Generalization Pattern’s Strategy of Junior High School students based on Gender

A M Firdaus1*, D Juniati2, P Wijayanti2
1 Universitas Muhammadiyah Makassar, Jalan Sultan Alauddin 259, Makassar 90222, Indonesia
1Doctoral Program Student of Mathematics Education, Indonesia
2 Universitas Negeri Surabaya

e-mail: *andi.mulawakkan@unismuh.ac.id

Abstract. This study aims to describe the Generalisation Patterns Strategy of junior high school students based on gender. The subject of this study is two junior high school students in Makassar City, one male, and one female. Data collection techniques are written tests and interviews which used to obtain data about the strategy of the generalization patterns of students. The validity used time triangulation. The analysis data consists of three stages: reducing data, presenting data, and daring conclusions. The results of this study show that the male subject used the strategy of Counting, Whole-object-No Adjustment, and Difference-Rate Adjustment. Meanwhile, the female subject used the strategy of Counting and Explicit in the generalization of patterns on numbers and pictures.

1. Introduction
Mathematics is one of the subjects taught in the school and have an important role in developing the thinking ability of the students. Besides, mathematics is also mean to think deductive in finding and developing science and technology with Firdaus [1]. A generalization is an important aspect of the learning process. It can take anywhere since as a baby who begins to explore and get acquainted with the world where they live Mason [2]. For example, they show that they naturally tend to induce patterns from objects they encounter in everyday life. They know that the candy was sweet after they taste it first. This process of learning is generalization through the experience. The generalization also occurs in the context of other learning, for example in learning addition. When the children noticed that 1 + 2 and 2 + 1 have the same number, and so are 3 + 4 and 4 + 3 and also 4 + 5 and 5 + 4, they might be able to convey the idea that the order in which two numbers are added is not important. They are said to have the mathematics generalization since they are able to articulate what they had seen only in a few examples for all cases.

On generalization patterns topic, students make inferences depend on the understanding of the concept that students’ have and how they used them to generalize. The process of generalization used in enriching the cognitive structures in students’ minds, since there is an activity to connect something. Inline, Barbosa & Vale [3], states that the Generalization plays a crucial role in the activity of any mathematician, being considered an inherent ability to mathematical thinking in general (p.58). Warren & Cooper [4], also asserts that the power of mathematics lies in relations and transformation which give rise to patterns and generalizations. Abstracting patterns are the basis of structural knowledge, the goal
of mathematics learning in the research literature (p. 305). It means that the power of mathematics lies in relations and transformations in the form of a pattern and generalization.

The generalization pattern is often considered as a difficult topic for students to learn. Generalizing patterns is an important aspect at all levels in mathematics and exists in every material that is often highlighted in teaching Dindyal [5]. The exploration of patterns, especially in students who are in junior high school is a pattern developing. The Pattern developing closely associated with the rows of mathematical objects in the form of numbers and pictures. Mulligan & Mitchelmore [6], said that the pattern in mathematics is represented as a regularity in the form of numerical relationships, spatial, or logical. In line with that, Tikekar [7], in his research shows that when students are given a pattern of numbers, then each student has a different way of generalizing patterns. Different with research conducted by Firdaus, Juniati, & Pradnyo [8], on the image pattern for junior high school students, where male students and female in resolving the problem of generalization patterns is still the stage of action, in which both of the students are still determining n-terms from previous knowledge.

Students still experience difficulties when determining the pattern in greater terms Barbosa, Vale, & Palhares [10]. For students, the formation of patterns from greater terms seem more complicated in comparison with determining the result of the nearest terms of the patterns that already exist. It means that students are able to search for nearest terms of the pattern with the use of the strategy of counting (make a model in describing the situation and calculate a desired object) or recursive (describe the sequence using a same-different), rather than look for a general rule or generalization of a pattern of a greater term. Lannin [11] revealed the students found difficulties in determining the number of stickers that must be installed from a series of cubes that are given stickers on every surface. Students just saw a geometry object in front of him without considering the context of the problem when doing the calculation in determining the next pattern. It seems that the students did not pay attention to the context of the problem.

