Plagiarism Checker X Originality Report

Similarity Found: 19%

Date: Wednesday, May 23, 2018
Statistics: 1423 words Plagiarized / 7500 Total words
Remarks: Low Plagiarism Detected - Your Document needs Optional Improvement.

International Education Studies; Vol. 10, No. 9; 2017 ISSN 1913-9020 E-ISSN 1913-9039 Published by Canadian Center of Science and Education 23 Developing Instruction Materials Based on Joyful PBL to Improve Students Mathematical Representation Ability Ani Minarni1 & E.

Elvis Napitupulu1 1 Mathematics Department, State University of Medan, Indonesia Correspondence: Ani Minarni, Mathematics Department, State University of Medan, Indonesia. E-mail: animinarni10@gmail.com Received: March 1, 2017 Accepted: April 5, 2017 Online P ublished: August 27, 2017 doi:10.5539/ies.v10n9p23 URL: https://doi.org/10.5539/ies.v10n9p23 Abstract Solving problem either within mathematics or beyond is one of the ultimate goal students learn mathematics.

It is since mathematics takes role tool as well as vehicle to develop problem solving ability. One of the supporting components to problem solving is ma thematical representation ability (MRA). Nowadays, many teachers and researchers find out secondary school students are so poor in MRA.

Considering the problem, this research developed instruction materials based on Joyful Problem-based learning (JPBL) to endorse eighth graders of public secondary school students grasp their MRA. The study took place in the Province of North Sumatera, Indonesia. A number of 88 students engaged as subjects. The study administered MRA test before and after implementing the instruction materials. Data is analyzed descriptively and by t-test.

The result showed that the learning materials developed is effective in improving the students' MRA. It increased significantly, though categorized mediocre. The study contributed to the existing instruction materials in pursuing MRA. Keywords: instruction materials, mathematical representation ability, joyful-PBL 1. Introduction In contrast to the industrial era, the information and communication technology era requires individuals not only able to pass procedural activities but also able to reas on or to think critically and creatively (higher order thinking skills, HOTs).

This era needs thinker as well as inventor or creator more than labor at all. HOTs has characteristics such as non-algorithmic (the path of action is not fully specified in advance), tends to be complex, often yields multiple (ways) solutions, involves judgment and interpretation nuances, the application of multiple criteria.

It often involves uncertainty, self-regulation of the thinking process, imposing meaning, finding structure in apparent disorder, and effortful (Hmelo and Ferrari, 1997; Resnick, 1987; Saragih & Napitupulu, 2015). It makes sense whilst Baker (1990) emphasizes that HOTs measures constitute tasks demanding more than information retrieval and either procedural or conceptual understanding.

It is so important then to take into account this competence as early as possible in the part of the student s. Since by embracing the competence aforementioned they become potential thinker and problem solver. One of the most important competencies constitutes HOTs is mathematical representation. As Cobb et al.

(1992) asserted, "Many of the current attempts to develop theories in mathematics education reflect the view that learning is a process of constructing internal mental representations". The authors proceed arguing, "learning is a process in which students modify thei r internal mental representations to construct mathematical relationship or structures that mirror those embodied in external in structional representations".

While, Pape and Tchosanov (2001) state that representation may be thought of broadly as mental states, narrowly be thought of as mental reproduction of mental state. A structural equivalent presentation through picture, symbol, or signs. Or 'something' in place of 'som ething'. According to theo ry of recognition and brain investigation, brain works more effectively while making representation patterns for encoding (internalizing) and decoding (externalizing) information. Teachers can and should develop representation ability at school through learning pr ocess.

One of the most responsible subjects to mediate and facilitate students gr asping this requirement is ma thematics. Therefore, the goals of school mathematics should be to teach students to think, to make them comfortable with problem solving, to help them pose questions and formulate hypotheses, investigate, and make mathematics vehicle to think (Kulm, 1990), as well as grasping representation ability (NCTM, 2000). ies.ccsenet.org International Educat ion Studies Vol. 10, No.

9; 2017 24 The preliminary research carried out in 2015 (Minarni, Napitupulu, & Husein, 2016) showed that learning in the classroom is still apparently without attempting to en courage students to contribute their own mathematical representation. This is reasonable, because expository method still dominated learning in the classroom and very rarely gives students chances to get involved in solving mathematical problems. Teacher still acts as the center of learning process in the classroom.

Fogarty (1997) mentioned that such learning could not make the students fully understand what is learned. Yet understanding is a major component that enables students solving problem (Schöenfeld, 2007). Indeed, this kind of learning is not going to foster students' ability to solve problems since the students do not have opportunity to do so (Ronis, 2008).

Furthermore, observations and intervie ws in this preliminary study revealed the teachers' complaints on the lower secondary students' weakness in drawing pictures , creating table and building mathematical equation to represent mathematical problems. These skills are clearly aspects of mathematical representations. As known for a long time, mathematical representation ability supports problem-solving skill.

Concerning this, it is then important to note suggestion Pape and Tchosanov (200 1) posed that teachers and students must develop classroom norms that facilitate explan ation and justification and the use of representations in the service of supporting argument. 2. Theoretical Framework 2.1 Developmental Research The study is developmental in nature, which aimed at both developing innovative intervention and identifying underlying design principles or theories (Plomp, 2013). Innovative intervention includes implementing developed learning model and learning materials.

Niev een and Folmer (2013) distinguish four quality criteria that are applicable to a wide array of educational intervention (these criteria suggest a logical hierarchy):" 1) Relevance (also called content validity) There is a need for the intervention and its design is based on state-of the art (scientific) knowledge. 2) Consistency (also called construct validity) The intervention is 'logically' design.

