

Encouraging Student's Emergent Model in Understanding Negative Number

Weni Dwi Pratiwi*, Nyimas Aisyah, Elika Kurniadi

Mathematics Education Department, Universitas Sriwijaya, Indonesia

*Corresponding author Email: wenidwipratiwi@fkip.unsri.ac.id

ABSTRACT

The negative number is broadly known as an unique concept that understudies struggle to get it. Giving a few rules of addition or subtraction including negative numbers might not effectively offer assistance the understudies to get a handle on the meaning of negative numbers. The point of the study is to explore the students' emergent model for making sense negative numbers. The study use Design Research approach. The discoveries recommended that the planned activities counting a few games to which the development of model occurred can progress students' conceptual understanding of addition including negative numbers.

Keywords: Emergence of model, Negative numbers, HLT.

1. INTRODUCTION

The concept of negative numbers can be sophisticated for children if the topic is not delivered in a meaningful method and strategy to students. Students have some specifics difficulties in calculating or doing any task involving negative numbers, such as in visualizing numbers less than zero; treating negative numbers as mathematical objects; and formalizing rules for the arithmetic of integer, particularly the meaning of the fact that the opposite of a negative number is a positive number. [1][2][3][4]. Students struggle how to grasp the idea and the meanings of negative numbers which match to their thinking and intuition. Moreover, they may find some difficulties in distinguishing between the minus sign of negative numbers and sign for the operation.

Children may figure out the idea of negative numbers if it is learned through context in which it can be real and/or familiar to stimulate their common sense and foreknowledge. The familiarity of the context might be different from one student to another. Using the context and specific situation, they will use their existing number concept, and the development of new concepts and strategies will be promoted by the contexts [4][5][6]. Whitacre et. al. managed to interview

a kid and found that kid interpret negative integers as something that are out of their imagination in which they need to interpret some related situation of proper analogical statement to understand it. The negative numbers is apparently can be written clearly, the calculation can be done in their head, in spite of the fact that the objects were not exist there. It suggests that students are capable to reason and interpret negative numbers by using their foreknowledge [7]. Some of the first grader who was not introduced yet about negative numbers could interpret and do the task successfully within the magnitude context [8]. The concept of magnitude context refers to opposite magnitude contexts, some context refers to opposite magnitude, few settings such as loaning and owing; voyaging forward and in reverse, moving up and moving down in a lift, and before long are included as inverse magnitude context [9][10][11] Children can have vigorous way of thinking the early concept of negative numbers.

Some of the contexts described previously could assist the students to understand negative numbers better. However, some of those are given for students with higher academic level, and and they contain some abstract calculation which can be too sophisticated for children aged 10 years old [12], and likely it isn't

replicable for lower grade. Also, the understudies got to know why negative concept of numbers show up. They must experience for themselves that negative numbers exist in their life so that they are stimulated to be able to use these numbers in certain situations.

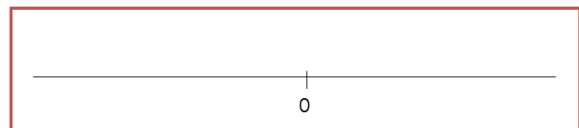
Taking this problem into account, through this study I intend to implement an activity that involves games and number lines to get third graders to understand negative numbers. With this game, students will construct their own understanding of negative numbers. Board game is a simulation game where students will move to move their game pins and stop at one of the boxes containing the items they will buy, the number of boxes that are passed will be drawn with the dice that has been provided. After their money runs out, they will have no more money to spend because they have to keep moving from one box to another until the game is over. They will find that the money is spent so they have to borrow money from the shop owner to be able to buy more things. I expect that by playing this game, students will experience themselves a situation that forces them to use negative numbers and find negative numbers themselves in this learning experience. Among other things they can learn is that negative numbers can arise by continuously subtracting a quantity of numbers. By creating a situation where students find that they do not have enough money to buy something and need to ask someone to lend them money, they are anticipated to get it that when they have debt, they have a 'negative' sum of cash. The term debt might be controversy because it is way too early to introduce them about financial thing but if it introduced through playing the board game, the debt concept is quite acceptable.

There are also situations in which they return the money they have borrowed; they will then have a 'positive' amount of money. I want understudies to get a handle on the thought by having them reflect the games, so they are able to clarify what negative numbers are inside this setting. Also, a few number line exercises are included to empower understudies to use this model to memorize addition of integers. The research question of this study is "How do the emergence of students' model support the understanding of students in making sense the negative numbers?". The study aims to investigate the emergence of model in supporting the understanding of students in making sense the negative numbers.

