

Secondary School Students' Abilities Through Problem Posing Activities

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Abstract

Creativity in problem posing activities can be measured or assessed via students' abilities through problem posing activities. In this study, the researchers considered secondary school students' abilities in problem posing activities can be measured via two main stages, namely "Uno problem" stage and "Due problem" stage. "Uno problem" stage requires students to add extra conditions from the original textbook problem and create a new demand. On the other hand, "Due problem" stage requires students to remove one or two conditions from the original textbook problem and create a new demand. This paper reports the study that examined secondary school students' abilities through problem posing activities. The purpose of the study was threefold. First, to investigate secondary school students' abilities in the problem posing activities, second, to identify secondary school students' performances in the problem posing activities, and third to evaluate the proposed teaching-learning material, which consisting of problem posing activities. The study involved the use of exploratory, quantitative and qualitative approaches as its study design. Sixty students involved in the test and interview sessions, and ten mathematics teachers involved in answering the questionnaire sessions. The results of the study revealed that more than three quarter of the students were "more able" in generating "Uno problem" correctly if compared to "Due problem". In other words, the students were "more able" to add extra conditions from the original textbook problem and create a new demand. On the other hand, it was found that more than half of the students were able to perform four out of five questions correctly. So this means that students' problem posing performances can be nurtured. In addition, the proposed teaching-learning material consisting of problem posing activities, which is appropriate to students' different abilities and performances can be used to enhance teaching and learning mathematics.

Keywords: structured problem posing activities, uno problem, due problem, problem posing framework

I. INTRODUCTION

One of the major concerns in mathematics curriculum in Malaysia, especially in the secondary school settings, is to enable students to become as effective mathematical problem solvers (Curriculum Development Centre, 2001). Perrin (2007) asserted that mathematics teacher should be able to pick a quality problem to students in order for them to be effective problem solvers. Researchers (e.g., Cifarelli & Sheets, 2009; Priest, 2009) revealed that problem posing could help to develop students' problem solving ability. Hence, students should be given an opportunity to involve in problem posing tasks (e.g., Siow, Hamzah, & Chua, 2005; Rozaili et al. 2006). Problem posing refers to a generation of new problems and a reformulation of given problems.

For the purpose of this report, we intend to investigate students' abilities in problem posing activities, which can be measured via both "Uno problem" stage as well

as “Due problem” stage. On one hand, “Uno problem” requires students to add one or more conditions to the original textbook problem and create a new demand, and on the other “Due problem” requires students to remove one or more conditions to the original problem and create a new demand.

II. OBJECTIVES OF STUDY

There are three objectives of the study, which to:

(a) Investigate secondary school students’ abilities through problem posing activities.

Thus, the research questions for the study are as follow:

(a) What are the types of secondary school students’ abilities through problem posing activities?

(b) What are the types of difficulties that secondary school students encountered through problem posing activities?

(c) What is the type of problem posing strategies relevant to such problem posing activities?

III. METHODOLOGY

1. Tasks and Administration

The study involved the use of exploratory study. It consisted of the integration of quantitative and qualitative approaches. Quantitative approaches were used to investigate secondary school students’ abilities in problem posing activities through their written work of test interventions. On the other hand, qualitative approaches were used to identify students’ difficulties, as well as students’ strategies in problem posing activities through their audio-taped responses of interview interventions.

There are two types of data collection techniques used in the study, namely test, and interview as shown in Table 1. The role of the researcher in the study was as a “complete participant”. This is due to the researcher was required to collect the entire data by himself.

Table 1: Data Collection Techniques

Data collection technique	Purpose
Test	Posing mathematical problems from given textbook problems
Interview	Identification of students' abilities in problem posing

The study involved a number of sixty secondary school students (from three different schools) who participated in problem posing test that varied in their socio-economic status, size and location. Each subject then involved in the interview sessions. The selection of schools is aimed at addressing reliability and validity issues that may be raised in relation to a small size sample (Golafshani, 2003). The entire subjects were moderate achievers. They were chosen purposefully by the school administration for the study. Most importantly, they were first encountered in problem posing activities. Secondary school students were targeted because they could be expected to have literacy levels sufficient to understand questions and articulate their posed question processes.

2. Example of problem posing tasks

An example of standard problem posing tasks adopted through the study is as follow:

Original textbook problem

- (a) Write a formula for each of the following statements.

William bought 5 shirts for RM x each and 8 pairs of shoes for RM y per pair.

