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Arts and Science Stream Students' Mathematical Problem Solving Strategies and Perspectives

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Abstract— **The interest of Malaysian students at upper secondary level towards science stream has declined over the years. The preference is towards arts stream as compared to science since there exists a perception that doing arts is easier than science. However, in Malaysian education system, mathematics is a compulsory subject for all students at upper secondary level. Therefore, it is crucial to study the differences of students in these two streams (i.e. science and art) in terms of mathematical problem solving aspect. This research aimed to explore the preferred problem solving strategies between students in the science and art streams and also to determine their perspectives towards mathematical problem solving. A descriptive quantitative design was used in this study. The study involved 60 students (30 science stream students and 30 arts stream students) from a secondary school in Kluang district, Malaysia. The students were given two non-routine mathematics problems in order to study their preferred problem solving strategies. Students were then given a set of questionnaire in order to investigate their perspectives towards mathematical problem solving. Descriptive statistics showed that students in the science stream applied scientific strategies in answering the problems such as by making a systematic list, and guess and check strategies. Meanwhile students in the arts stream preferred to use their imagination and creativity such as by drawing while answering the mathematics questions.**

Keywords— Mathematical Problem, Problem Solving Strategies

I. INTRODUCTION

The main goal in the teaching and learning of mathematics is to develop and expand the ability to solve mathematical problems. Ref [1] defines problem solving as an attempt to achieve a result, when there are no known methods to achieve it. Therefore, problem solving skills is important and essential in our daily lives. Problem solving skills can help people to make better decisions and plan daily activities successfully. Problem solving skills involve a range of process such as predicting, reflecting, analysing, interpreting, reasoning and evaluating [2][3]. In general, science and arts stream students possess different problem solving approaches and skills [4]. Even though mathematics curriculum is developed for all students regardless their streams, arts and science students use different ways or approaches in solving mathematics questions. Therefore problem solving skills should always be emphasized and practiced correctly in order to ensure that all students are able to solve mathematics problems systematically and effectively.

II. BACKGROUND OF STUDY

A. Malaysian Students Weaknesses in Solving Non-Routine Mathematics Questions

Malaysian students have difficulties in solving non-routine mathematics questions. As a result, Malaysian students performed poorly in international assessments like TIMSS and PISA. The questions in PISA focus on knowledge and skills which are required in dealing with real life challenges, not solely on determining whether students have mastered a particular school curriculum [5]. In addition, a report from the Trends in International Mathematics and Science Study (TIMSS) showed that Malaysian students' achievement in cognitive domains namely knowledge, applications and reasoning was low since these domains emphasize thinking skills and problem solving. Thus, the findings of students' achievement in these two assessments show that Malaysian students are weak in the skills of solving non-routine mathematics questions. Subsequently, a 2012 survey conducted by Organization for Economic Co-operation and Development (OECD) found that more than one in five Malaysian could not even reach the basic level of problem solving. This finding need to be taken seriously and therefore the issue needs to be studied and rectified immediately. One way to overcome this issue is by identifying the strength of students who come from diverse background and strengthening the strength in order to develop the students' potential. In the context of this study, diversity of students referred to students who belonged to

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science and arts streams, and strength refers to the strategies they used in solving non-routine mathematical problems and their perspectives on non-routine mathematical problem solving.

B. Problem Solving skills among Science and Arts Stream Students

Traditionally, science students viewed problem solving as a linear, lock-step process of problem identification, selection of a solution heuristic, application of a plan, prior knowledge, and a problem solving problem and communication of various style of problem solving skills no matter in any science-based classes or mathematics classes. Problem solving among science students acts as a high level cognitive process which interacts with many other cognitive activities such as analysing, synthesizing, abstracting, decision-making and inferring based on those internal knowledge representation [6]. Science students learn complex mathematics calculation and more engineering terms and thus enable them to use more scientific strategies or approaches in solving mathematical problems [7]. Science stream students prefer to use formulae, concepts and theories to answer questions. Therefore, the methods or approaches they use are more systematic and easy to be understood. In addition, they perform logical and analytical skills to solve the problems. Thus all answers or solutions are based on valid and reliable concepts, theories, and formulae.

