction between the problem solving processes demonstration and values between courses from the Faculty of Education and the Faculty of Mathematics. The differing and slightly conflicting messages can bring different influences to the ways student teachers model teaching problem solving in school. As a further research, I am investigating how student teachers select from these messages into their teaching of problem solving during the teaching practicum using the notion of recontextualisation (Bernstein 2000).

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