INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Relationship between Teacher Trainee's Proficiency in Solving Standard Linear Equations (SLE) and Their Proficiency in Posing Word Problems Involving Standard Linear Equations

Anthony Alorkpa
Tutor, Department of Mathematics and ICT Education,
E. P. College of Education, Amedzofe, Ghana
Anthony Kwadzo Badu-Domfeh
Tutor, Department of Mathematics and ICT Education,
Presbyterian College of Education, Abetifi, Ghana

Abstract:
The major aim of teaching Mathematics at every level of education is to help students solve problems. Mathematics teachers, therefore, need to possess these requisite skills to impact these problem-solving techniques in the students they teach. Hence, this paper employed a case study to investigate the strength of the relationship between teacher trainees' Problem Solving and their Problem Posing skills, using a simultaneous linear equation. It involved forty-five teacher trainees from College of Education. Three research questions were used and an achievement task was used to collect data. The data was analyzed along some thematic dimensions, in percentages. A Pearson Product Moment correlation matrix was used to determine the relationship between teacher trainees' proficiency in Problem Solving and Problem Posing. The result revealed a significant positive relationship r=0.34 between Problem Solving and Problem Posing ability of trainees. There also exist gender differences in this relationship, with females performing better than males. This shows that when the two concepts are integrated into teaching Mathematics, it could promote students' proficiency in solving word problems. Teaching mathematics through Problem Solving should be reinforced and the introduction of Problem Posing into the mathematics curriculum at the College of Education be considered.

Keywords: *Problem solving, problem posing, teacher trainee*

1. Introduction

Even though there has been an increasing interest in integrating Problem Solving, PS, and Problem Posing, PP, as a crucial component of national mathematics instructional activity, little has been known about the cognitive processes involved when students are allowed to generate and solve their problems(Romberg & Shafer, 2020; Widodo & Ikhwanudin, 2018). Little is also known about how these two constructs can be used as assessment tools to measure students' learning(Lee, Capraro, & Capraro, 2018). Additionally, much study has not been done to find out the instructional strategy that can best be used effectively in integrating PS and PP in mathematics instruction or even to determine if engaging students in PS and PP activities in the classroom is an effective pedagogical tool(Akben, 2020). Ghana joined Trends in International Mathematics and Science Study (TIMSS), an international comparative study of student achievement in grades four and eight in 2003, two seasons after it was instituted in 1995. Since Ghana joined, her performance has always been below the international average(Fletcher, 2018). In her first appearance in 2003, she was second to last with an average score of 255 as compared to an international average of 473. In 2007 Ghana was placed at the bottom of 48 participating countries. In 2011, the result was not different from the two previous results. Ghana was placed at the bottom again. Most of the questions posed for the students to respond to demanded creative thinking. This abysmal performance of Ghanaian learners has a lot of implications for Mathematics and Science education in Ghana.

1.1. Mathematical Creativity, Problem Solving and Problem Posing

For Ghanaian students to perform well on such international examination, there is a need to teach through PS and its ally, PP(Cai & Hwang, 2020). These two concepts have the potential of developing creative thinking abilities in students. However, creativity as a concept has not been uniquely defined by the literature and this has negatively impacted research efforts. Hasibuan, Saragih, and Amry (2019) defined mathematical creativity as the ability to solve problems and/or develop structured thinking while referring to the logical-didactic nature of knowledge and adapting the connections to the mathematical content. They emphasized that creative activity is not related to a familiar algorithm, and it usually leads to a novel concept of the definition or an expression of a new mathematical argument and its proof.

We agreed with these seasoned authors, so in this study, when a teacher trainee can solve a given standard linear equation correctly by whatever method and poses an appropriate word problem that models the linear equation that has already been solved or vice-versa then they are considered to be creative. In creating word problems in this way by the teacher trainees, something novel has been developed by them and this cannot be different from what previous authors have described as creativity. The curriculum at the College of Education deals with basic concepts that involve PS in mathematics. Since teacher trainees are being prepared to teach mathematics at the basic school, it is prudent to investigate if it will be beneficial for them to study PP as it can promote their understanding of questions that deal with PS and vice versa(Cai & Hwang, 2020).

1.2. Student Achievement, Problem Solving, and Problem Posing

It is the expectation of every educator for his/her students to perform well in any form of assessment. The very reason for teaching mathematics at all levels of education is to promote PS skills in students and not just obtain correct answers to tasks(Cenberci, 2018). Even though this is the case, most traditional school mathematics programmes in Ghana and most parts of the world put more premium on what the student does at the expense of what he/she thinks.

