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Instructional Guidance for Beginner Students in Problem Posing

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Abstract: ***This study aimed to conduct an instructional guidance for beginner students in problem posing. There were 26 students involved in this study in which divided in two groups using the rapid diagnostic test where seventeen are considered distinguished and nine beginner. During problem posing without guidance, 78 responses were generated coming from the respondents (distinguished and beginner) prior to instruction and 51 responses from the beginner students after the structured approached was introduced. All the posed problems were examined and analyzed for solvability, linguistic and mathematical complexity. It was found that the type of the problem student's posed prior to instruction by beginnerswere more on non-math questions and most of the math questions were non-solvable. On the other hand, distinguished students generated more on conditional propositions and math questions that are solvable. Thus, distinguished students have good abilities in posing mathematical problems compare to beginner students. Moreover, when the structured approach was introduced the type of the problem posed by the beginner students were improved. With this, beginner students have the capacity to improve their abilities in posing mathematical problems and structured approach is effective in improving their abilities in posing mathematical problems. Thus, this suggests that the multi-step data coding scheme and structured approach in problem posing are useful to the teachers and researchers who are interested in evaluating the students' posing of problem.***

Keywords: problem posing, cognitive theory, diversity of learners, mathematically complex, linguistic complexity

1. Introduction

Problem posing gained a considerable attention as an effective strategy of teachers inside the classroom that can give an experience to the students of the real essence of mathematics (Rosli, Capraro, M. & Capraro, R., 2014). It will give to students a satisfaction especially if they have such difficulties in understanding any topic in mathematics.

Moreover, difficulties in understanding any topic will lead to ineffective discussion since there is an absence of interaction between a teacher and students. But through problem posing strategy this problem will be addressed because it required an active participation between a teacher and students. Furthermore, it will also engage on how the problem was being posed, when were the problem being posed, what problem was posed and why the problem was being posed. Tichá andHošpesová (2012) added that problem posing can be a significant motivational force resulting in deeper exploration of the mathematical content.

However, using instructional strategies without knowledge of human cognitive processes, teaching-learning process become ineffective. Since, in the absence of an appropriate framework to suggest instructional techniques, we are likely to have difficulty explaining why instructional procedures do or do not work (Sweller, Ayres &Kalyuga, 2011**).** They added that the teacher need to consider the diversity of learners in making an effective instructional design**.** Understanding how we deal with different categories of knowledge is a requirement in determining which aspects of human cognition are important from an instructional design perspective.Kalyuga&Sweller (2004) exposed the expertise reversal effect which they stated that it occurs when a learning procedure that is effective for beginner becomes ineffective for more knowledgeable learners. Through this, they suggested to use a rapid method of measuring learners levels of knowledge in a specific area in which students were presented with intermediate stages of a task solution and asked to indicate their next step toward solution for each stage instead of providing a complete solution. This serves as a guide in making an appropriate instructional design.

These prompted the researcher to conduct a study about instructional guidance considering the cognitive aspect of the diversified learners in problem posing. The result of this study will be beneficial to both the teacher and the learners since they will be guided in making appropriate instructional design to be used in the classroom. Thus, it would be of great help to make the teaching-learning process effective. This study will be conducted on January 2019.

2. Method

Participants

The respondents were the 26 students in Grade 11-ABM/HUMSS from the public school. They came from the different barangays within the Municipilaty of Libjo. The students were introduced to the basic concept of Statistics then undergone with the rapid diagnostic test in which adopted and modified from Kalyuga and Sweller (2004). Afterwards, the group was divided into two groups; the distinguished (upper median group) and the beginner (lower median group).The structured approach then introduced to the beginners to measure if their capabilities in posing a type of mathematical problems were improved.