3) Practicality Expected: The intervention is expected to be usable in the settings for which it has been designed. Actual: The intervention is usable in the settings for which it has been designed. 4) Effectiveness Expected: Using the intervention is expected to result in desired outcome. Actual: Using the intervention results in desired outcome". 2.2

Mathematical Representation Ability "Representation is a configuration that can represent something else in some manner" (Goldin, 2002). People develop representations in order to interpret and remember their experiences in an effort to understand the world. Kilpatrick, Swafford, & Findell (2001) stated that representation could be used to understand mathematics.

Mathematics requires representations because of its abstract nature such that people have access to mathematical ideas only through the representation of those ideas. Carpenter & Lehrer (1999) classify representations in to two categories, namely internal representation and external representation. Internal representation is everyt hing that exists in the cognitive structure of students, while the external representation is pictures, tables, graphs, sketches, symbols, equation (mathematical model), words (verbal) made by the students as a reflection of internal representation.

Meira (2002) states that representa tions can bridge difficulties in understanding mathematics and can make mathematics more attractive and interesting (not rigid and monotonous). Representation is helpful in presenting problems more clearly and makes the students comprehend concepts or ideas of mathematics better. Representation enables students to create and use representation to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representation to solve problems; use representation to model and interpret physical, social, and mathematical phenomena (NCTM, 2000).

Based on various meaning of represen tation above, it can be viewed that mathematical representation presented by the students in the form of figure, graph, table, equation (mathematical model), explanation in words or sentences that constitute wo rd problem faced by the st udents, are pointed out repr esentation in the cognitive ies.ccsenet.org International Educat ion Studies Vol. 10, No. 9; 2017 25 structure of the students, vice versa. 2.3

Joyful Problem-Based Learning Students' mathematical representation ability will grow by giving them chances to solve various mathematical problems since by solving mathematical problems they will grasp various mathematical representations (NCTM, 2000). One of the best moments for teachers giving students chances to solve various mathematical problems surely in the teaching and learning processes in the classrooms.

On the other side, Arends (2004) stat es that learning approach which is in accordance with the purpose mentioned earlier is problem-based learning (PBL) since it is designed to promote students' ability in mathematical problem solving. Problem solving requires five others mathematical ability i.e. mathematical comprehension (understanding), reasoning, connection, communication, and representation.

Therefore, through solving problems students will develop their capabilities wholly in doing mathematics. PBL begins with presenting students authentic and meaningful problem situation that can serve as springboards for investigation and inquiry. PBL integrate learning from different sources and disciplines through synthesis and collaborative inquiry.

PBL respect the situation in which students are not sure about the data, information, as well as a solution, situation that stud ents will face in real wo rld. All students, regard less of their abilities, can benefit from PBL. One important feature in PBL is a problem. Problem should be able to act as trigger in early learning and should be designed to improving high order thinking.

Such problem can be designed by relating it to the characteristics of high order thinking which proposed by Resnick (1987). Meanwhile, applying learning approach in eighth grade need considering the development of students' mental. At this age, students are in the transition from concrete to formal stage.

Therefore, combining PBL with a joyful learning environment will lead the students feel comfortable and happy to learn mathematics. The idea is in line with Puri's (2014). In her work, she suggests that learni ng in the classroom should be made as interesting as game so that students addicted to learn as they addicted to play the game.

Joyful Problem-Based Learning is problem-based learning designed such that the learning activity conducted in pleasant environment and convenient situation. Someti mes learning is conducted outside the cl assroom and using a variety of hands-on manipulatives around the classroom or school yard, which is interesting for students; the teacher scaffolds the stud ents with friendly language (tone of the teachers' voice, facial expression, body posture and gesture makes the child comfortable).

The objects that exist inside and outside the classroom, as well as the environment around the classroom used as devices to increase the interest of students to learn, but the focus remains on efforts to lead the students making a variety of representations of a problem so they truly understand the subject matter at hand. We presented in Table 1 learning activity follows the modified PBL in joyful learning environment.

The learning activity took place not only in the classroom, but also outside. For example, in solving the problems related to the topic of two-variable linear equation system, the students are invited to a bookstore located around the school area. At the bookstore, students learn to determine the price of goods sold such that the solution of problem-price become more meaningful.

Meanwhile, for the problems related to Pythagorean rule, the students solved the problem in the classroom using hands-on manipulatives. During conducting the lesson, the teach er should confirm that the students show th eir understanding on the problem, show the effort to represent it in the form that made it easier or aid them attaining the solution.

Of course, the teacher, when n eeded, provides assistance or scaffolding to students who have difficulty in understanding the problem. While working on problems in the students' activity sheet (SAS), teacher asked the students did it individually in time duration of 10 to 15 minutes. They at least attempted to grasp what information the problem gave and what it demanded.

Then teacher asked them to work collaborativ ely, while teacher observed and gave scaffolding to who needed. ies.ccsenet.org International Educat ion Studies Vol. 10, No. 9; 2017 26 Table 1. Syntax of modified problem-based learning Phase Teacher Behavior 1. Orient the students to the problem - Inform objectives of the lesson - Describe the important logical requirements - Motivates students to engage in self-directed and problem-solving activity 2. Organize the students to learn Helps students define and organize learn tasks related to the problem presented in SAS. 3.

Assist indepe ndent and group Investigation - Encourage students to gather appropriate in formation, understand the problem (make various appropriate representation as an aid to attain the solution), and search for explanations and solutions - Give appropriate scaffolding to the students who could not move or develop their thinking in attempting to solve problem. 4.

Develop and present artifacts and Exhibits - Assists students in planning and preparing appropriate report associated with the solution they get to the problem - Help the students displaying their work on the white/black board - Helps students share their work with others 5. Analyze and evaluate the problem-solving process Helps students to reflect on their investigation, using appropriate representations and the processes they used to get the solution of the problems. 3. Methodology 3.1

Subjects, Design, and Data Sources The subject of the research is the students from three public junior high school (PJHS) in the Province of North Sumatera, Indonesia. Of each, the researchers took one eight graders class. Totally, there are 88 students engaged in the research. They are from PJHS in Medan, Pematang Siantar, and Percut Sei Tuan. The study is developmental in nature.