Sak (2013) examined the differences between academically gifted students (who achieved high grades in school mathematics) and the creatively talented students in mathematics (but not necessarily high achieving in school mathematics). His result revealed statistically significant differences in cognitive competencies used by the two groups with the creatively talented being more cognitively resourceful. This, however, does not mean that students cannot be both academically gifted and creatively talented in mathematics. Usually, educators use classroom performance, test scores, and teacher recommendations to identify mathematical giftedness in students (Worrell, Subotnik, Olszewski-Kubilius & Dixson, 2019). However, the literature suggests that a high level of achievement in school mathematics does not necessarily promote a high level of accomplishment in mathematics. This accomplishment in |Mathematics could come from creatively talented individuals. These students enjoy doing Mathematics. They do not give up on solving problems in mathematics, no matter how long it might take them. They are not bothered about the neatness or messiness of their work. They are persistent(Widodo & Ikhwanudin, 2018). This is the hope for Ghana's future. In this work, when a student can consistently obtain the correct response to a given mathematics question/problem, he/she is considered academically gifted. However, if a student can analyse questions in a manner that is consistently deemed appropriate to solve a problem apart from the known procedure, then he/she is creatively talented in mathematics. For this reason, this study challenged teacher trainees to pose a task on two linear problems they have already solved simultaneously. They were also demanded to pose a problem on a linear graph drawn in the first quadrant, for which they have written an equation.

1.3. Gender Differences, Problem Solving, Problem Posing, and Academic Achievement

Even though the literature is inundated with gender differences in mathematics achievement, not much has been researched about mathematics PS or PP concerning gender. For instance, Zhang, Ren, and Deng (2020)carried out a study on the Gender differences in the Creativity- Academic Achievement Relationship. This research was conducted in Beijing, China, and used a sample of 1082 Upper primary students aged 8 to 15 years. Their study used the Chinese language version of the Torrance Test of Creative Thinking (TTCT) Figural Form A. This Figural Form A included three activities: Picture construction, picture reading, and repeated figure of lines. To investigate this relationship between the academic performance of boys and girls, a Pearson Product Moment Correlation coefficient was calculated using the students' self-reported grades for a particular semester. There was a significant positive relationship between creativity and academic achievement and it ranges from r = .07 to .21. Even though there exists a positive relationship between creativity and the academic performance of boys and girls, it is a low to moderate relationship. Their study also revealed some gender differences in creativity and academic performance between boys and girls on some constructs of creativity.

Purwasih, Anita, and Afrilianto (2019) also studied junior high school students' mathematical creative thinking based on gender differences in a plane and solid geometry. Their study was descriptive qualitative research that demanded the students think creatively in solving mathematical problems on a plane and solid geometry. This study was conducted in Bandung Barat, Indonesia using four students. The sample included two male and two female students in class 8 junior high school. The instruments used were a test that demanded participants to think creatively and interview. Their analysis revealed that female students are better at thinking creatively in mathematics than their male counterparts. It also revealed that females can be more accurate in solving problems. This study also demands students to think creatively to solve standard linear equations and pose a word problem. It also compares the difference in performance based on gender. The instruments used were the achievement test and graph task. In their two studies carried out on Gender differences in creativity: Examining the greater male variability hypothesis (GMVH) in different domains and tasks, Taylor and Barbot (2021) examined the GMVH about two groups of people: adults (Study 1; $N = 120$) on a creative writing task and adolescents (Study 2; $N = 529$) on a creative drawing task, and also on figural and verbal divergent thinking tasks. Their results showed no significant differences between the scores obtained by males and females on the tasks. Although males obtained significantly higher mean scores than females on the verbal divergent thinking task in Study 2, no significant mean differences were found for any other task. In all, their results do not support the GMVH. They suggested that gender differences in creative variability are most likely to occur in a particular task and domain. For this reason, this study used simultaneous Linear Equations tasks as conditions to investigate the possibility of any significant difference in the performance of male and female teacher trainees in their academic performance concerning their creativity.

To support the study, the following research questions were raised:

- How proficient are teacher trainees in solving problems involving standard linear equations (SLE)?
- How proficient are teacher trainees in posing problems involving standard linear equations (SLE)?
- What is the relationship between teacher trainees' proficiency in solving problems involving standard linear equations (SLE) and their proficiency in posing word problems involving standard linear equations (SLE)?