3. Materials and Procedure

The experiment was conducted in a realistic class environment.During the first session (about 5 min long), the researcher applied the rapid diagnostic test (reliable and validated) adopted and modified from Kalyuga and Sweller(2004) study about Measuring Knowledge to Optimize Cognitive Load Factors During Instruction to measure the initial level of student's knowledge in the domain. All the students had been taught a basic introduction to the measure of central tendency necessary for solving the tasks included in the test. The instruction is presented at the top of the first page. The problems are ordered according to the level of knowledge that is required to solve them. After about 10 s on the first task, the students were instructed to proceed to the next task. Thus, the time taken to complete the test was the same for all students (around 90 s).If a learner omitted some intermediate stages while trying to find the answer to the problem, he or she was allocated an additional score for each skipped step. For example, if a student indicated the final answer for the problem number 1 (skipping three steps) a score of 4 was allocated for this question. An answer consisting of the final step for the second problem qualified for a score 3, and so on. Thus, if a student was knowledgeable enough to indicate the correct final answers for page number 1 with four tasks and the correct final answers for the page number 2 with four tasks, the allocated (maximum) score was 4 + 3 + 2 + 1 + 4 + 3 + 2 + 1 = 20. The result will serve as basis in classifying them as distinguished (upper median group) and beginner (lower median group).

During the second session, there was a discussion took place and students were introduced to problem-posing task, which is shown in Figure 1, asked students to pose three questions that could be answered on the basis of some given information. The problem posed by the students were tallied and analysed using the coding scheme of Silver and Cai(1996) showed in Figure 2.

Write three different questions that can be answered from the information below.

Problem:
A Eastwest bank located at San Jose ,Dinagat Islands wants to improve the processes in serving the customers' time spent (in minutes)from entering the line until they finished their transaction. They found out that the customers spent an average time of 15.8 minutes with a standard deviation of 1.25 minutes. The time is normally distributed.

Question #1
Question #2
Question #3

Note: In the task booklet, students were given more space in which to write their responses.

Figure 1: Problem-posing task

In the last session, the teacher conducted topic discussions focused with the beginner students using the problem posing structured approach (Fig.2) that gave to the student's ideas on how to pose a good mathematical problems. The students take note all the problems posed in the provided task booklet. In this case the problem was not similar to the first problem introduced instead related to the new topic which is application of Normal Distribution(Normal Curve).Then the collected problems' posed will be categorized using the coding scheme (Fig.3).On the other hand, the distinguished students will have unstructured approach.