Construct a formula for the total amount of money M spent.

Conditions: 5 shirts for RM x , 8 pairs of shoes for RM y

Demand : Total amount of money M spent.

Solution:

$$\underline{M = 5x + 8y}$$

- (b) Pose “Uno problem” where the total amount of money M spent was $M = 4x + 6y$.

Change the above solution of original textbook problem to $N = 5x + 8y + 2z$

New conditions: 5 shirts for RM x , 8 pairs of shoes for RM y , and 2 bags for RM z

New demand : Total amount of money N .

Solution:

Ilfi bought 5 shirts for RM x each, 8 pairs of shoes for RM y each, and 2 bags of RM z each. Construct a formula for the total amount of money N spent.

- (b) Pose “Due problem” where the total amount of money M spent was $M = 4x + 6y$.

Change the above solution of original textbook problem to $F = 4m$

New conditions: 4 bags for RM m

New demand : Total amount of money N .

Solution:

Ilfi bought 4 bags for RM m each. Construct a formula for the total amount of money F spent.

IV. FINDINGS AND DISCUSSIONS

1. Problem Posing Abilities

The respective numbers of the ratings recorded at each stage of Kilpatrick’s (1987) problem posing test were presented in Table 2, Table 3, and Table 4.

Table 2: Test Results: “Original textbook problem” Stage

Problem	No. Rated			No. of correct solution
1	0	0	60	54
2	1	3	56	46
3	5	4	51	47
4	0	5	55	31
5	5	2	53	20

Totals	11 (4%)	14 (5%)	275 (92%)	198 (66%)
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More than three quarters of students’ responses scored ‘2’ indicating complete understanding of the “Original textbook problem” stage. Only 25 of students’ responses received a rating of ‘0’ and ‘1’ indicating a sound misunderstanding of what the problem required them to do. 198 students’ responses, however, resulted in correct solutions, due to difficulties at other stages of the problem posing processes.

Table 3: Test Results: “Uno problem” Stage

Problem	No. Rated					
	0	1	2	3	4	5
1	0	0	4	0	0	56
2	0	0	0	3	11	46
3	0	0	1	2	4	53
4	3	0	0	7	7	43
5	0	0	1	23	1	35
Totals	3 (1%)	0 (0%)	6 (2%)	35 (12%)	23 (8%)	233 (78%)

More than half of students’ responses scored ‘5’, indicating complete understanding of the “Uno problem” stage. 67 of students’ responses received a rating of ‘0’ to ‘4’, indicating a sound misunderstanding of what the problem required them to do.

Table 4: Test Results: “Due problem” Stage

Problem	No. Rated					
	0	1	2	3	4	5
1	0	0	0	5	1	54
2	0	0	0	5	4	51
3	0	0	0	9	4	47
4	0	0	0	10	19	31
5	0	0	0	39	1	20
Totals	0 (0%)	0 (0%)	0 (0%)	68 (23%)	29 (10%)	203 (68%)

203 of students' responses scored '5', indicating complete understanding of "Due problem" stage. Only 33% of students' responses received a rating of '3' and '4', indicating a sound misunderstanding of what the problem required them to do. Most importantly, neither one of them received a rating of '0' to '2' in generating "Due problem".

According to the test results, it was found that the number of students' responses received a rating of '5' for "Uno problem" and "Due problem" stages were 233 and 203 respectively. Hence, this means that, students were "more able" in generating "Uno problem" if compared to "Due problem". In other words, these students were "more able" to add more or new conditions to the original textbook problem then create a new demand. The findings is quite similar to the findings which obtained by Rohana, Munirah and Ayminsyadora's (2009) findings, namely the students' progress in the years of schooling influences the percentage of correct responses.

2. Problem Posing Difficulties

The study found out that there are several factors, which contributing to students' difficulties through problem posing activities. Unfamiliar with the topic (Subject 5 in Q1), lacks of knowledge in generating "Uno problem" and "Due problem" (Subject 18 in Q1), as well as lacks of skills of how to relate the topics with real life situations (Subject 60 in Q1) were some of the major difficulties.

3. Problem Posing Strategies

The students were able to improve their abilities in generating "Uno problem" and "Due problem" correctly via changing the values of the given data (Subject 3 in Q2), changing the context (Subject 26 in Q2), and changing the number of conditions (Subject 49 in Q2). The percentage of students who preferred to generate their "Uno problem", and "Due problem" by changing the values of the given data, changing the context, and changing the number of conditions were 49%, 20% and 31% respectively. Table 5 reveals the types of problem posing strategies used by the subjects.