Learning material consists of Lesson Plan, students' activity sheets (SAS), Student's Book, MRA-test consisting Pre-test, Post-test (Test-I and Test-II). In addition, Observation and responses sheet and Interview Guidelines are also used. Teaching material constitu te of Linear Equation of Two Vari ables and Pythagorean Theorem. The problems posed in SAS are an important part of learning materials.

Most of them as well as the MRA-test are developed by considering some thoughts of Resnick on HOTs. Observation and interview guidelines are set-up based on survey research theory. Last, teaching materials are chosen by considering Indonesian 2013-Curriculum, which is well suited for modified JPBL model. 3.2

Instruments, Data Collection and Analysis MRA-test comprises of two aspects, i.e. (a) Represent word problem into picture, figure, table, graph, or mathematical model as an aid to solve problem; (b) Interpret problem presented in figure, table, graph, mathematical model verbally with supporting explanatio n.

Indicators as the details these aspects set up for measuring the students MRA-test conveyed in Table 2. There were five problems designed and posed to measure the students' MRA for each pre-test and post-test. Guideline for scoring students' performance in the MRA-test is depicted in Table 3.

This rubric is developed by considering Baker (1990) concerning assessing high order thinking. Table 2. Indicators of MRA Aspect Indicators Problem Number (a) Create figure to represent word problem at hand Represent word problem in figure/picture/graph 1 Create table as an aid to attain solution Represent problem in a table as an aid to attain solution 3 (b) Interpret problem in figure verbally with supporting explanation 4 Create mathematical model as a tool to solve problem Use mathematical model (equation) to solve problem 2, 5 ies.ccsenet.org International Educat ion Studies Vol. 10, No.

9; 2017 27 Table 3. Rubric scoring for MRA-Test Components of Mathematical Representation Score Construct appropriate mathematical representation accurately and manipulated it perfectly to get the right solution.

4 Construct appropriate mathematical representation accurately and manipulated it perfectly but there are some mistakes in numeri cal computing. 3 Construct appropriate mathematical representation but there is not any necessary manipulation to solve problem 2 There have been attempts to construct mathematical repres entation and

communicate the problem but failed moving forward the work 1 No attempt made to construct a mathematical representation for the problem 0 Observation sheet on instruction is us ed to record the learning and teaching processes.

Using it, we analyze to what extent the degree of the learning materials develo ped was implemented and to analyze the way of teachers conducted the lessons in the classroom. It comprises of teachers' effort in endorsing students' willingness to learn, directing students to study hardly (keeping perseverance), forcing the students' engagement in discussion to solve problems, encouraging students to do investigation, providing opportunity to students solving problems in different ways and different mathema tical representation, endorsing inter action within group-work, and giving necessary scaffolding and guiding reflection activity.

On the other side, observation sheet on students' activities is based on students' involvement in doing math problems, students' participation in-group discussions as well as in classroom, students' activity in responding questions, posing suggestions and critics to others, and students' response towards teacher's direction. Last, the researchers used responses scale to reveal students and teachers' responses toward and perception to the learning materials developed.

In our developmental research, the intervention is the implementation of instruction materials developed based on Joyful Problem-Based Learning (JPBL). According to Nieveen and Folmer (2013), intervention in instruction is effective if it results in desired outcome. Cai et al. (2009) state "the quality of mathematics instruction can be judged by two criteria: desirable outcomes in students' learning and the processes that yield those desirable learning outcomes".

Concerning to the first aspect Nieveen, Folmer, and Cai mention, in their work Napitupulu, Suryadi, and Kusumah (2016) find the highest average score of upper secondary students in mathematical reasoning ability, which is part of HOTs, was 58 of 100 and only achieved by 26% of the students. Considering the result and the effectiveness criteri a they propose, to be judged effective, we determined the desired intervention of our developed instruction materials should fulfil the following criteria: 1) More than 65% of the students attain minimal score 65 in MRA test (from ideal score 100) and the students' MRA improved significantly.

2) Students' activities while learning, especially in solving mathematical problems, and teachers' activities in teaching process can be classified well, that is ¯ (¯ is activity average score). 3) Both students and teachers mark positive perception to and response towards the learning materials that is the average score is greater than 75.

All data was analyzed descriptively except the improvement of students' MRA, which used t-test to draw conclusion. 4. Results and Discussion 4.1 MRA test, Observation, Perception and Response of Students & Teachers Table 4a presents the students' average score on MRA- test. The table shows a relatively high increasing score from the Pre-test to the Test-1. On the contrary, from Test-1 to Test-2 the increasing was small.

Albeit small, it was very important for it contributed to the more amounts of the students who passed the minimum criteria. ies.ccsenet.org International Educat ion Studies Vol. 10, No. 9; 2017 28 Table 4a. Average Score on Pre-test, Test-I, and Test-II Test PJHS 27 Medan PJHS 1 Percut PJHS 7 P. Siantar Percentage Percentage Percentage Pre-test 6,74 33,70 6,96 34,80 6,89 34,45 Test-I 12,18 60,90 12,04 60,40 12,14 60,73 Test-II 13,38 66,90 13,04 65,20 13,00 65,00 Note.

Ideal Score = 20; Percentage = Ratio between average score and ideal score Percentage and the number of the students attained minimum score 65 is presented in Table 4b. It means that part of the first criteria of the effectiveness is fulfilled. Table 4b. Percentage of the Students Attained Minimum Score PJHS 27 PJHS 1 PJHS 7 Overall # Student 23 17 20 60 N 34 26 28 88 % 67.65 65.38 71.43 68.18 Note.