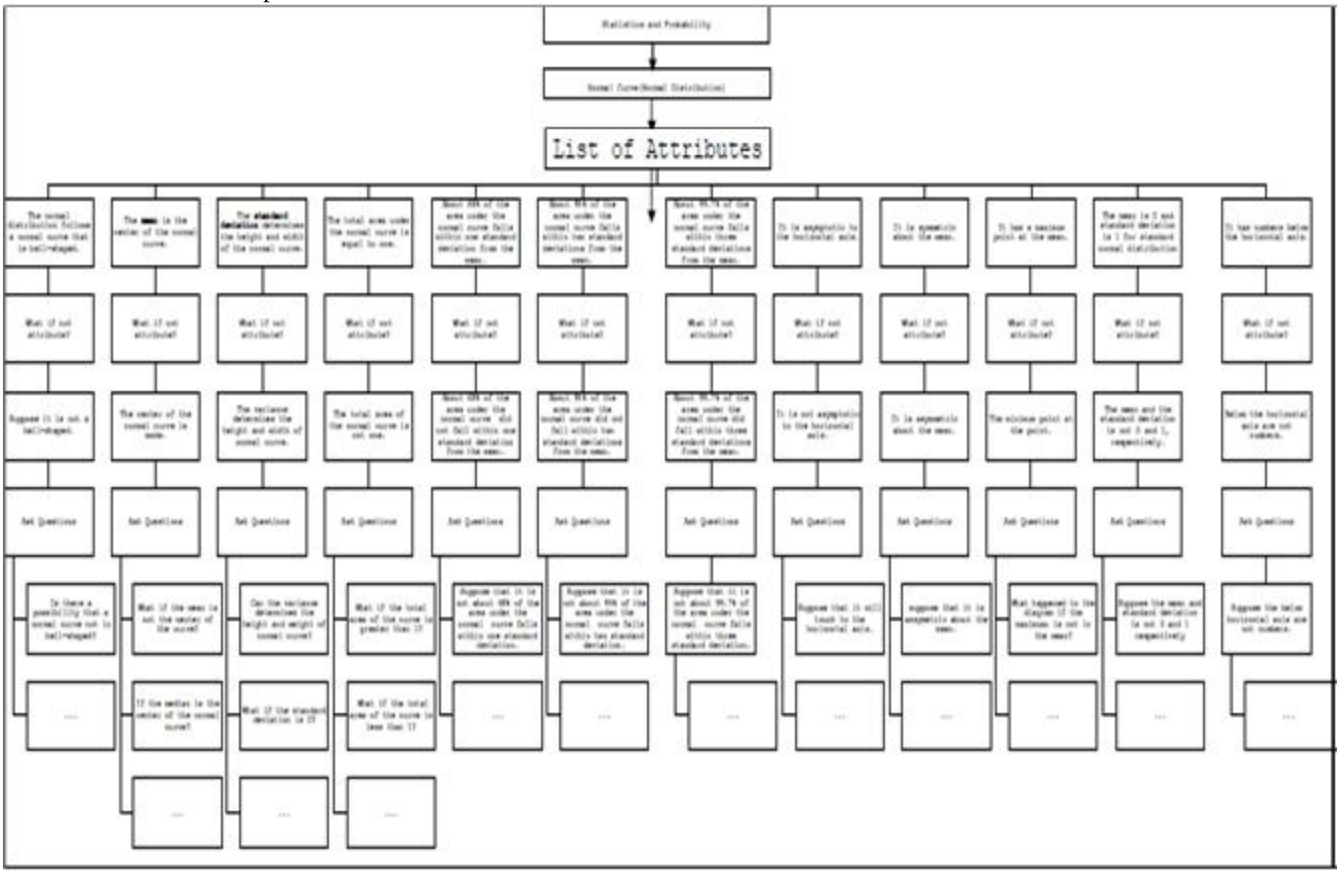

Figure 2: Structured Approach

Adopted and modified from Brown, S. and Walter, M. (2005). The Art of Problem Posing(Third Edition)

In addition**, t**he adopted summary of multiple-step data coding scheme of Silver and Cai (1996) was used in this study in which the students' problem-posing responses were first categorized as mathematical questions, nonmathematical questions, or statements form of mathematical questions, when taken together with the information given in the task core, can be considered to constitute a mathematical problem. Thus, it was possible to consider the student-generated questions to be problems and to analyze them as such. The next step involved categorizing the mathematical problems as solvable or not solvable. Problems were considered to be not solvable if they lacked sufficient information or if they posed a goal that was incompatible with the given information. In general, problem posing exists for the benefits of the students to understand and learn more specifically in the subject of statistics.

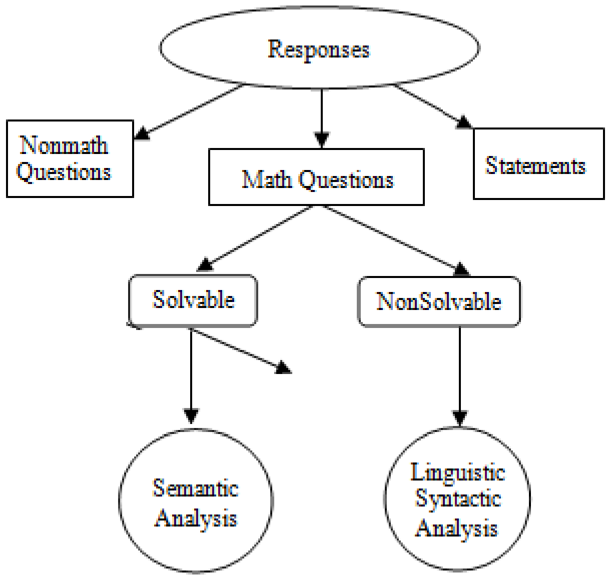

Figure 3: Summary of multiple-step data coding scheme

4. Results and Discussions

The results are presented in two sections. The first section provides a summary of all expert and novice students' problem-posing responses, including the analyses of complexity and relatedness; and the second presents the summary of the novice students' problem-posing responses after the structured approach.

On the Type of Problem Student's Posed Prior to Instruction

Table 1 presents the percentage of the problem posed by the beginner and distinguished students prior to instruction. As observed in the Table, there were total of 78 collected responses coming from the respondents. Out of 78 responses 51 or 65.38% and 27 or 34.62% were from the beginner and distinguished, respectively. In the total responses, 26 or 33.33% were Non-Math Questions; 36 or 46.15% were Math Questions-Solvable; 13 or 16.67% were Math Questions-Non-Solvable; and 3 or 3.85 % were statements. In this study, the respondents were taking Academic strand and it is observed that 62.82% of the responses were Math Questions. This coincide to the result in the study of Tichàand Hošpesovà, (2013) in which they stated that pupils with higher levels of knowledge pose mathematically rich problems, and they notice other problem characteristics. In contrary, there were 37.15% identified as Non-Math Questions and Statements and this is quite alarming since