1.1. Emergent Modeling

This is a how the arrangement of instructional activities includes the levels of emergent modelling [10][11][12]

Activity in the task setting, understudies may translate the concept of negative numbers within the learning circumstance they lock in. For case, by playing the game, they may say that negative numbers appear as the continuously losing money and end up in having debt to someone since they don't have sufficient cash to purchase things (situational level); (2) Referential activity, the understudies endeavour to demonstrate the circumstance by utilizing their own clarification and representation [10][12][20]. They may model the setting of owning debts with some notes in hands during the game; (3) General activity, students begin to create their and build number line as a mathematical tool for solving more complex situation, the change of their visualization regarding the problem into the use of a number line demonstrate the shifting to a formal level; (4) Formal level of reasoning, the understudies who are in this level will not depend on the model for since they direct to work the numbers and ordinary operation formally. The moving demonstrate within the lesson is the number line which is use to model the situation and afterward is also utilized as a model for thinking. [11][12][13][14]. Given this number line, they will make some marks and numbers on it to appear the circumstance given, consider the preliminary guideline test, the students had inconvenience in constructing a straight line and it took much time for them to make a line. Hence, the straight line is provided within the to begin with put within the preparatory issue until they get utilized to utilizing the number line.



The number line could be a effective instrument in making sense the negative numbers [15][16][17], since it gives clear representation almost extension of number. The part of zero is additionally highlighted through the setting to create meaning the situation[16][21].

2. METHOD

The research approach of the study is plan investigate, which points to explore the students' new show for making sense negative numbers. In this consider, a game setting with the thought of having-owing cash was displayed for understanding negative numbers. It was anticipated that through the learning groupings that had been outlined, students' conception of negative numbers can be progressed since it is significant for understudies

to be able to provide meaning to negative numbers inside the appropriate setting [17][18][19]. Design research was chosen as the research approach since it was planning to be an intervention in science instruction by planning a learning arrangement in understanding negative numbers, which are based on Realistic Mathematics Education. Through this study, my desire is to allow a contribution in creating educating materials for mathematics instructors in supporting understudies in learning the concept.

3. RESULT AND DISCUSSION

The understudies did this activity in a team consisting of 4 members, each team gather got 5 cards, they talked about the issues on the cards at the side their teams. A short time later, one team exchanged their cards to other teams and draw hops once more in another problem sheet. A short time later, one group displayed their work based on what they recorded during the game; they checked their answer and clarified about the way they might get the answer. There were a few discoveries from the activities that was quite unexpected and required to be refined for the teaching experiment. The common sense things such as organizing the issues and the pictures (the picture of the number lines) that students will not be confused and giving the number for each problem.

- The teacher should make some advance explanation about the instruction in the problem sheet to make it clear for students. The teacher should remind the students in differentiating the starting number-initial number showing the beginning of the movement and the numbers after jumps-the resulting number.
- The discourse among understudies ought to be more encouraged. It is needed to be checked to students whether they fully get the idea about the situation and the meaning of numbers operation in the activities. They need to understand how to start to make jumps along the number line, how should they make jumps, in which direction they have to move according to the problem. Also they need to know that after having the result of their jumps, the result represents the result of the operation. Therefore, student need to be assisted to translate the situational problem into more formal representation of number operation. The thing is to form beyond any doubt that teacher can get much data about students' information

through lesson discourse. Students can get prediction about students' understanding about the solution of the problem and how they can talk almost that. The discourse among students ought to be observed.

- The worksheet should contain sufficient space so that students can write down their impressions of the assignment given, as well as so that students have sufficient space to write a few conclusions about the learning activities undertaken. The conclusions written by students can be an indicator of students' understanding of learning. It is additionally fundamental to know how students justify the answers of the problems.

In this excerpt, students were asked to imagine the situation in the problem card of paying money 11, with the starting point 5. They knew when the reach zero, they no longer had the money.

Student 1(S1) : "I don't think I know how to do this problem"

Researcher (R): "How about comparing it to the previous problem? Can you see something similar? Let say, I have 5 here, and where should we start?"

Student 2 (S2) : "Hmm.. I think 5 (writing on the worksheet)"

Researcher : "says 'Then I need to pay 11... let see if you can make some movements. Look at the picture of the number line, the picture may help you a little bit probably."

S2: "Oh ya, To the shop"

Researcher: "Let making some hops then"

S1: "1..2...3...4...5...6.....7....." (making jumps while counting)

R: "where should you stop?"

S2: "At zero"

Researcher: "Can you say something about that? I need answer from others."

S2: "Hmm..the money has run out."

S2 constructed a line and composed the numbers on it, making jumps, and did a few revisions on that. She attempted to figure out the ultimate position after making 11 jumps to the cleared out from 5. He realized that he made excess hops and after that made hops to right get to 5 checked it until 11 to check his reply. After he was persuaded to his reply, she put -6 within the box.