In a problem of generalization of pattern, the student will be asked to define certain terms on a pattern to write down the rules to determine any terms. Stacey [12], show that students generalized patterns using strategies of counting, whole object, and linear methods. Rivera [13], adds another strategy used by the students, they identified the patterns and then simplify or transform into a similar pattern with the same characteristics then make generalizations of the pattern. Lannin, Barker & Townsend [14], conducted research on students in secondary schools on a task about the generalization of patterns. They groups strategies students’ used into six strategies: the Counting Recursion, Whole-Object, Contextual, Guess and Check, and Rate-adjust. In his research, there are students who use more than one strategy in solving problems. Furthermore, the research by Lannin [11] and Lannin, Barker & Townsend [15] then developed Barbosa, Vale, & Palhares [10], classified the six strategies and expand the strategy of the whole-object into three parts and the difference-rate into two parts.

According to Lannin, Barker & Townsend [14], the use of strategies in the generalization of patterns students’ used influenced by the students’ ability to visualize the problems presented. Investigation of the process of generalization patterns performed by the students, especially the strategy used in solving the generalization problems is important to know which strategy will bring the students to the correct result, and which strategy will bring the students to answers that are less precise. In this study, the generalization of patterns of the students refers to the strategy used to make general conclusions from statements The purpose of this study is to describe the strategy of the generalization Patterns of junior high school students in Makassar city based on gender.
2. Method
This is qualitative research using descriptive data. Qualitative is research that describes a phenomenon, event, facts, and events to produce a clear picture and detailed results of the activity the research subject Moleong [15]. The events described in this research is the strategy of the generalization patterns of junior high school students based on gender. Subjects in this study were two junior high school students in Makassar City. The selection of the subject assisted by the mathematics teacher in the junior high school to get accurate information about the mathematical ability of the two subjects. It is also to get information related to the communication skills of the subject in expressing their opinion or the ways in solving problems orally and in writing. Consideration of the researchers chose the male and female subjects with high ability in mathematics and in communication because the two subjects expected to complete the Task of Generalizing Mathematical Patterns efficiently and can communicate orally and in writing so the researcher can describe the strategies used in the generalize pattern by the two subjects.

The instrument in this research is the task of generalizing the pattern and interview guidelines. Data collection methods used were test, observations, and interviews Lestari and Juniati [16]. Data collection techniques were test of the generalization of the pattern and the interview guide used to obtain data on the strategy of generalizing patterns of student, guidelines for interview-based tasks as semi-structured interview as a guideline for the researcher to get the main objective of the research which is to know the strategy of the generalization patterns of junior high school students. Test validity used triangulation time. The task of generalization of the pattern is designed in the essay test and developed by the researchers and consulted to experts.

The analysis stage data includes reduction, data presentation, and conclusion. Data reduction performed with sharpens, classify and organize the data obtained from tests and interviews that related to the strategy of the generalization patterns of junior high school students based on gender. It means that at this stage, the process of selecting and simplifying the data during the research process performed by removing the data that is not needed and focus on the important information. Data presentation is organizing the data about the information that has been collected for drawing conclusions. At this stage, the researcher presents the data as a result of data reduction. The data is identified and presented descriptively with the chart. The data that has been presented facilitated researchers in understanding the data to draw a conclusion. The conclusion in this research aims to look at the strategy of the generalization patterns of junior high school students based on gender.

3. Result and Discussion
Generalizing pattern’s task is presented in the form of a picture, the subject of male (LK) involves the several stages in the process of generalizing a pattern and use different strategies depending on the type of the test that was given and the finding terms. While working on the test in the form of pictures, to determine attributes of the desired value which is relatively small, the first steps of the subject LK were drawing of the model based on the picture in the problem. The model is adjusted with the input term. Furthermore, the subject LK calculated the attributes that are desired directly from the model created. The strategy used is the strategy of “counting”. For the value which is large enough (input value = 65) the subject LK using the attribute that is the value of input = 10 as the multiplier factor. Subject LK described the 65 as 6 × 10 + 0.5 × 10. Next, the “10” in the expansion is replaced with the attribute value to the input value = 10 that has been searched before. The strategy used is the strategy of “Whole object-No adjustment”.