Table 5: Types of problem posing strategies

Subject	Problem posing strategy
3	<p><i>Change the values of the given data</i></p> <p>“Uno problem” - If $2y = 4x^2 + 2$. Find x when $y = 4$?</p> <p>“Due problem” - If $2y = 4x^2 + 2$. What kind of equation is this?</p>
26	<p><i>Change the context</i></p> <p>“Uno problem” - If $2m = 4n + 2$ with gradient is 2. Then what is y-intercept for the equation?</p> <p>“Due problem” - If $2y = 4x^2$. Change the equation to real life problem?</p>
49	<p><i>Change the number of condition</i></p> <p>“Uno problem” – Given $2y = 4x + 2$ and $y = x$. What is the intersection point for these equations?</p> <p>“Due problem” – Given $2y = 4x + 2$ and $y = x$. Create a situation based on the given equations?</p>

V. CONCLUSION

In conclusion, the findings of the study revealed that students were “more able” in generating “Uno problem” correctly if compared to “Due problem”. This means that they were more capable to add one or more conditions to the original textbook problem and create a new demand. Also, there exists several types of difficulties in generating “Uno problem” and “Due problem” correctly, namely unfamiliar of the topic, lacks of knowledge in generating “Uno problem” and “Due problem”, as well as lacks of skills of how to relate the topics with real life situations. In order to improve the students problem posing abilities, the researcher found that the students were able to generate “Uno problem” and “Due problem” correctly via changing the values of the given data, changing the context, and changing the number of conditions. Table 6 shows the steps of how to generate “Uno problem” and “Due problem” respectively.

Table 6: Steps of how to generate “Uno problem” and “Due problem”

No.	Uno problem	Due problem
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1.	Know how to relate the topic with real life situation.	Know how to relate the topic with real life situation.
2.	Use either one of these techniques, namely: a) Change the values of the given data b) Change the context c) Change the number of conditions	Use either one of these techniques, namely: a) Change the values of the given data b) Change the context c) Change the number of conditions
3.	Create “Uno problem”	Create “Due problem”

VI. BIBLIOGRAPHY

Ball, D.L., Lewis, J., & Thames, M.H. (2008). Making mathematics work in school. *Journal for Research in Mathematics Education Monograph*, 14, 13-44.

Cifarelli, V., & Sheets, C. (2009). Problem posing and problem solving: A dynamic connection. *Journal of the School Science and Mathematics Association*, 109(5), 245-146.

Curriculum Development Centre (CDC) (2001). *Syllabus for Mathematics Form 4*. Kuala Lumpur: DBP.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4), 597-607.

Ilfi Norman. (2008). Secondary school students' abilities through problem posing activities. Unpublished Master Degree Project Work. Universiti Teknologi Malaysia.

Ilfi Norman, & Md. Nor Bakar. (2010a). Secondary school students' problem posing strategies: Implications to students' problem posing performances. In. Mohamad Bilal Ali, Zainal Abidin Zainuddin, Yusof Boon, Fatin Aliah Phang Abdullah, Diyana Zulaikha Abdul Ghani, Syahrzaman Kamarudin, & Chuzairy Hanry (Eds.). *Proceedings of the Education Postgraduate Research Seminar 2010*. Johor: Faculty of Education, Universiti Teknologi Malaysia.

Ilfi Norman, & Md. Nor Bakar. (2010b). Kemahiran Pengutaraan Masalah Dalam

International Seminar and the Fourth National Conference on Mathematics Education 2011
Department of Mathematics Education, Yogyakarta State University
Yogyakarta, July 21-23 2011

-
- Pendidikan Matematik (Problem Posing Skills in Mathematics Education). *Buletin Persatuan Pendidikan Sains Dan Matematik*, 20(1), 10-19.
- Perrin, J.R. (2007). Problem Posing at All Levels in the Calculus Classroom. *School Science and Mathematics*, 107(5), 182.
- Priest, D.J. (2009). *A problem posing intervention in the development of problem solving competence of underachieving middle year students*. Doctoral thesis. Queensland University of Technology.
- Siow, N.C., Hamzah, S., & Chua, L.T. (2005). *Integrated curriculum for secondary school: Mathematics form 4*. Shah Alam: KDEB Anzagain Sdn Bhd.
- Rohana Alias, Munirah Ghazali, & Ayminsyadora Ayub (2009). Student's problem posing strategies: Implications to student's mathematical problem solving. *Proceedings of 5th the 5th Asian Mathematical Conference* (pp. 724-731). Malaysia.
- Rozaili Mohd Ali, Yong, K.Y., Saripah Ahmad, Markonah Kusnin, & Siti Zuraidah Md. Bashah (2006). *KBSM (Integrated Curriculum for Secondary Schools) Mathematics form 5*. Semenyih: Awan Metro (M) Sdn Bhd.