Meanwhile, arts stream students have different problem solving skills and occasionally against the skills used by science students. Students who are in the arts stream have divergent thinking in problem solving [4]. They prefer to use imaginative and creativity skills in solving problems. Traditional problem solving approaches are dull and unattractive to them. Arts stream students like to create their own "theories and concepts" in solving problems. Therefore, existence of huge difference in problem solving skills for both science and art students is inevitable. The divergent thinking skills which are widely used by arts stream students in solving problems include imaginative skill and creativity skill [4]. Therefore, arts stream students like to create own "theories and concepts" in solving problems. In addition, arts students also use creativity to solve problem by using new and different ways to find solutions. They have the ability to visualize problems by forming mental images of what they want to create [8]. Besides that, there are differences in the personality of artists and scientists whereby "artists are more effective, emotionally unstable and less socialized and concerting of group norms while scientists are more conscientious." The "divergent" artist has innovative and inspiration skills while the "convergent" scientists have more logical, analytical and craft skills. Therefore, arts stream students are able to interpret the world through the expression of artists while scientists explain the natural observable process in the world. In contrast to Science stream students, arts students are found to have lower logical analytical thinking. Therefore, to cater to the different abilities, curriculum which includes creativity, ability to cope with uncertainty, to work under pressure and to communicate effectively, demonstrate skills in team working, networking, creativity, self-confidence, self-management and willingness to learn should be developed [9].

III. Research Question

1. What preferred strategies adopted by science and arts stream while solving non-routine mathematics problem?
2. What are the perspectives of science and arts stream students towards non-routine mathematics problem skills?

IV. Methodology

A descriptive quantitative design was used in this study. The study involved 60 students (30 science stream students and 30 arts stream students) from a secondary school in Kluang district, Malaysia. The students were given two non-routine mathematics questions from a study [10] in order to investigate their preferred problem solving strategies. The questions were chosen due to their appropriateness in terms of degree of challenge offered to the selected age group and their potential to be answered using various strategies both across the problems and for any given tasks [12]. Students were then given a set of questionnaire in order to investigate their perspectives towards non-routine mathematical problem solving. The questionnaire consists of 4-Likert scale items which were arranged from "1-Strongly Disagree, 2-Disagree, 3-Agree & 4- Strongly Agree". Table 1.0 shows the demographic profile of the samples.

TABLE I. Demographic profile of the samples

Demographic Background	
Stream	Frequency of Students
Science Stream	30
Arts Stream	30

Race	Frequency of Students
Malay	34
Chinese	24
Indian	2
Others	0

V. Findings and Discussions

A. Research Question 1: What preferred strategies adopted by science and arts stream students while solving non-routine mathematics problem?

Two non-routine questions were given to the science stream and arts stream students. Subsequently, an answer checklist was prepared in order to study the students' preferred problem solving approaches.

TABLE II. Frequency of Scores for Science Stream and Arts Stream Students

	Frequency of Students	
	Science Stream Students	Arts Stream Students
Making systematic list	22	9
Looking for pattern	16	12
Working backward	12	8
Simplifying problem	22	7
Making drawing	7	29
Using Guess and check strategies	22	12

Descriptive statistics in Table 2.0 shows that students in the science stream applied scientific strategies in answering the problems such as by making a systematic list, and using guess and check strategies. Based on the students' answer sheets, science stream students were seen prefer to underline or circle the keywords of the questions. Then, they applied formula, concepts and theories that they learnt from textbooks in order to answer the mathematics questions. Some of the science students also preferred to make a systematic list while answering the mathematics questions. Making a systematic list while doing the mathematics questions would give the students a clear path and enable them to understand the requirements of the questions. The finding indicated that science students always apply scientific reasoning to encounter any tasks or challenges they met. [7] believed that science stream students always solve mathematics or daily tasks systematically because they managed to integrate complex problem solving opportunities which can enrich knowledge constructive and thinking capacity. In addition, science students simplified the mathematics questions before attempted to answer the non-routine problems. This is because effective problem solving requires students to identify, define and solve the questions using logics, concepts and theories as well as creative thinking [13]. A study by [14] showed that students did simplification of mathematics problems to ensure that they arrived at deep understanding of the topic, constructed new knowledge and able to understand the problems before making decisions. Findings from this study indicated that a few science stream students applied the guess and check strategies to solve the questions. They made sure that the answers were logical and suitable for the question hence they managed to solve the question correctly. Previous findings proved that the guess and check strategies are crucial in problem solving for science stream students. This is because the strategies involve high level cognitive process which interacts with many other cognitive activities such as analyzing, synthesizing, abstracting, decision-making and inferring based the internal knowledge representation [6].