To determine the general rule, the subject LK realized that he must see and understand the problems presented. On the first test, the subject LK saw that if the base is incremented by one block then a lot of blocks required will be increased by 4 bocks. Meanwhile, in the second test, the subject LK saw that when the rung is incremented by 1, then juliennes needed is 3. Indirectly, the subject LK performed a sequence of numbers of the problems presented and looking for a different constant in the sequence. The subject LK then tried entering some numbers into the calculations and comparing the results of these calculations with the results if he enumerates directly the desired attribute on the model of the pictures previously created. Subject LK found that there is a difference constant between the calculation
results and the results of counting on the image. The subject LK thought that if the general rule or the n-
terms is a different constant time n minus or plus the difference obtained from the results of the
calculations and the results enumerate. The strategy used by the subject LK in determining the general
rule is the strategy of “Difference-Rate adjustment”.

Other information obtained from the results of the work the subject LK was that he tends to use the
strategy of different generalization patterns to determine the terms with the value of the different inputs.
From the results of the subject LK in solving the test which was in the form of images and numbers, it
shows that when asked to determine the attribute with the value of the input is small, the subject LK did
the modeling directly and enumerates the desired attributes of the model. This is in accordance with the
results from Lammin, Barker, & Townsend [14], about the factors that affect the use of the strategy of the
generalization of patterns. The study states that the value of a given input affects the strategy used by
the subject and the current value of the input is small enough, students tend to use the strategy of
counting.

In the task of generalizing the pattern in the form of a sequence of numbers, the subject LK
recognized patterns by finding the difference of two consecutive terms in the sequence. The subject LK
found that the difference is a different constant, but the subject LK extending the sequence to determine
certain terms, this strategy is the strategy of recursive.

In determining the general rules or n-term, the subject LK using a different constant which is
obtained as the multiplier factor. The subject LK realized that he might not extend the sequence until n
term because n itself is variable. Then, the subject LK thought that to determine the particular term, the
requested terms multiplied by the difference obtained. Subject LK checked the correctness of the answer
on the sequence of numbers obtained, and find that there is a difference constant between the results of
the multiplication with the terms in the sequence.

In the test of sequence, the subject LK used a similar strategy to determine certain terms but
different strategies to determine the n-terms. Of the four terms presented in the sequence, the subject
LK already recognized the pattern on the sequence. However, the subject LK has not been able to use
the pattern to find a general rule for any terms without extending the sequence of numbers.
In the same case with the subject LK, in solving the task of generalization patterns, the female subject
(PR) performed several stages in the process of generalizing a pattern and used different strategies
depending on the type of the task and the finding terms.

In working the test in the form in pictures and numbers, the initial steps of the subject PR in
determining the attributes for the input value = 10 was drawing model corresponding to the picture given.
The Model is adjusted with the input value requested. Furthermore, the subject PR did the calculations
systematically in accordance with the picture and the context of the problems presented from the
calculation. The subject PR saw the calculation pattern to find terms with different inputs.
In solving the first test, the subjects PR found that many of the blocks on the top is one less than a
number of blocks on the base part and the number of blocks in inclined sections is twice the number of
blocks on the base. In finding the number of blocks, it summed the numbers blocks earlier. On the second
test, the subject PR saw that many of the matchstick on the right and left is one more than the number
of rungs. In finding the number of matchsticks, she just summed up the numbers of matchsticks before.
From the systematical calculation, the subject PR found the other terms without having to do the
modeling directly, the subject PR was only able to enter the terms based on the calculations.
In finding the general rules, it is performed using the calculation to determine some of the previous
terms because it already checks the answers by entering a few numbers. The subject PR understood that
the pattern of these calculations can be used for any numbers. So at the first test, to determine the number
of blocks needed to create the skeleton of the bridge with the base n, the subject PR changed the number
of bocks on the basis of n (in the previous problems, the base is as a specific number). The subject PR
did the same steps on the second test. The calculation systematically carried out beforehand. The subject
PR changed rungs which were in the form n. This strategy performed by subject PR in determining
certain terms and the general rule is called the explicit strategy.
From the results of the work the subject PR in solving the first test in the form of numbers and pictures, the subject PR tends to look for patterns in finding determining the attribute with the small input value. However, the pattern of the new attribute used when the subject PR determines the attribute with the larger value of the input and the general rule. According to Lannin, Barker, & Townsend [14], the students with a strong visual ability will be able to visualize the problems presented to determine the pattern.