Minimum Score = 65; Ideal Score = 100 Moreover, the improvement of students' MRA is investigated through the difference score between pre-test to Test-II. Statistical t-test used to dr aw the significance of the differences. Re sult of t-test between pre-test and Test-II is significant at 5% level. It means that th e students' MRA improved.

Data on the difference score between Pre-test and Test-I is presented in Table 5, wh ile the difference score between Pre-test and Test-II is presented in Table 6. Output of t-test for the difference of test I and pretest as well as for test I and test II is presented in Appendix 2. The test is conducted after te st of normality of the data and homogeneity of variance was fulfilled. Table 5.

The MRA score difference between Pre-test and Test-I PJHS 27 Medan PJHS 1 Percut PJHS 7 P.Siantar 5.44 5.08 5.25 Table 6. The score difference between Pre-test and Test-II PJHS 27 Medan PJHS 1 Percut PJHS 27 Medan 6.647 6.077 6.107 The result of observation on the teachers' activity is presented in Table 7, meanwhile on the students' activity is presented in Table 8.

From the Table 7, we saw that t eachers' activity average score is higher than 85. At the same time, from Table 10, we got that the students' activity average score is also highe r than 85. In overall, the students engaged actively in the learni ng and teaching process.

In this cas e, the result exceeded the target has been set for the second effectiveness criteria. Table 7. Percentage of teachers' activity in learning process No. Teachers' Activity Average Percentage I The teacher use contextual problems in learning 91.67 II The teacher lead students to construct knowledge 87.85 III The teacher use scaffolding to help students solve problems 88.03 IV The teacher build learning communities 97.23 V The teacher assess authentically and encourage the students to reflect their work 91.28 Average 91.21 ies.ccsenet.org International Educat ion Studies Vol.

10, No. 9; 2017 29 Table 8. Percentage of students' activity in doing SAS on MRA problems No Students' activity Percentage 1 Sharing ideas to group partners while group discussing 90.2 2 Sharing ideas while classroom discussing 85.7 3 Ask teacher/other group when his group get stuck 80.3 4 Ask teacher when classroom discussion 90.4

5 Posing different idea while group discussion 85.7 6 Posing different idea while classroom discussion 80.1 7 Answering teacher's or other's while classroom discussion 95.3 8 Pose suggestion while classroom discussion 86.7 9 Pay attention to other group work when presented 93.5 10 Try other method in solving problem 90.0 11 Posing question which need explanation 90.2

12 Posing "yes" or "no" question 85.7 Average 87.82 The scale on students and teachers' perception to and response toward the learning materials developed revealed the average score is 83.9. In consequence, the data fulfilled the third criteria of the effectiveness accordingly.

To sum up, from the objective viewpoint the instruction materials developed is effective. It implies that the learning devices is eligible used at a wider scope (disseminate) (Nieveen & Folmer, 2013). 4.2 Students' Performance in Learning Process We investigated Students' performance during the learning process by analyzing thei r work on the problems in the SAS.

Examples of the problems showed in Table 9. An example of full SAS attached in Appendix 1. Table 9. Examples of problems in SAS No Problem 1 From The center of Baby Health, we obtained the following data, which explained the growth weight of a baby. Baby's age (months) Weight (g) 1 3000 2 3300 3 3600 4 3900 Based on the data, determine: a. The weight of a baby at age 10. b.

Mathematical model that represent the relationship between age and weight. 2 At a strait, a swimmer started to swim as far as straight. Then, he went on swimming to left as far as 4000 . Determine the distance (in meter) if he directly swam from the starting point to the end position. ies.ccsenet. One grou p b etween w received t e 2.

For probl e 3, the stu d they then a the unit f r what to d o right tria n continued b arrier to e org p 's performan c w eight and ag e e acher's scaff o e m number 2, s d ents previou s a meliorated b y r om me t er int o o . Teacher the n n gle with the t working as s h e xchange one r c e in solving p r e of the baby, o lding, they a m s tudents perfo r s ly were not a w y putting the s q o kilometer to n scaffold b y s u t wo sides at t h h own in Figur e r epresentatio n Internatio n Figure 1.

Pro b r oblem numb e even though t m eliorated the i r med an inter e w are of the P y q uare sign on make it easi e u ggesting the m h e right angl e e 3. Many stu d n to another. Figure 2. P r n al Education St u 30 b lem: Weight o e r 1 is showed t hey were ca p i r work and s o e sting solution , y thagorean fo r (e r to handle.

C m comparing w e has measure d ents committ e r oblem: Baby w u dies o f a baby in Figure 1. It p able to mani p o lved the prob l , as depicted i n r mula they w r). Moreov e C onsequently, t w hat they face d 3 and 4. Ha v e d this mistak e w eigh t revealed that p ulate the equ a l em correctly a n Figure 3. As r ote.

Teacher w e r, they did n o t hey then sto p d to a specific v ing had this e , it pointed o u Vol. 10, No. 9; the group con f a tion. After h a a s shown in F we observe F w arned them o o t directly rep r p ped, did not k situation. Th a scaffold, they u t that they ha d 2017 f used a ving i gure i gure o n it, e sent k now a t is a then d still ies.ccsenet. Along th e continuou s 4.3

Stude n Problem n Figure 4 relationsh i For probl e forgotten t then conn e fact. org e learning pr o s ly, it could b e n ts' Performan n umber 1 is i n showed the s i p between an g e m number 2, t he concept of e cted them to o cesses, whic h e then expecte d ce in MRA Pr e n tended to m e s tudent was n g les, which wi less than a q u drawing line t draw a line a Internatio n Figure 3.

h p assing th e d that the stud e e -test, Test- I , a e asure the abi l n ot aware of ll lead him to t u arter of the s t hrough two p o s representati o n al Education St u 31 Problem: Dist e lesson by s e nts' MRA en h a nd Tes t -II l i t y to create a the concept t he equation d s tudents comp l o ints. Some o f o n of point (- 2 u dies ance olving probl e h anced. a mathematic s of suppleme n d emanded. I eted this task f them plot 2 2 , 0).