2. Methodology

This case study research has two aims. The first part looks at how PS and PP complement the creative thought process of male and female teacher trainees' whilst the second part focuses on the relationship that exists between students' PS and their PP skills. Both aims were investigated by analyzing the written responses (products) of the students on two tasks. Purposive sampling was used to select students who were specializing in Mathematics from Level 200 and 300 at E.P. College of Education, Amedzofe, Ghana, West Africa. The sample consisted of 45 teacher trainees with 34 males and 11 females.Data was collected using systems of linear equation and graph tasks. The two linear tasks were prepared to elicit students' responses to PS and their PP abilities on the same task. Each task has a PS and a PP part in it. In each task, the two parts were situated in the same mathematical context –SLEs. The first task presents students with two systems of linear equations, both of which were in the standard form, $Ax + By = C$. The participants were required to solve the SLE and subsequently pose a real-life problem that could be solved by using the linear equation system given. The participants could solve the linear equation in whatever way they chose as the problem did not limit them to any approach. The SLEs are supposed to assess various ways of respondents' thinking, procedurally and conceptually(Star & Stylianides, 2013). In the first place, it assesses participants' knowledge of solving a SLE in the standard form concerning the method used (procedurally) and concerning what it means to find a solution of a linear system (conceptually). The task challenged participants to make sense of the system in a realistic context. The PP component assessed their understanding of the variables used in the equations. In other words, participants have to understand that the variables could stand for quantities whose values could change, but the only appropriate set of values is the set whose value satisfies the functional relationship defined by the equations conceptually. The participants' have to understand the relationship between the variable units in each equation, conceptual. The second task involved a linear graph, drawn in the first quadrant, x > 0. Participants were asked to find an equation for the linear graph and pose a real-life problem that the graph could represent. More explicitly, participants were asked to write the equation of the line $y = 3x + 2$ based on its graph in the first quadrant. Also, participants were not limited to any particular solution method. This graph task also assessed multiple dimensions of participants' procedural and conceptual knowledge. For instance, it assessed participants' understanding of the relationship between linear equations and their graphs conceptually. The PP component of the graph task assessed conceptual understanding more than procedural knowledge, by evaluating, for instance, the knowledge that the graph that moves up and to the right is increasing and vice versa and by describing it appropriately in their posed problem. Participants' real-world understanding of the meaning of y-intercept was also assessed by this graph task (conceptual) and the related understanding of real-life situations that are linear and proportional against those that are linear and not proportional and those that are not linear at all. Also, the PP task evaluated participants' understanding of the functional relationship between x and y conceptually. They have to understand that x and y are quantities that are related in a particular way beyond the mere use of the letters x and y as placeholders. Thus, the participant's understanding of the variables in the function was also assessed. The two tasks were administered to the students which they responded to within one lecture period of 60 minutes.

2.1. Scoring Procedure (Problem Solving)

2.1.1. System of Equation Task

For each task, participants were required to respond to an item. Within each item were both PS and PP tasks. Scoring rubrics were prepared to rate students' thought processes in responding to the tasks. It was envisaged that students will be more comfortable with the two basic approaches of solving SLE, hence the rubrics were mainly based on these, though not limited. The following were used for the award of marks: B = if thought process and accuracy cannot be separated, M = thought/reasoning process, and A = accuracy mark. The maximum score for each task in both parts was five.

2.1.1. Method of Substitution

B1 is awarded if the student makes any of the variables from either equation the subject. M1 is awarded the student if he/she substitutes the new equation into the unused equation, expands the new equation, and gets a single variable equation. A1 is awarded to the student if he/she makes the single variable the subject. The student is awarded M1 if he/she substitutes the variable's new value in any of the equations and simplifies it. Finally, the student is awarded A1if he/she finds the correct values of the second variable.

2.1.1.1. Method of Elimination

The following criteria were used; B1 was awarded if the student multiplies one equation correctly by a constant to get the same coefficient of variable in the second equation, he/she wants to eliminate. M1 is awarded if the student eliminates the variable of interest and gets a single variable equation. A1is awarded if the student gets the correct value of the variable. The student is awarded M1 if he/she substitutes the variable's new value in any of the equations and simplifies it. Finally, the student is awarded A1if he/she finds the correct values of the second variable.