Meanwhile students in the arts stream preferred to use their imagination and creativity such as by drawing while answering the non-routine mathematics questions. They preferred to draw something either before or while answering the mathematics questions. Drawing was the way for them to simplify the questions and hence made it easier for them to interpret their answers. Based on the students' answer sheet, arts students did not prepare a systematic list to every mathematics question. For example, most of the art students did not show clear steps or procedure to answer the questions. They preferred to draw in order to analyze the problem. This means that they preferred to use their imagination and creativity to solve the mathematics questions. [4] conducted a research and the results showed that arts students had divergent thinking skills which include imaginative and creativity skills in solving the problems. In addition drawing is one of the ways for them to understand the questions and to interpret their answers. Besides that, arts stream students also applied looking for a pattern strategy to solve the questions.

B. Research Question 2: What are the perspectives of science and arts stream students towards non-routine mathematics problem solving?

TABLE III. STUDENTS' PERSPECTIVES TOWARDS NON-ROUTINE MATHEMATICS PROBLEM SOLVING

Items	Frequency & %	Strongly Disagree		Disagree		Agree		Strongly Agree	
		Science	*Art*	*Science*	*Art*	*Science*	*Art*	*Science*	*Art*
Drawing pictures or imagining real physical situations helps me to solve mathematics problem.	Frequency	0	1	5	0	17	3	8	26
	%	0	3.3	16.7	0	56.7	10	26.7	86.7
Reading a problem more than once is a waste of time.	Frequency	2	0	22	9	4	17	2	4
	%	6.7	0	73.3	30	13.3	56.7	6.7	13.3
Solving a mathematical problem, involves finding a rule or formula that applies.	Frequency	1	1	1	15	3	9	25	5
	%	3.3	3.3	3.3	50	10	30	83.3	16.7
I enjoy solving problem that requires me to figure out my own individual approach.	Frequency	0	0	5	1	5	6	20	23
	%	0	0	16.7	3.3	16.7	20	66.7	76.7
When I finish working a problem, I check my calculation for errors.	Frequency	0	2	4	10	16	16	10	2
	%	0	6.7	13.3	33.3	53.3	53.3	33.3	6.7
After reading a problem, I try to remember if I have ever done a similar problem before.	Frequency	0	3	2	12	10	10	18	5
	%	0	10	6.7	40	33.3	33.3	60	16.7
I try to restate a new math problem in my own words.	Frequency	4	1	8	8	8	8	10	13
	%	13.3	3.3	26.7	26.7	26.7	26.7	33.3	43.3
When I get the answer, I look back at the problem to see if my answer makes sense.	Frequency	0	3	4	9	8	10	18	8
	%	0	10	13.3	30	26.7	33.3	60	26.7

In terms of students' perspectives towards mathematical problem solving, science stream students highlighted that reading a problem more than once was not a waste of their time because they were able to understand the problem and helped in the process of interpreting the question easily. However, students from the arts stream showed negative attitude because they did not like to read the questions more than once and considered the process as wasting their time. In addition, science stream students were willing to spend their time by reading and understanding the questions before giving any judgments so that they were able to explain and justify their ideas [14]. Furthermore, according to [15],

science stream students agreed that reasoning and problem solving skills involved the abilities to generate, test and revise hypothesis or theories. Majority of art stream students agreed that drawing pictures or imagining real physical situations helped them to solve mathematics problems. [17] and [10] stated that drawing is one of the problem strategies which can hold a great promise to enhance students' problem solving skill in mathematics learning. Furthermore, art students have the ability to visualize problem as the students will form a mental image of what they want to create [8]. Moreover, arts stream students disagreed that solving mathematics problems involved finding suitable rules or formula. This happened because they felt bored when they memorized all formula and concepts. Meanwhile, 93.3% of science stream students agreed with the statement that solving a mathematical problem involved finding a rule or formula that applied. According to [18; 19], effectively applying formula, concepts and theories may likely result in the success of students' problem solving. Therefore, this research showed that students in the science and arts streams had their own perspectives towards mathematics problem solving skills. However they still appreciated the state of art of scientific and creative mathematical problem solving.

VI. CONCLUSION

As a conclusion, both science stream and arts stream students had different perspectives towards non-routine mathematics problem solving and used different strategies while solving the questions. Therefore, the results highlighted that science stream students preferred to use various strategies such as making a systematic list, doing simplification for questions before answering and lastly they also used check and guess strategies to solve the problems. They also applied theories and formulae to answer the mathematics questions. On the other hand, arts stream students were more creative and innovative while answering the questions. They applied the drawing strategy before and while answering the questions. In addition, it can also be concluded that both science stream and art stream students have their own perspectives towards non-routine mathematical problem solving. Their perspectives towards non-routine mathematics problem solving were seen reflected their practices while solving the questions.

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