It seems e m using var i s equation fro n tary angle t o . More than a 2 axi s s as if it is im p Vol. 10, No. 9; i ous represen t m a given pi c o exhibit a s i a half of them s and 0 at p ossible, but i 2017 ation c ture. mple have axis, t is a ies.ccsenet. Next are t w number 1 showed t h connected b oth ants m materials, Test - 1. S u Ano t poin t 2.

S o Afte r Dete r The 88 st u not alwa y different s draw the l i revealed t h number 1. org wo problems aimed to elic i h at the student them to form t m et. This con f growth in ma t - II problem s u ppose the tr a t her one pas s t where both o phia got $5 f r completing r mine in ho w u dents engage d y s all true, bu t olution for pr o i nes and focu s h at he was ex h of Tes t - II. O n i t students' ab i understood w t he line.

To th e f irmed that af t t hematical rep r s a jectory of a t s ed the track ants met. f or each pass e the entire t e w many subje c Fig u d in the resear t at least, the y o blem numbe r s ed only to th e h austed for fi r Internatio n Figure 4. M n e of Student' i lity to draw l i w hat to do. He e end, he concl t er experienci n r esentation ab i t ravelling an t .

e d subject e x e st, Sophia s u c ts she succe u re 5. Problem : ch performed y have tried r r 1 on trajecto r e demand on d e r stly working n al Education St u 32 M easuring an a s p erformance i nes as the tr aj put first two p uded tha t the i n n g the interve n i lity occurred i t is represent e Draw the gr x am in schoo l u cceeded fou r eded.

: Trajectory o f vary solution s r epresenting w r y of traveling e termining th e consecutively u dies a ngle e s on problem 1 aj ectory of tra v p oints of each n tersection of n tion that is t h i n the part of t h e d by equati o aph of the t r l , but should r r times as s h f traveling an t s to each prob l w hat they un d ants emerged e coordinate w on number 2 1 is depicted i n v elling ants. T h line on the C the lines to be h e implementa t h e students. o n r ajectories.

D r eturn $10 f o h e failed, an d l em. The diffe r d erstood from in Figure 6. T w here the ants m up to numbe r Vol. 10, No. 9; n Figure 5. Pr o T he figure disp l C artesian plane the point whe r t ion of the lea r 5 . D etermine th e o r failed. d gained $60. rent solutions the problem. T his student di m et. Intervie w r 5 then retur n 2017 blem l ayed then r e the r ning were One d not then e d to ies.ccsenet.

Problem n aid them comprehe n incapable reward fo r reward of represent ' and low r e but he sto p On the co n into a ma t the ability In overall, This prov e students' M org n umber 2 requ i reaches the n sion thus rep r to engage all r success nor p success, he s u ' failed' as -v a e presentation a p ped without a n trary, the se c t hematics equ a to use substit u the mean sco r e d that the u s M RA in some d Figure 6. A i res the stude n solution.

Tw r esentation on the informati o p enalty for fail u mmed up bo t a riable. This i s a bility. Thoug h a ny effort to a m c ond work sh e a tion and obt a u tion techniqu e r e of students' s ing of the le a d istricts in the F Internatio n A student's an s n ts' ability to r o students' w the problem. T o n given into t ed in the equa t h. The advan t s a significant p h at the end of t m eliorate it.

e et (Figure 7b) a ining a syste m e to solve the p MRA in Test - a rning materi a Province of N F igure 7a. Re w n al Education St u 33 s wer to the tra v epresent the p r w orks picked T he first work t he ma t hemati tion. Moreov e t age that was a p rogress for a s t he work eme r) showed one' m of linear eq u p roblem and fi - II is significa n a ls developed N orth Sumater a w ard for succe s u dies v eling ant pro b r oblem into m in Figure 7a k sheet (Figure cs equation d e e r, instead of s u a ble to repres e s tudent with l o r ged an attemp ' s understandi n u ations of tw o fi nally got the s n tly higher in c based on JP B a .

s s proble m b le m m athematical m and 7b de m 7a) revealed t e manded. He n u btracted pen a e nt 'successes o w mathemati c p t to check the n g how to rep o variables. It s olution. c omparing to t B L implied th e Vol. 10, No. 9; m odel as a bri d m onstrated dif f t hat the studen t n either consi d a lty of failure t ' as -variabl e c al prior know l truth of his an p resent the pr o continued sh o t heir Pre-Test s e increasing o 2017 ge to f erent t was e ring t o the e and l edge s wer, b lem w ing s core. o f the ies.ccsenet. 4.4

Stude n The avera g is the asp e aspect of t aspect of a Table 10. A Note. Ide a It can be c supportin g continuou s their mat h (2001) ha v 5. Conclu s The instr u outcomes. score 65 i activities p rocess c a towards t h Acknowl e This rese a Indonesia. Faculty o f Referenc e Arends, R Baker, E. A sse s org F n ts' Performan g e score for e a e ct of the abil i t he ability to i n a bility to use r e A verage score a l score = 4. c oncluded tha t g explanation.

s ly ask stude n h ematical repr e v e established. sion u ction materia l As mentione d i n MRA test while learnin g a n be classifi e h e instruction m e d g ments a rch was supp o The authors f Mathematics e s . I. (2004). Le a L. (1990). D e s sing High O F igure 7b.