2.1.2. Graph Task

On the other hand, the graph task demanded participants write the linear equation of the graph drawn in the first quadrant (x > 0). They were specifically required to write $y = 3x + 2$ as the standard linear equation for the graph. Students' responses were also marked and scored out of five based on the following conditions. B1 is given if the student writes any two ordered pairs from the graph correctly. M1 is awarded if the student substitutes the ordered pairs correctly into the gradient formula. If the student successfully gets the correct gradient as three, then he/she is awarded A1. If there is sufficient evidence of obtaining the y-intercept, then he /she is awarded B1. If the student finally writes the linear equation correctly, a B1 mark is awarded. If the student scores three marks and above in both tasks, he is coded as a pass. Three is the median from one to five. On the other hand, if he scores less than three marks, he is coded as fail. Percentages were calculated for each score.

2.2. Scoring Procedure (Problem-Posing)

Students were required to pose two-word problems for the SLE they had already solved. These posed problems were marked and scored out of five for each task. They were marked using the following criteria. Students were awarded one mark, B1, if there is any evidence of a meaningful attempt to pose a problem for any SLE. They were awarded another one mark, B1, if their posed problem was valid. For the problem to be valid for the SLE, it must reflect the same variable in each equation. For the graph task, the posed problem must contain the gradient values and the y-intercept, as task conditions. Students were awarded another mark, B1, if their posed problem is situated in the same context (setting of the problem). For instance, the context could be fruits, ages, heights, money, quantity, and so on for both equations whilst two different variables are allowed for the graph task. Another mark, B1, was awarded for the SLE if the posed problem fit the two standard linear equations already solved. The graph task was awarded another mark, B1, if there is evidence of linearity (for only the graph. Here the exponents of the variables must be one. The student was finally awarded a mark, B1 if all conditions are met. For the student to merit the final mark the two equations must be valid and for the graph task, the posed problem must fit, at least, one condition of the graph. These conditions are the slope and the y-intercept.

Performance of students in PP was grouped into five thematic areas; attempt to pose a problem, if the problem posed was valid, if it is situated in context, if it reflects linearity (for only graph task) and if the posed problem matches at least one condition. From the scoring, the number of students who performed correctly in each category was summed up and divided by the number of students in the study and expressed as a percentage. A score of 40% and more shows a satisfactory performance in each category(Cai, Hwang, Jiang, & Silber, 2015; Cai et al., 2013).In assessing the relationship between students' PS and PP ability, a Pearson correlation coefficient was used to investigate the relationship between these two concepts. In doing this, the performance of each students' PS was correlated with his/her PP task performance for each of the tasks.

3. Results

The findings, firstly, reveal the teacher trainees' performance of participants that successfully solved the SLEs and participants that could not (See Table 1). The findings on participants' performance on the word problems posed for the SLE they had already solved. The findings were presented in Table 2. The relationship between teacher trainees' PS abilities and PP abilities was presented as a Correlation Matrix in Table 3.

Participants	% of Participants Pass		% Participants Fail	
	System of Equation	Graph	System of Equation	Graph
Male (n = 34)	91	85	9	15
Female (n = 11)	100	64	0	36
Total (N = 45)	93	80	7	20

Table 1: Performance on Problem Solving Tasks based on gender

Category	Gender	N	System of equation (n = 45)	N	Graph task (n =45)
Attempt to pose	M	29	84	22	66
	F	11	100	10	91
	T	40	89	32	73
Valid pose	M	23	69	14	41
	F	9	86	4	36
	T	33	73	18	40
Situated in context	M	27	78	14	41
	F	10	91	4	36
	T	37	82	18	40
Reflected linearity	M		NA	10	31
	F			3	27
	T			13	31
Matched at least one condition	M	29	84	14	40
	F	10	95	6	55
	T	39	87	20	44

Table 2: Distribution of Participants' Performance on PP by Gender
M = Male Participants, F = Female Participants, T = Total Number of Participants

	Problem Posing (System of Linear Task)	Problem Posing (Graph Task)
Problem Solving (System of Linear Task)	0.248(0.100)	
Problem Solving (Graph Task)		0.338 (0.023)

Table 3:Summary of Correlation Matrix of the Relationship between Teacher Trainees' PS Ability and PP Ability
**Correlation Is Significant at the 0.05 Level (2-Tailed)*

4.Discussion

From the students' performance on the two given tasks, the results show that both male and female teacher trainees did well in solving the SLE and graph problem. However, whilst the performance of male participants outweighed their female counterparts in SLE, the female also did better than the male respondents on the graph task

From Table 1, 93% of respondents obtained correct responses to the two tasks. Out of these successful participants, 91% were males. All the female participants (100%) successfully solved the SLE.Nonetheless, it is observed from the table that a total of 80% of students were able to write the correct linear equation for the graph task. However, 85% of male students against 64% of female students successfully wrote a correct equation for the graph.Table 2 the shows performance of students on the PP task along with the various themes. These results are discussed in two sections; system of equations and graph tasks.