Table 1: Problem Student's Posed Prior to Instruction

Responses			Novice		Expert	
			N	Percentage (%)	n	Percentage (%)
Non-Math Questions			21	41.18	5	18.52
Math Questions	Solvable	Semantic Analysis Linguistic Syntactic Analysis	16	31.37	20	74.07
	Non-Solvable	Linguistic Syntactic Analysis	11	21.57	2	7.41
Statements			3	5.88	0	0.00
Total			51	100.00	27	100.00

The respondents were all enrolled in Academic strand even though they are unaware of problem posing.The result showed that in the said strand there are also students who are no good in making or posing mathematical problems. It is similar to the study of Ellerton (2013) in which revealed that the students posed during class sessions were rarely polished and often included imperfections in wording or logic since students are beginners in problem posing they are experimenting with all of the parameters involved.

Moreover, table 1 showed that out of 51 beginner responses, 21 or 41.18% were Non-Math Questions, 16 or 31.37% were Math Questions-Solvable, 11 or 21.57% were Math Questions Non-Solvable and 3 or 5.88 % were statements. A total of 52.94% in responses were Math Questions but the 21.57% responses were Non-Solvable. This means that there are still needs to improve the ability of the students in posing mathematical problems. The result shows congruence to the study of Mestre (2002) that even good beginners are lacking in the way their conceptual knowledge is organized in memory and linked to problem contexts and procedures. Also, 47.06% in the responses were Non-Math Questions and Statements and it suggests that in the beginners group there is a higher percentage that the students posed a problems that is not related to the problem or simply implies that they are not good in posing mathematical problems.

This is also true to the study of Silver et al., (1996) that the posed problems were not always ones that subjects could solve, nor were they always problems with "nice" mathematical solutions and he added that many responses were also ill-posed or poorly stated problem. Furthermore, the result is also supported by Tichà and Hošpesovà, (2013) stated in their analysis of the problems posed by the students it revealed shortcomings in their conceptual understanding of problem.