An o ce in Each As p a ch indicator o i ty of represe n n terpret probl e e presentation s of each MRA Sc h PJ H PJ H PJ H t the students m The result w e n ts pose vario u e sentation abi l In addition, i t l s we develo p d earlier, the d (from ideal s g , especially e d well; and (m aterials. o rted by the M are thankful t and Natural S c a rning to Tea c e veloping Co m O rder Thinki n Internatio n o ther student' s p ect of MRA Te o f the student s n ting word pr o e m in figure v s uch as figure / indicato r h ool 1 H S 27 2.2 6 H S Percu t 2.7 3 H S Sianta r 2.7

9 m ost powerfu l e obtained in t u s representa t l ity. This resul t supports the g p ed in this st u d esired outco m core 100) an d in solving m (3) Both stud e M inistry of Re s t o Rector of S c iences for pr o c h (6th ed.).

Ne m prehensive A n g in Mathe m n al Education St u 34 s answer on th e Te s t s ' MRA in Tes t o blem in pict u v erbally with s / picture or ma t Indicato 2 3 6 2.44 2.44 3 2.35 2.73 9 2.18 2.57 l is in the asp e t his study pro v t ion of mathe m l t is in line wi t g oals of learni n u dy succeede d m es are: (1) O d the student s m athematical p e nts and teac h s earch, Techn o S tate Universi t o viding neces s e w York: The M A ssessments o m atics.

Was h u dies e traveling an t t -I was presen u re, figure, ta b upporting ex p t hematics mo d r 4 5 2.62 2.24 2.23 2.04 2.29 2.21 e ct of interpre t v e that teachi n m atical probl e t h what Meir a ng mathemati c d achieving it s O verall, 68.18 % s ' MRA impr o p roblems, and h ers mark pos i o logy and Hig h t y of Medan, s ary facilities t M cGraw-Hill C o f Higher Or d h ington DC: t proble m ted in Table 1 0 b le, or symbo l p lanation. Indi c d el/equation to t problem in fi n g and learni n e ms will enab l a (2002) and P c s NCTM (20 0 s intention.

It % of the stud e o ved signific a teachers' ac t i tive p ercepti o h er Education Research Dir e t o conduct the C ompany, Inc d er Thinking. American A s Vol. 10, No. 9; 0 . Indicator 1 a l . Indicator 3 i c ator 4 and 5 i solve proble m fi gure verbally n g processes w l e them impr o P ape & Tchos h 0 0) declared. fulfills the d e e nts attain mi n a ntly; (2) Stu d t ivities in tea c o n to and res p of the Repub l e ctor, and De a research. . In G.

Kulm (s sociation fo r 2017 a nd 2 i s the i s the m . with w hich o ving h anov e sired n imal d ents' c hing p onse l ic of a n of (Ed.), r the ies.ccsenet.org International Educat ion Studies Vol. 10, No. 9; 2017 35 Advancement of Science. Cai, J. (2009). What is Effective Teaching? A Study of Experienced Math ematics Teachers from Australia, the Mainland China, Hong Kong-China, and the United Stat es. In J.

Cai, G. Kaiser, B. Perry, & N.-Y. Wong (Eds.), Effective Mathematics Teaching from Teachers' Perspectives. Rotterdam: Sense Publisher. Carpenter, T. P., & Lehrer, R. (1999). Teaching and Learning Mathematics with Understanding. In E. Fennema, & T. A. Romberg (Ed.), Mathematics Classrooms that Promote Understanding . Mahwah: Lawrence Erlbaum Associates, Inc. Cobb, P., Yackel, E., & Wood, T. (1992).

A Constructivis t Alternative to the Representational View of Mind in Mathematics Education. Journal for Research in Mathematics Education, 23 (1), 2-33.

https://doi.org/10.2307/749161 Fogarty, R. (1997). PBL and Other Curriculum Models for the Multiple Intelligence Classroom. Melbourne, Vic: Hawker Bronlow Education. Goldin, G. A. (2002). Representation in mathematical learning and problem solving. In L. D. English (Ed.), Handbook of international research in mathematics education (pp. 197-218).

Mahwah, NJ: Lawrence Erlbaum Associates, Publishers. Hmelo, C. E., & Ferrari, M. (1997). The Problem-Based Learning Tutorial: Cultivating Higher Order Thinking Skills. Journal for the Education of the Gifted, 20(4). https://doi.org/10.1177/016235329702000405 Kilpatrick, J., Swafford, J. , & Findell, B. (2001). Adding It Up: Helping Children Learn Mathematics . Washington DC: National Academy Press. Kulm, G. (1990).

Assessing High Order Thinking Mathematical Thinking: What We Need to Know and Be Able to Do. In G. Kulm (Ed.), Assessing High Order Thinking in Mathematics . Washington DC: AAAS Publication. Meira, L. (2002). Mathemat ical Representation as System of Natatio n-in-use. In Gravemeijer et al. (Eds.), Symbolizing, Modelling and Tool Use in Mathematics Education. Dordrecht: Kluwer Academic Publisher. Minarni, A., Napitupulu, E. E., & Husein, R. (2016).

Mathematical Understanding and Representation Ability of Public Junior High School in North Sumatera. Journal on Mathematics Education, 7 (1), 43-56. https://doi.org/10.22342/jme.7.1.2816.43-56 Napitupulu, E. E., Suryadi, D., & Kusumah, Y. S. (2 016). Cultivating Upper Secondary Students' Mathematical Reasoning Ability and Attitude towards Mathem atics through Problem-Based Learning.

Journal on Mathematics Education, 7(2), 117-128. https://doi.org/10.22342/jme.7.2.3542.117-128 NCTM. (1989). Curriculum and Evaluation Standards for School Mathematics. Reston, VA: NCTM. NCTM. (2000). Principle and Standards for School Mathematics. Reston, VA: NCTM. Nieveen, N., & Folmer, E. (2013). Formative Evaluation in Educational Design Research. In Plomp, & Nieveen (Eds.), Educational Design Research. Enschede: SLO. Pape, S. J., & Tchosanov, M. A. (2001).