VII.APPENDIX

Examples of Data Transcriptions

Q1 Why can't you perform well in each question when generating "Uno problem" and "Due problem"?

Terdapat topik yang belum saya belajar lagi...*(There are topics which I haven't learned it yet...)* (Subject 5)

I don't really know how to "Uno problem" and "Due problem"...*(Subject 18)*

I don't even know what is the relationship between the topic and real life situations...*(Subject 60)*

Q2 Given three kinds of techniques in generating problems, namely change the values of the given data, change the context and change the number of conditions. Which kind of techniques would you most preferable when generating "Uno problem" and "Due problem"?

“Bagi saya, saya lebih suka untuk memilih teknik ‘change the values of the given data’. Ini kerana teknik ini adalah lebih mudah. Saya hanya perlu tukar nilai masalah asal terlebih dahulu, kemudian barulah saya cuba tambahkan atau kurangkan syarat soalan...” *(For me, I prefer to use ‘change the values of the given data’ technique. This is due to it is easier. I just need to first change the values of the original problem, then I’ll add or remove some of the problem’s condition...)* (Subject 3)

I would like to use ‘change the context’ technique. I just need to change the situation and build a problem...*(Subject 26)*

I love to use ‘change the number of condition’...As I don’t need to build a new problem...*(Subject 49)*

Framework used for analyzing students’ problem posing attempts

Aspect of analysis	Kilpatrick’s (1987) problem posing activities framework
Original textbook problem	What is the condition of the problem? What is the demand of the problem?
Uno problem	What is a new posed problem with an extra condition? What is a new condition for the new posed problem? What is a new demand for the new posed problem?
Due problem	What is a new posed problem with a removing condition? What is a new condition for the new posed problem? What is the new demand for the new posed problem?

Rating scales for assessing students’ mathematical problem posing attempts

Aspect of analysis	Ratings
Original textbook problem	<p><u>Condition</u></p> <p>0-No attempt or completely misinterprets the problem’s condition correctly.</p> <p>1-Complete interprets the problem’s condition correctly.</p> <p><u>Demand</u></p> <p>0-No attempt or completely misinterprets the problem’s demand correctly.</p>

	<p>1-Complete interprets the problem’s demand correctly.</p>
<p>Uno problem</p>	<p><u>First posed problem</u></p> <p>0-No attempt or complete posed problem incorrectly. 1-Partly posed some problem incorrectly. 2-Partly posed a bit of problem incorrectly. 3-Complete posed problem correctly.</p> <p><u>New Condition</u></p> <p>0-No attempt or completely misinterprets posed problem’s new condition correctly. 1-Complete interprets posed problem’s new condition correctly.</p> <p><u>New Demand</u></p> <p>0-No attempt or completely misinterprets posed problem’s new demand correctly. 1-Complete interprets posed problem’s new demand correctly.</p>
<p>Due problem</p>	<p><u>Second posed problem</u></p> <p>0-No attempt or complete posed problem incorrectly. 1-Partly posed some problem incorrectly. 2-Partly posed a bit of problem incorrectly. 3-Complete posed problem correctly.</p> <p><u>New Condition</u></p> <p>0-No attempt or completely misinterprets posed problem’s new condition correctly. 1-Complete interprets posed problem’s new condition correctly.</p> <p><u>New Demand</u></p> <p>0-No attempt or completely misinterprets posed problem’s new demand correctly. 1-Complete interprets posed problem’s new demand correctly.</p>

Interview questions

- 1) How are you able to pose new problems in your own words?
- 2) How are you able to determine the data and the information need to be found?
- 3) How are you able to plan new problems correctly?
- 4) How are you carried out the problem posing strategy systematically?
- 5) Did you able to use alternative problem posing strategies in a flexible manner?
- 6) Did you ever evaluate and look back on the posed problem?
- 7) How is your opinion about problem posing activity in general?