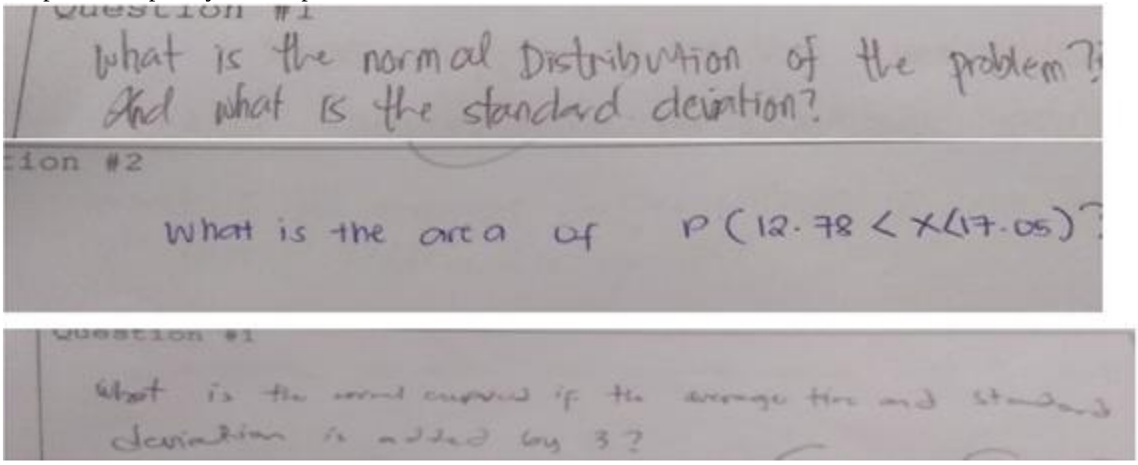

Figure 4: Examples of Mathematical-Solvable Problems

In addition, as reflected in the table out of 27 distinguished responses, 5 or 18.52% were Non-Math Questions, 20 or 74.07% were Math Questions-Solvable, 2 or 7.41% were Math Questions-Non-Solvable and 0 or 0 % were statements. As observed in the result, there is a total of 18.52% are Non-Math Questions and Statements which implies that even the students were already experts might not be good in posing a mathematical problems. This is also similar to the result in the study conducted by Van Harpen (2011) in which suggested that gifted students or giftedness does not necessarily imply creativity in the mathematics classroom or at posing mathematical problems. A total of 81.48% are Math Questions and only 7.41% in the responses were Non-Solvable which means that distinguished students have a higher percentage in posing a mathematical problems and more of these are solvable. This is alike to study conducted by Singer et al., (2011) which stated that the more students advances in the abstract dimension of the problem and its context, the more mathematically relevant are his/her newly obtained versions. This result also supported in study conducted by Silver and Cai, (1996) in which students' problem posed was examined to reveal that "good" problem solvers generated more mathematical problems and more complex problems than "poor" problem solvers did.

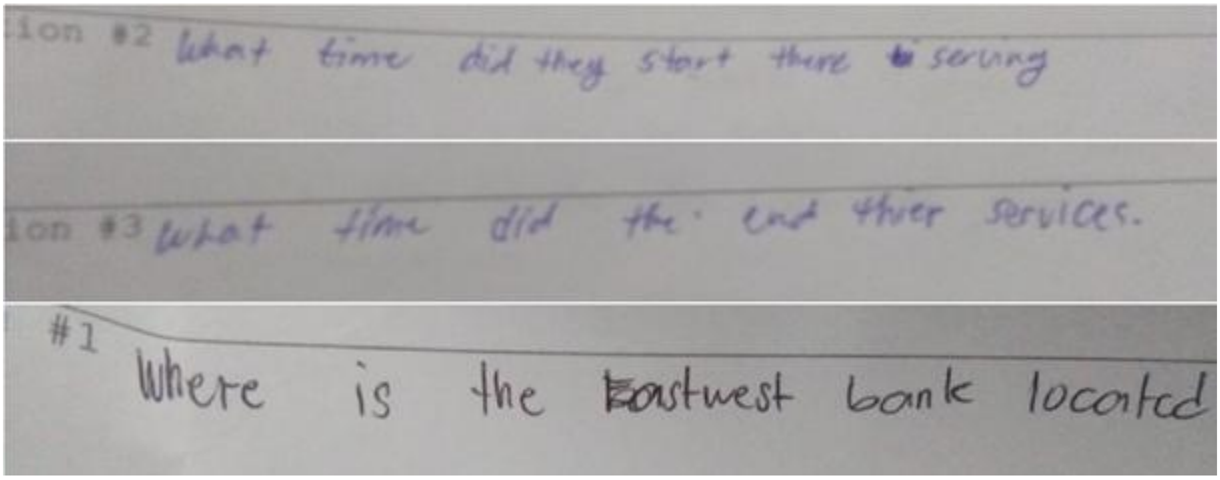

Figure 5: Example of Non-Mathematical Problems

Linguistic Complexity

The linguistic or syntactic complexity of the posed problems was determined by examining all posed mathematical questions for the presence of assignment, relational, and conditional propositions. Similar to the study conducted by Silver and Cai, (1996), the presence of conditional relation propositions in the posed question is taken to be an indication of problem complexity. In the responses obtained in this study, nearly 50% of the mathematical questions involved only assignment propositions, and about 24% and 26% involved relational and conditional propositions, respectively. More than half of the students (55.56%) generated at least one mathematical question involving an assignment proposition. Although relational propositions (24.49%) were found only about one fourth of the responses, about one third of the respondents (33.33%) generated at least one mathematical question involving relational propositions. Similarly, conditional propositions (26.53%) were found only about one fourth of the responses but one third of the respondents generated at least one mathematical question involving conditional propositions (37.04%).

In the linguistic responses, distinguished students covered only 37.5% assignment propositions, 12.5% were relational propositions but 69.23% were conditional propositions. This shows that they have good abilities in posing higher mathematical problems. Moreover, from the generated responses of at least one mathematical questions involving assignment propositions covered only less than half of the distinguished students, one third of at least one mathematical questions involving relational propositions but there was more than three fifth of at least one mathematical questions involving conditional propositions. This implies that more of the novice students generated a higher percentage of assignment propositions but lower percentage of conditional propositions. On the other hand, they generated a higher percentage in relational propositions and this means that there are good novices within these respondents.