The Role of Representation(s) in Developing Mathematical Understanding. Theory into Practice, 40(2), 118-127. https://doi.org/10.1207/s15430421tip4002_6 Plomp, T. (2013). Educational Design Research: An Introduction. In Plomp, & Nieveen (Eds.), Educational Design Research. Enschede: SLO. Puri, A. (2014). How to Create Joyful Learning in the Classroom. Retrieved from https://www.howtolearn.com Resnick, L. B. (1987). Education and Learning to Think.

Washington DC: National Academic Press. Ronis, D. L. (2008). Problem-based Learning for Math & Science; Integrating Inquiry and the Internet . California: Corwin Press. Saragih, S., & Napitupulu, E. E. (2015). Developing Student-Centred Learning Model to Improve High Order Mathematical Thinking Ability. International Education Studies, 8 (6), 104-112. https://doi.org/10.5539/ies.v8n6p104 Schöenfeld, (2007).

Reflection on an Assessment Interview: What a Close Look at Student Understanding Can Reveal. In A. H. Schöenfeld (Ed.), Assessing Mathematical Proficiency. New York: Mathematical Sciences Research Institute. ies.ccsenet.org International Educat ion Studies Vol. 10, No. 9; 2017 36 Appendix 1. An Example of Student Activity Sheet (SAS) Data from a Community Health Center showed the weight growth of a baby as presented in the table below.

Baby's age (month) Weight (gram) 1 3000 2 3300 3 3600 4 3900 a. If constitutes its age and its weight, construct an equation represents the relationship between and . b. What is the baby's weight at the tenth month? STRAIGHT-LINE EQUATION Problem 1 Answer: ....

....
....
....
....
.... Problem 2 ies.ccsenet.org International Educat ion Studies Vol. 10, No. 9; 2017 37 The following table shows the charge should be paid when using a certain taxi to travel.

Distance (in km) Charge (in Rupiah) 0 3,000 1 8,000 2 13,000 3 18,000 4 23,000 .... 10 53,000 .... N ..... 1. Determine a mathematics equation which governs the data. 2. Determine the charge if one travels 30 . 3. What is the mathematical term for the equation you got? Observe the following number sequence: 0 1 2 3 ... 13 50 47 44 41 ... 1 Determine a mathematics equation which reveals the relationship between the first and the second row. Answer: ....

....
....
.... Answer:
....
....
....

....
.... Problem 3 ies.ccsenet. Appendi x Output o f S P J P P Cop y ri g h t Copyright This is an license (h t Gener a Atte While Concl u org x 2 f t-Test for M R S chool JHS 27 P JHS 1 P JHS 7 t s for this articl e open-access a t tp://creativec o a lly, g is calle d u si R A Score Levene's T e Equality of V a F 1.313 6.602 .072 e is retained b y a rticle distrib u o mmons.org/li c g ht-line equ r d .... a n Internatio n e st for a riances Sig. .256 .013 .789 y the author(s) u ted under the c enses/by/4.0/ p r e called ... ... n n al Education St u 38 t - T 14.474 10.797 13.330 , with first pu b terms and co n).

p re ... . ed .... Wo o act u u dies - test for Equal i df S 66 50 54 b lication right s n ditions of th e ... ... o w... doing u ally fun.... H i ty of Means S ig.2-tailed .000 .000 .000 s granted to th e e Creative Co m ... . math is H aha.... Vol. 10, No. 9; Mean Difference 6.647 6.077 6.107 e journal. m mons Attrib 2017 u tion

INTERNET SOURCES:

1% - http://ccsenet.org/journal/index.php/ies/issue/archive
11% - https://files.eric.ed.gov/fulltext/EJ1153605.pdf
1% - https://eric.ed.gov/?id=EJ1153605
<1% - https://eric.ed.gov/?q=exploration+of+mathematics+problem+solving+process+based+on+their+thinking+level+students+in+general+high+school&pr=on&ft=on
<1% - https://en.wikipedia.org/wiki/Information_and_communication_technologies_for_development
<1% - https://www.researchgate.net/publication/277881194_Developing_Student-Centered_Learning_Model_to_Improve_High_Order_Mathematical_Thinking_Ability
<1% - http://www.univie.ac.at/constructivism/archive/fulltexts/2967.html
<1% - http://www.academia.edu/3242565/The_Role_of_Representation_s_in_Developing_Mathematical_Understanding
<1% - http://www.colorincolorado.org/article/connect-students-background-knowledge-content-ell-classroom
<1% - http://diggingdeeper.pbworks.com/f/Tartre+Spatial+Orientation+Skill.pdf
<1% - https://www.sciencedirect.com/science/article/pii/S2214629616301359
<1% - http://www.dailygood.org/story/478/35-scientific-concepts-that-will-help-you-understa