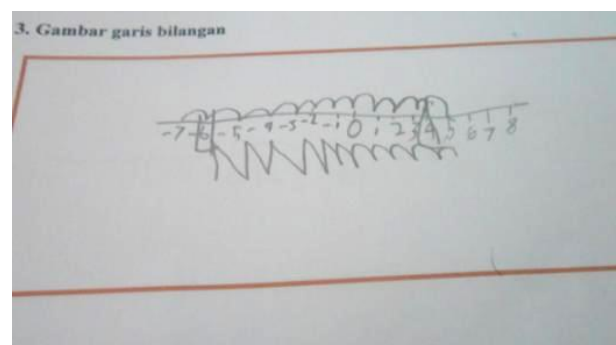


Figure 1. A number line-as a model of situation as well as a model for thinking.

Within the mini lesson, students were challenged to decide the position of each number within the rectify put along the number line. The goal of the mini assignment was to assist student get it the magnitude of the negative numbers. When they associated the concept of number

size to the past setting, it was less demanding for them to create meaning why the magnitude of a negative number decreases because it moves further to the left along a number line

Table 1. The Comparison between the Hypothetical Learning Trajectory and The Actual Students' Learning

The Hypothetical Learning Trajectory	The actual students' learning
When working the problem card, "I have a \$4 debt, I get a voucher for shopping \$7". Here, they check on the number line, determining the initial position on 4, and make moves 7 times to the right, until 3. 3 is the expected result.	There were some unexpected findings about this task, the first, is that the student did not determine the initial position based on the problem. Instead, they started from zero. Another thing is that, not all the student was familiar enough about the term shopping voucher. The thought getting shopping voucher means paying cash instead of getting cash.
The negative should refer to 'debt' and students are expected to automatically define minus sign as 'debt' within the context to make problem simpler and to introduce them about the appearance of negative number based on the context.	Few students did not use the negative sign to change the term 'debt', they knew that negative referred to debt, but some of them still not get used to it.
Moving to the right can increase amount of cash they have, meaning that they will have less debt because they have the money to pay. If they get much money, it would probably cause them for not getting the debt, or not getting the negative numbers at all. The students should understand that negative numbers appear when they constantly spending money until they have no more to pay to the shop.	Students sometimes misinterpret the problem that paying money always ended up with debt; therefore, they jumped until they reach negative numbers. There could be possibility for a student not getting any negative numbers, because one did not spend enough money.

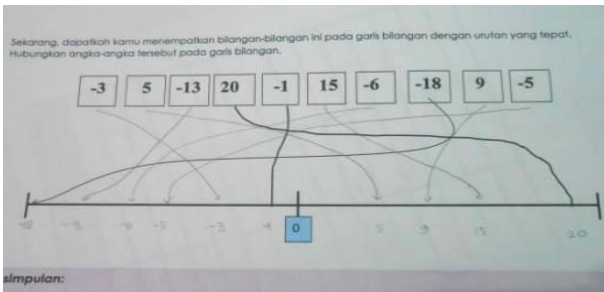


Figure 2. A student ordered negative numbers in the number line.

There were some different way of strategies used by students to decide the location of numbers along the number line. Suprisingly, S1, S2, and S3 were very quick in understanding the problem. In any case, they still require additional clarification from the educator since two cases (20 within the positive numbers; -18 within the negative numbers) given within the worksheet did not offer help and effectively assist students in doing the problem. To know the position, S1 straightforwardly made line connecting the number to the position within the number line. She just approximated it by based on the position of 20 within the positive number and -18 within the negative number.

In case it was little number she pointed forward from zero, on the off chance that it was very huge number, she pointed in reverse from 20. A short time later, she connected the number to her approximated point.

4. CONCLUSION

The conclusion of this study is that learning to use a game context can help students improve their understanding of the concept of negative numbers and also arithmetic operations involving negative numbers by promoting the use of number lines to solve problems related to a given context. Each visualization and representation they build in each learning sequence develops from situational understanding to a more formal level. The context of the game with debt simulation can add to their insight about the appearance of negative numbers in everyday life. The model of their situation presents itself and will vary depending on their prior knowledge. The game of dice helps them represent movements along the number line to become more formal by making left and right steps and interpreting each move. The representations they make in every move can model the situation. This activity, in addition, uses the number line as a model to determine the final result of the addition of two integers. However, some

exercises and repetitions are recommended for better and more effective learning. The activities in the dice game for opportunity may be used for additional learning. A revision and a few additions are needed so that this activity can be extended to other integer arithmetic operations, such as integer subtraction. In short, it can be concluded that learning contributes to making a difference to further energize classroom discourse.