Mathematical Complexity

Similar to the study conducted by Silver and Cai, (1996), all mathematically solvable problems were examined for the presence of the five fundamental semantic structural relation-Change, Group, Compare, Restate, Vary-or combinations of these relations. Using the said approach, almost 67% in the responses of expert students were solvable and only about 35% in the responses of the novice students were solvable. Consequently, over 95% of the solvable mathematical problems could be classified with respect to semantic complexity, or the number of relations required for solution.

Furthermore, all solvable mathematical problems posed by distinguished students were semantically complex and most of the problems posed were semantically complex. In fact, more than 70% of the solvable mathematical problems involved two or more relations and these hereafter referred to us multirelation mathematical problems. Slightly, about 25% of the problems involved one relation, and 0% involved zero relations. Also, the generation of semantically complex problems was fairly well distributed across the sample. In fact, nearly 60% of the students generated at least one multirelation mathematical problem, and more than 30% of the students generated at least two multirelation problems. Similar to the study conducted by Silver and Cai,(1996), there was a tendency for mutirelation problems to appear later rather that earlier in the response sequence. Only 35% of the first responses, whereas almost 40% of the second responses were multirelation problems.

However, there were only about 26% of the solvable problems involved two or more relations and almost 10% of the problems involved one relation for the novice students. In addition about 18% of the students generated at least two multirelation problems and less than half of the students generated at least one multirelation problems.

Table 2: Examples of Mathematical Problems and the corresponding Number of Semantic Relations

Number of relations	Examples
Zero	What is the standard deviation? [None]
One	If the average and standard deviation are 15.8 and 1.25, respectively, how the normal curve looks like? [Restate]
Two	If the standard deviation was changed into 2.1 minutes, what is now the difference of two normal curve? [Compare/restate]
Three	What is the total percent when you add the area of $P(x>17.05)$,$P(15<x<16)$ and $P(x<12.78)$ all together? [Group/restate/restate]
Four	If the customers spent an average time between 11.53 and 18.23 and the standard deviation was changed to 1.5, How many customers can finish transaction in just one day? [Vary/group/restate/restate]
Five	Can 32 customers finished their transaction in one day? What if there are 15 males and 16 females inside the bank and they spent an average time of 15 minutes(1 standard deviation) and 17 minutes(0.5 standard deviation),respectively and bank insist to serve alternately. How many males and females or both will be occupied and finished their transaction in one day? [Compare/restate/group/restate/vary]

On the Type of Problem Student's Posed After Structured Approach

Table 3presents the percentage of the problem posed by the beginner students after structured approach. As reflected in the table, out of 51 respondents there were 2 or 3.92% in the responses considered as Non-Math Questions; 33 or 64.71 as Math Questions-Solvable; 16 or 31.37% as Math Questions-Non- Solvable; and 0 or 0.00% as statements. It was observed that 49 or 96.08% in the responses of the beginner students now are Math Questions. This shows that the abilities of the students in posing good mathematical problems were improved. This was concluded by English(1997) that the program did appear successful in developing this understanding of problem structure, including children's ability to identify corresponding problem structures.

Table 3: Problem Student's Posed after Structured Approach

<table>
<tr><td colspan="3" rowspan="2">Responses</td><td colspan="2">Novice</td></tr>
<tr><td>n</td><td>Percentage (%)</td></tr>
<tr><td colspan="3">Non-Math Questions</td><td>2</td><td>3.92</td></tr>
<tr><td rowspan="4">Math Questions</td><td rowspan="3">Solvable</td><td>Semantic Analysis</td><td rowspan="3">33</td><td rowspan="3">64.71</td></tr>
<tr><td>Linguistic</td></tr>
<tr><td>Syntactic Analysis</td></tr>
<tr><td>Non-Solvable</td><td>Linguistic Syntactic Analysis</td><td>16</td><td>31.37</td></tr>
<tr><td colspan="3">Statements</td><td>0</td><td>0.00</td></tr>
<tr><td colspan="3">Total</td><td>51</td><td>100.00</td></tr>
</table>

Linguistic Complexity

The presence of conditional or relational propositions in the posed question is taken to be an indication of problem complexity (Silver &Cai, 1996). In the responses obtained after the structured approach, nearly 70% of the mathematical questions involved conditional propositions, about 17% involved relational propositions and only about 14% involved assignment. Although relational propositions were found only 24% but all students (100%) generated at least one mathematical question involving conditional propositions, and only about 40% generated at least one mathematical question involving assignment.