nd-the-world-aimee-groth/
<1% -
https://gse.berkeley.edu/sites/default/files/users/alan-h.-schoenfeld/Schoenfeld_2008%20Theory%20of%20Teaching%20Proficiency.pdf
<1% - https://files.eric.ed.gov/fulltext/EJ1096318.pdf
<1% - https://www.learner.org/courses/teachingmath/grades3_5/session_05/index.html
<1% -
https://www.researchgate.net/publication/311917843_Relationship_between_Student%27s_Self-Directed-Learning_Readiness_and_Academic_Self-Efficacy_and_Achievement_Motivation_in_Students
<1% - https://brocku.ca/webcal/2017/undergrad/math.html
<1% -
http://www.ascd.org/publications/books/104428/chapters/Higher-Order_Thinking.aspx
<1% - https://quizlet.com/98297426/act-child-development-motiviation-flash-cards/
<1% -
http://www.rpi.edu/~nobler/Games/Psychology%20of%20games%20reading%20assignment.doc
<1% - http://digital.lib.usf.edu/SFS0025614/00001
<1% - http://web.calstatela.edu/faculty/jshindl/cm/Chapter7motivation.htm
<1% - http://scholar.lib.vt.edu/ejournals/JTE/v17n1/frank.html
<1% - https://misscronin.wikispaces.com/Education+occurs+only+inside+a+classroom.
<1% - https://kangdjime.wordpress.com/2011/11/16/problem-based-learning/
<1% -
https://www.coursehero.com/tutors-problems/Algebra/10480138-In-attempting-to-solve-the-system-of-equations-y-3x-2-and-6x-/
<1% - https://www.scribd.com/document/313109723/Ref
<1% - https://quizlet.com/22905791/inquiry-learning-flash-cards/
<1% -
https://www.transtutors.com/questions/math-337-homework-4-solution-key-problem-1-3-1-a-3-use-euler-s-method-by-hand-to-app-1129761.htm
<1% - https://www.researchgate.net/profile/E_Elvis_Napitupulu
<1% -
https://www.scribd.com/document/222053821/The-Golden-Fountain-Coen-Van-Der-Kroon-1994
<1% - https://www.sciencedirect.com/science/article/pii/S0964339705000406
<1% - https://repository.nie.edu.sg/bitstream/10497/1923/1/TL-7-1-2.pdf
<1% - https://bmcmededuc.biomedcentral.com/articles/10.1186/1472-6920-14-157
<1% -
https://www.physicsforums.com/threads/cant-seen-to-get-the-right-solution-a-sluice-gate-dams-water-up.116954/

<1% - http://www.qualitative-research.net/index.php/fqs/article/view/466/996
1% -
https://www.researchgate.net/publication/226428574_What_is_effective_mathematics_teaching_A_study_of_teachers_from_Australia_Mainland_China_Hong_Kong_SAR_and_the_United_States
<1% - https://link.springer.com/article/10.1007%2Fs11858-007-0029-0
<1% -
https://implementationscience.biomedcentral.com/articles/10.1186/s13012-017-0590-z
<1% - http://www.real-statistics.com/students-t-distribution/paired-sample-t-test/
<1% -
https://www.researchgate.net/publication/285796888_Comparison_of_ANOVA_F_and_WELCH_Tests_with_Their_Respective_Permutation_Versions_in_Terms_of_Type_I_Error_Rates_and_Test_Power
<1% - http://www.apa.org/pubs/info/brochures/develop.aspx
<1% -
https://www.canada.ca/en/treasury-board-secretariat/services/planned-government-spending/budgets-expenditures/actual-performance-information-program-organization-2016-17.html
<1% -
http://pasca.um.ac.id/wp-content/uploads/2010/01/8-kumpul-abstrak-MAT-S2-2.doc
<1% - https://www.sciencedirect.com/science/article/pii/S1877050915036182
<1% - https://swimmingcoach.org/category/training/
<1% - http://mathcentral.uregina.ca/QandQ/topics/distance
<1% - https://documents.mx/engineering/power-system-analysis-55b0cfb53aee0.html
<1% -
https://www.coursehero.com/file/p34u5n/42-329-318-309-302-296-286-278-266-258-250-242-236-229-225-219-216-213-27-421/#!
<1% -
https://www.researchgate.net/publication/271585454_Comparing_mathematics_teachers'_beliefs_about_good_teaching_the_cases_of_Estonia_Latvia_and_Finland
<1% -
https://www.researchgate.net/publication/301298529_What_is_good_mathematics_instruction_-_Mathematics_teachers%27_individual_criteria_for_instructional_quality_and_attributions_for_instructional_success
<1% -
https://www.thefreelibrary.com/Creating+a+culture+of+(in)dependence.-a0142636430
<1% -
http://www.academia.edu/10233644/EDUCACI%C3%93N_EL_CONSTRUCTIVISMO_RADICAL_Y_LA_PSICOLOG%C3%8DA_COGNITIVA
<1% - http://riset.unisma.ac.id/index.php/jpm/article/view/405

<1% - https://ptgi.uncc.edu/publications/
<1% - http://journals.sagepub.com/doi/full/10.1177/0016986216671806
<1% - https://www.nap.edu/read/9822/chapter/6
<1% - http://www.coe.tamu.edu/~gkulm/gkulm.doc
<1% - http://ejournal.unsri.ac.id/index.php/jme/article/view/2816
<1% - https://ejournal.unsri.ac.id/index.php/jme/article/view/2816
<1% - http://ejournal.unsri.ac.id/index.php/jme/article/download/3542/1882
<1% - https://www.researchgate.net/publication/321364497_Analyzing_the_Teaching_and_Learning_of_Mathematical_Reasoning_Skills_in_Secondary_School
<1% - http://jurnal.uin-antasari.ac.id/index.php/jpm/article/view/49
<1% - https://www.researchgate.net/profile/Brenda_Bannan/publication/263733328_The_Integrative_Learning_Design_Framework_114_-_133_An_Illustrated_Example_from_the_Domain_of_Instructional_Technology/links/0046353bc22945ecfd000000.pdf
<1% - http://www.tandfonline.com/doi/full/10.1080/00131881.2014.983718
<1% - http://www.slo.nl/downloads/2009/Introduction_20to_20education_20design_20research.pdf/download
<1% - https://link.springer.com/article/10.1007%2Fs10984-010-9075-6
<1% - http://jogjapress.com/index.php/EduLearn/article/view/574
<1% - https://www.researchgate.net/profile/Ed_Elbers
<1% - http://watertown-algebra.wikispaces.com/file/view/Algebra+3_6+Study+Guide+Arithmetic+Sequences.pages.pdf
<1% - https://quizlet.com/251087648/human-development-and-family-studies-final-flash-cards/