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REFERENCES

- [1] M. Stephan, A. Didem, A proposed instructional theory for integer addition and subtraction, *J. Res. Math. NCTM*, New York, 2012, pp. 428-464.
- [2] A.S. Ozdemir, M. Sahal, The effect of teaching integers through the problem posing approach on students' academic achievement and mathematics attitudes, *Eurasian Journal of Educational Research*, ANI Publishing Company, Istanbul, 2018, pp.117-136.
- [3] N.M. Wessman-Enzinger, J. Tobias, D. Olanoff, Prospective teachers' attention to realism and consistency with negative integers, addition, and temperature. *Investigations in Mathematics Learning*, Taylor and Francis Group, London, 2020, pp.226-241.
- [4] Bishop, Jessica Pierson, et al. "Using order to reason about negative numbers: the case of Violet." *Educational Studies in Mathematics* 86.1 (2014): 39-59.
- [5] Beswick, Kim. "Positive Experiences with Negative Numbers: Building on Students in and out of School Experiences." *Australian Mathematics Teacher* 67.2 (2011): 31-40
- [6] L. Linchevski, W. Julian, Using intuition from everyday life in filling the gap in children's extension of their number concept to include the negative numbers, *Educ. Stud. Math*, vol. 39 no. 1-3, 1999, pp. 131-147
- [7] K. Beswick, Positive experiences with negative numbers: building on students in and out of school experiences, *Australian Mathematics Teacher*, vol. 67 no. 2, 2011, pp. 31-40.
- [8] L. Bofferding, S. Farmer, Most and least: Differences in integer comparisons based on temperature comparison language, *Int. J. Sci. Math. Educ.*, vol. 17 no.3, 2019, pp.545-563.
- [9] I. Whitacre, J.P. Bishop, L.L. Lamb, R.A. Philipp, B.P. Schappelle, M. Lewis, Integers: History, textbook approaches, and children's productive mathematical intuitions, in: *Proceedings of the 33rd annual conference of the North American Chapter of the International Group for the Psychology of Mathematics Education*, 2011, pp. 913-920.
- [10] Gravemeijer, K., 2007. Emergent modelling as a precursor to mathematical modelling. In *Modelling and applications in mathematics education* (pp. 137-144). Springer, Boston, MA
- [11] Gravemeijer, K.P., Lehrer, R., van Oers, H.J. and Verschaffel, L. eds., 2013. *Symbolizing, modeling and tool use in mathematics education* (Vol. 30). Springer Science & Business Media.
- [12] Bos, R., Doorman, M. and Piroi, M., 2020. Emergent models in a reinvention activity for learning the slope of a curve. *The Journal of Mathematical Behavior*, 59, p.100773.
- [13] H. Cetin, Explaining the concept and operations of integer in primary school mathematics teaching: Opposite model sample, *Univers. J. Educ. Res.*, vol. 7 no. 2, 2019, pp.365-370.
- [14] Bishop, P. Jessica, Using order to reason about negative numbers: the case of Violet, *Educ. Stud. Math*, vol. 86 no. 1, 2014, pp. 39-59.
- [15] K.P. Gravemeijer, R. Lehrer, H.J. van Oers, L. Verschaffel, eds., *Symbolizing, modeling and tool use in mathematics education* 30, Springer Science & Business Media, Gewerbestrasse, 2013.
- [16] R. Bos, M. Doorman, M. Piroi, Emergent models in a reinvention activity for learning the slope of a curve, *The Journal of Mathematical Behavior*, vol. 59, 2020, p.100773.
- [17] W.D. Pratiwi, E. Susanti, J. Araiku, March. supporting mathematics learning in situational-referential phase with emergent modeling, in: *Journal of Physics: Conference Series*, vol. 1480 no. 1, IOP Publishing, Bristol, 2020, p. 012002.
- [18] M. Zandieh, C. Rasmussen, Defining as a mathematical activity: A framework for characterizing progress from informal to more formal ways of reasoning, *The Journal of Mathematical Behavior*, vol. 29 no. 2, 2010, pp. 57-75.
- [19] W.D. Pratiwi, S.M. Amin, A. Lukito, F.V. Galen, Supporting students's first conception about addition of integers through number line activities for third grade primary school, in: *Proceeding of SEA DR Sriwijaya University*, 2013.
- [20] Gravemeijer, K.P., Lehrer, R., van Oers, H.J. and Verschaffel, L. eds., 2013. *Symbolizing, modeling and tool use in mathematics education* (Vol. 30). Springer Science & Business Media.
- [21] Bos, R., Doorman, M. and Piroi, M., 2020. Emergent models in a reinvention activity for learning the slope of a curve. *The Journal of Mathematical Behavior*, 59, p.100773.