Mathematical Complexity

All the solvable mathematical problems could be classified with respect to semantic complexity. Most of the problems posed were semantically complex since there are about 70% of the solvable mathematical problems involved multirelation; nearly 25% of the problems involved one relation and about 6% involved zero relation. Moreover, the generation of the semantically complex problems now was fairly, well distributed across the sample. In fact, more than 80% of the students generated at least one multirelation mathematical problem and more than 75% generated at least two multirelation problems. With regards to the sequence of the appearances of the multirelation problems in the posed problems, now almost 65% were posed in the first responses. This shows the improvement of the novice students in posing a complex mathematical problems. This is true to the study conducted by English(1997) in which students displayed improvement in their abilities to model a new problem on an existing structure and by doing so, they were able to diversify the story of the context of the problem.

On the Significant Increase to the Type of Problem Student's Posed

Table 4 presents the increase percentage of the type of the problem posed by the beginner students after structured approach was introduced.

Table 4: Significant Increase to the Type of Problem Posed by the Students Prior to Instruction and After Structured Approach was introduced

<table>
<tr><th colspan="3" rowspan="2">Responses</th><th colspan="3">Novice</th></tr>
<tr><th>Prior (&)</th><th>After (%)</th><th>Difference (&)</th></tr>
<tr><td colspan="3">Non-Math Questions</td><td>41.18</td><td>3.92</td><td>37.26</td></tr>
<tr><td rowspan="2">Math Questions</td><td>Solvable</td><td>Semantic Analysis
Linguistic Syntactic Analysis</td><td>31.37</td><td>64.71</td><td>33.34</td></tr>
<tr><td>Non-Solvable</td><td>Linguistic Syntactic Analysis</td><td>21.57</td><td>31.37</td><td>9.8</td></tr>
<tr><td colspan="3">Statements</td><td>5.88</td><td>0.00</td><td>5.88</td></tr>
</table>

As observed in the table, from 52.94% of the posed Math Questions it became 96.08%; although the Non-Solvable Math Questions was increase, on the other hand the Solvable Math Questions significantly increase more than half before; from 41.18% of posed Non-Math Questions now became 3.92% after structured approach was introduced and a higher difference of 37.26% which means almost all of the novice students displayed an improvement in constructing higher mathematical problems. This is alike to the study of English(1997) stated that through the program, students showed an improvement in their ability to construct their own contexts. Moreover, this result is compatible to the study of Sun, et al. (2012), which found out that the overall scores of the respondents under the investigation were significantly higher. In addition, this is also true to the study of Tichà and Hošpesovà (2013) in which they provided strong evidences that the problem posing can be a significant motivational force resulting in deeper exploration of the mathematical content.

5. Conclusions

Based on the findings of the study, the following conclusions were drawn:

1) The type of the problem student's posed prior to instruction by beginners were more on Non-Math Questions. There was also a higher percentage of assignment propositions constructed rather than relational and conditional propositions. Moreover, there was a low percentage of posing mathematical problems that are solvable. However, distinguished students gained a higher percentage of posing Mathematical Questions. They also generated higher percentage of conditional propositions and Solvable Math Questions. Thus, distinguished students have good abilities in posing mathematical problems compare to beginner students.
2) After the structured approach was introduced to the beginner students there was a higher increase of the type of the problem posed. More of the problem posed were Math Questions, Solvable, and almost all generated responses were mathematically and linguistically complex. This implies that beginner students have the capacity to improve their abilities in posing mathematical problems.
3) There was a significant increase to the type of the problem posed by the students prior to instruction and after the structured approach was introduced. Thus, structured approach in problem posing is effective in improving the abilities of the students in posing mathematical problems.

References

[1] Akay, H., et al., (2009). World Conference on Educational Sciences 2009 Prospective teachers' views about problem-posing activities. Elsevier Procedia Social and Behavioral Sciences 1.

[2] Arikan, E. E.,&Unal, H. (2015). An investigation of eighth grade students' problem posing skills (Turkey sample). International Journal of Research in Education and Science (IJRES), vol.1(1), pp. 23-30.

[3] Brown, S. & Walter, M.(2005). The Art of Problem Posing (Third Edition).Lawrence Erlbaum Associates, Publishers.Mahwah, New Jersey London.