In comparing their performance on the two PP tasks, participants in the study found the PP part of the system of equations task with less difficulty. The table shows that the female participants were more successful problem posers than their male counterparts. In four out of five coding dimensions in which the participants' responses to the PP parts of the system of the linear tasks were coded, the percentage of success of the female participants outnumbered that of the male participants. As many as 89%of the participants attempted to generate a word problem for the system of the linear equations that they have solved. Of these successful attempts made by participants to pose a problem, 84% of the male participants were able to attempt to pose a problem whilst, 100% of females did the same to model the system of the linear equations.

Also, the result for the PP for the system of equations task indicated that, out of the 89% of participants who have attempted to pose a problem, 73% were problems posed by the participants to model the linear system. 86% of problems posed by female participants were valid as against 69% of the male participants. It was expected that a problem generated for the system of the linear equation task is valid if the respondent correctly poses a problem that represented the linear equation in the standard form, $Ax + By = C$, for the two linear equations which he or she has already solved simultaneously. For example, a teacher trainee posed a valid problem that matched the two conditions of the system task as follows:

> 'The cost of a tin of milk and a packet of sugar is GH¢15.00. If the cost of two tins of milk and five packets of sugar is GH¢ 40.00, find the price of a tin of milk and a packet of sugar.'

Another teacher trainee also posed the following problem:

> 'Kwame's mother sells two mangoes and five oranges for GH¢20.00. If an orange and a mango cost GH¢ 7.00, find the price of mango and an orange'.

Also, another participant wrote, 'Emmanuel bought two erasers and five pencils at the cost of GH¢ 15.00, if an eraser and a pencil cost GH¢ 7.00, find the respective prices of an eraser and a pencil'.

Furthermore, the performance of the participants as displayed in Table 2 showed that out of the number of participants who attempted to pose a real-life problem to model the mathematical linear equations they solved, about 87% of the responses matched at least one of the task's conditions. This means that the problems the participants have generated either modelled one or both of the linear systems in the standard form.

Participants' responses to the PP part of the SLEs tasks showed that their ability to think creatively in mathematics concerning linear equations has been developed.

The second part of Table 2 shows the percentage of responses to the PP part of the graph task along the five different coding dimensions. The result showed that 73% of the participants attempted to pose a mathematical problem concerning the graph task, comprising 66% males and 91% females. Out of the 73% of the participants who attempted to generate a real-life problem to model the graph task, only 40% of the participants wrote a valid problem each. This shows that as many as 60% could not pose a valid problem. In all, 27% of the participants did not pose any problem at all. Only 16% of these participants tried to pose a problem for the equivalent of either:

$y - 3x - 2 = 0$ or $y - 3x = 2$

These students were writing statements instead of a problem.

For instance, one participant wrote:

''The difference between the ages of Kwame and three times the age of Dennis is two''. Another participant also wrote, 'the price of a book minus three times the price of a calculator is GH¢ 2.00.'

The percentage of participants that attempted writing a valid problem for the graph task was 40%. Coincidentally, this number was the same as those participants whose posed problems were situated in a context.

As a result of the inability of some of the participants to pose a valid problem for the graph task, most of them could also not pose a problem that reflected linearity. Only 31% of the participants posed a problem that reflected linearity. The percentages of the problems posed for the graph task by male and female participants appeared to below; it was 31% and 27%f males and female participants respectively.

Out of the problems posed by the participants to model the graph task in the first quadrant, only 44% of the participants posed problems that matched, at least, one of the task conditions. From the result, there was a slight difference between the performance of male and female participants for the graph condition. The percentage of success for the males in matching at least one task condition was 40%, and the percentage of the females was55%.

Considering the results, teacher trainees were able to solve the standard linear equations well and were also able to pose problems related to them. More than 85% of the students were able to solve the problems for the system of linear equation and graph task correctly. Also, about 87% of students were able to pose standard linear equations which matched both conditions for the system of linear equation tasks, whilst 44% matched the two conditions for the graph task.

From Table 3, the correlation between Students' PS ability and PP ability was positive for each task. This relationship is weak but statistically significant(r = 0.25, p < 1.00) for the system of linear tasks. Also, the study revealed that there was a positive but moderate relationship between PS and PP ability of the graph task. This relationship is moderate and statistically significant(r = 0.34, p < 0.02). This implies that if a student can solve the SLEs or graph task correctly, he or she is likely to pose the word problem for the same.