In the task of generalizing the pattern in the form of a sequence of numbers, the subject PR recognized patterns with finding the difference of two consecutive terms in the sequence. The subject PR found that the difference is constant. With the difference, the subject PR extends the sequences until the 15th term and finding 15th term by directly looking at the sequence. After extending the sequence until the 15th term, the subject PR found that the constant difference used as a multiplying factor. Thus, in finding a particular term, the subject PR multiplied the difference with the requested term. The subject PR tried some of the numbers to be multiplied with a difference. The subject PR then compared the result of the multiplication with the terms on the sequence. She realized that there existed a constant difference between the results of calculation with the terms on the sequence. Therefore, the subject PR dawn a conclusion to determine the particular term by multiplied the requested term by difference and add or subtract the difference obtained from the results of multiplication. The subject PR used the pattern to determine the other terms and the n-term. In determining the n-term, the subject PR just replaced the numbers that should be entered into the calculation with n. Strategy this strategy is the difference-Rate adjustment.

4. Conclusion
From the results of this research, two students from junior high school based on gender, the strategy of generalization patterns that are used by subject LK on the determination of the certain attributes for a small term only through the directly modeling stage and finding the terms. The subject LK did not perform the pattern identification strategy. When the value of a given input is large, the subject LK no longer does the modeling directly. Stages performed were the stages of pattern identification and the determination of the particular terms. The strategy used involves the use of a certain term as one unit, giving the multiplier factor is not done with the final adjustments. This strategy is the strategy of the whole object-no adjustment. To determine the attribute with the value of the input = n, the subject LK performed the stages of the identification pattern, the test pattern and the determination of general rules. The strategy used involves the use of patterns as a multiplication factor and proceed with the final adjustments. Strategy this strategy is the difference-rate adjustment.

The strategy of the generalization of a pattern that involves patterns in numbers and pictures that made the Subject PR in determining the small-term begins with the modeling. The subject PR did not do the pattern identification strategy. She used a strategy of counting. In finding the big terms, the Subject PR was not to the modeling directly. The stage performed is the stage of the identification pattern, the test pattern and the determination of the particular terms. The strategy used involves the discovery of a calculation rule based on the context of the problems presented which allows determining the desired terms with the random value, this Strategy is the explicit strategy. To determine the term with the value = n, the subject PR performed the stages of the identification pattern, the test pattern and the determination of general rules. The strategy used involves the discovery of a calculation rule based on the context of the problems presented and allows us to determine the desired terms. This strategy is an explicit strategy.

Acknowledgments
This work was supported by Lembaga Pengelola Dana Pendidikan (LPDP) Indonesian under grant no. 20161141080709.
References

[1] Firdaus A M 2019 Application Of Cooperative Learning Model Type Thinks Pair Share (TPS) On Mathematical Communication Ability *Daya Matematis: Jurnal Inovasi Pendidikan Matematika* 7 (1) 59-68.

[2] Mason J 2008 Making use of children’s powers to produce algebraic thinking In Kaput J J, Carraher D W, and Blanton M L (Eds.) *Algebra in the early grades* (pp. 57 - 94) (New York: Lawrence Erlbaum Associates)

[3] Barbosa A and Vale I 2015 Visualization in pattern generalization: Potential and Challenges *Journal of the European Teacher Education Network* 10 57-70

[4] Warren E and Cooper T J 2008 Patterns That Support Early Algebraic Thinking in The Elementary School In Greenes, Carole E, and Rubenstein M L (Eds.) *Algebra and Algebraic Thinking in School Mathematics* (Reston VA: National Council of Teachers of Mathematics)

[5] Dindyal J 2007 High School Students’ Use of Patterns and Generalizations Proceedings of the Fifth Congress of the European Society for Research in Mathematics Education 844-851

[6] Mulligan J and Mitchelmore M 2009 Awareness of Pattern and Structure in Early Mathematical Development *Mathematics Education Research Journal* 21 (2) 33-49

[7] Lannin J 2003 Developing Algebraic Reasoning Through Generalization (The National Council of Teachers of mathematics, Inc. www.nctm.org)

[8] Barbosa A, Vale I, and Palhares P 2012 Pattern tasks: thinking processes used by 6th-grade students *Revista Latinoamericana de investigación en matemática educativa* 15 (3) 273-293

[9] Moleong L J 2012 *Metode Penelitian Kualitatif* (Edisi Revisi) (Bandung: PT. Remaja Rosdakarya)

[10] Lestari N D S and Juniati D 2018 Exploring the Knowledge of Content and Teaching (KCT) of a prospective math teacher in planning mathematical literacy teaching *J. Phys. Conf. Series* 1097 (1) 012150