[4] Cankoy, O., &Darbaz, S. (2010). Effect of a problem posing-based problem-solving instruction on understanding problems. HacettepeUniversitesi Journal of Education, 38, 11-14.

[5] Chang, Kuo-En., et al., (2012). Embedding game-based problem-solving phase into problem-posing system for mathematics learning. Elsevier Computers and Education Journal.

[6] Christou, C., et al., (2005). An empirical taxonomy of problem posing processes. - The Montana Mathematics Enthusiast. (Vol.37)

[7] Cunningham, R. (2004). Problem posing: an opportunity for increasing student responsibility, mathematics and computer education, 38(1), 83-89.
[8] Ergün. (2010).The effect of problem posing on problem solving in introductory physics course.Journal of Naval Science and Engineering 2010, Vol. 6 , No.3 , pp. 1-10.
[9] Kalyuga, S. and Sweller, J., (2004). Measuring Knowledge to Optimize Cognitive Load Factors during Instruction. Journal of Educational Psychology. Vol. 96, No. 3, 558–568.
[10] Kayuga, S. and Sweller, J., (2005). Rapid Dynamic Assessment of Expertise to Improve the Efficiency of Adaptive E-learning. ETR&D, Vol. 53, No. 3, 2005, pp. 83-93.
[11] Kitchings. (2014).Problem posing in middle-grades mathematics classes.Athens, Georgia 2014.
[12] Lavy, I., and Bershadsky, I., (2003). Problem Posing via "What if not?" strategy in Solid Geometry - A Case Study. The Journal of Mathematical Behavior, 22, (4) 369-387.
[13] Leung, S. S. & Silver E. A. (1997). The Role of Task Format, Mathematics Knowledge and Creative Thinking on the Arithmetic Problem Posing of Preservice Elementary School Teachers. Mathematics Education Research Journal, 9(1) 5-24
[14] Lin, Pi-Jen. (2004). Supporting Teachers on Designing Problem-Posing Tasks as a Tool Of Assessment To Understand Students' Mathematical Learning. Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education. (Vol. 3 pp 257–264)
[15] Rosli et al.(2014).The Effects of Problem Posing on Student Mathematical Learning: A Meta-Analysis.Published by Canadian Center of Science and Education.December 22, 2014.
[16] Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. ZDM-The International Journal on Mathematics Education, 97(3), 75-80.
[17] Singer et al.(2013).Problem-posing research in mathematics education: new questions and directions.Published online: 21 March 2013 # Springer Science+Business Media Dordrecht 2013.
[18] Tulok-Ucar. (2008). Developing pre-service teachers understanding of fractions through problem posing.2008 Elsevier Ltd. journal homepage: www.elsevier.com/locate/tate.
[19] Paas, F., Renkl, A., Sweller, S., (2003). Cognitive Load Theory and Instructional Design: Recent Developments. Educational Psychologist, 38(1), 1–4
[20] Staebler-Wiseman, H. A. (2011). Problem posing as a pedagogical strategy: A teacher's perspective. Ph.D. dissertation, Illinois State University.
[21] Silver, E. A. (1994). On mathematical problem posing, For the Learning of Mathematics, 14(1), 19-28.
[22] Silver, E. A., Mamona-Downs J., Leung, S. S. & Kenney P. A. (1996). Posing Mathematical Problems: An Exploratory Study, Journal for Research in Mathematics Education, 27 (3) 293-309
[23] Singer, F. M. (2012). Exploring mathematical thinking and mathematical creativity through problem posing. In R. Leikin, B. Koichu, & A. Berman (Eds.), Exploring and advancing mathematical abilities in high achievers (pp. 119–124). Haifa: University of Haifa.
[24] Singer, F. M., Pelczer, I., &Voica, C. (2011). Problem posing and modification as a criterion of mathematical creativity. In M. Pytlak, T. Rowland, & E. Swoboda (Eds.), Proceedings of the Seventh Congress of the European Society for Research in Mathematics Education (pp. 1133–1142). Rzeszo ´w, Poland: University of Rzeszo ´w.
[25] Van Harpen, X., et al., (2011). Creativity and Mathematical Problem Posing. An Analysis of High School Students' Mathematical Problem Posing in China and the United States.
[26] Yuan, X., and Presmeg, N., (2010). An exploratory study of high school students' creativity and mathematical problem posing in China and the United States. Proceedings of the 34th International Conference of the International Group for the Psychology of Mathematics Education.