From the discussion of the results, it is indicative that teaching through PS and PP help in developing proficiency of students' thinking in working problem in SLE. This result supports the findings of Cai et al. (2015) which suggest that the quality of a problem posed by an individual might serve as an index to how well he or she can solve a problem. It also confirms the empirical evidence that subjects pose questions they can solve or think they can solve. Following the data analysis, it is evident that there is a moderate relationship between PS and PP abilities of students.

5. Conclusions and Recommendations

The study investigated the relationship between teacher trainees' proficiency in solving a standard linear equation and their proficiency in posing word problems for the same. The results revealed that teacher trainees' ability to pose a standard linear equation is influenced by their ability to solve a standard linear problem.

This study, therefore, recommends that this investigation be extended to other Colleges of Education in Ghana. Suppose the findings still support the complementary roles of PS and PP in supporting the creative thinking ability of teacher trainees. In that case, a recommendation can be made to the Ministry of Education to integrate PP into the mathematics curriculum both at the College of Education and basic education level in Ghana.

6. References

i. Akben, N. (2020). Effects of the problem-posing approach on students' problem-solving skills and metacognitive awareness in science education. Research in Science Education, 50(3), 1143-1165.

ii. Cai, J., & Hwang, S. (2020). Learning to teach through mathematical problem posing: Theoretical considerations, methodology, and directions for future research. International Journal of Educational Research, 102, 101391.

iii. Cai, J., Hwang, S., Jiang, C., & Silber, S. (2015). Problem-posing research in mathematics education: Some answered and unanswered questions. In Mathematical problem posing (pp. 3-34): Springer.

iv. Cai, J., Moyer, J. C., Wang, N., Hwang, S., Nie, B., & Garber, T. (2013). Mathematical problem posing as a measure of curricular effect on students' learning. Educational Studies in Mathematics, 83(1), 57-69.

v. Cenberci, S. (2018). The Investigation of the Creative Thinking Tendency of Prospective Mathematics Teachers in Terms of Different Variables. Journal of Education and Training Studies, 6(9), 78-85.

vi. Fletcher, J. (2018). Performance in Mathematics and Science in basic schools in Ghana. Academic Discourse: An International Journal, 10(1), 1-18.

vii. Hasibuan, A. M., Saragih, S., & Amry, Z. (2019). Development of Learning Materials Based on Realistic Mathematics Education to Improve Problem Solving Ability and Student Learning Independence. International Electronic Journal of Mathematics Education, 14(1), 243-252.

viii. Lee, Y., Capraro, R. M., & Capraro, M. M. (2018). Mathematics teachers' subject matter knowledge and pedagogical content knowledge in problem posing. International Electronic Journal of Mathematics Education, 13(2), 75-90.

ix. Purwasih, R., Anita, I., & Afrilianto, M. (2019). Junior high school students' mathematical creative thinking ability based on gender differences in plane and solid geometry subjects. Paper presented at the Journal of Physics: Conference Series.

x. Romberg, T. A., & Shafer, M. C. (2020). Mathematics in Context (MiC)—Preliminary evidence about student outcomes. In Standards-Based School Mathematics Curricula (pp. 225-250): Routledge.

xi. Sak, U. (2013). Education Programs for Talented Students Model (EPTS) and its Effectiveness on Gifted Students' Mathematical Creativity. Education & Science/Egitim ve Bilim, 38(169).

xii. Star, J. R., & Stylianides, G. J. (2013). Procedural and conceptual knowledge: Exploring the gap between knowledge type and knowledge quality. Canadian Journal of Science, Mathematics and Technology Education, 13(2), 169-181.

xiii. Taylor, C. L., & Barbot, B. (2021). Gender differences in creativity: Examining the greater male variability hypothesis in different domains and tasks. Personality and Individual Differences, 174, 110661.

xiv. Widodo, S., & Ikhwanudin, T. (2018). Improving mathematical problem solving skills through visual media. Paper presented at the Journal of Physics: Conference Series.

xv. Worrell, F. C., Subotnik, R. F., Olszewski-Kubilius, P., & Dixson, D. D. (2019). Gifted students. Annual review of psychology, 70, 551-576.

xvi. Zhang, W., Ren, P., & Deng, L. (2020). Gender differences in the creativity–academic achievement relationship: A study from China. The Journal of Creative Behavior, 54(3), 725-732.