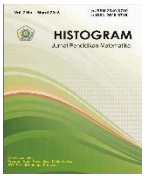

Available online at http://journal.stkip-andi-matappa.ac.id/index.php/histogram/index
Histogram : Jurnal Pendidikan Matematika 7(2), 2023, 85-95

INVESTIGATION OF STUDENT QUANTITATIVE REASONING IN GENERALIZING (CASE STUDY ON FEMALE JUNIOR HIGH SCHOOL STUDENTS)

Nasrun[1], Muhammad Muzaini[2*], Rahmat Kamaruddin[3]
[1,2]Universitas Muhammadiyah Makassar, Makassar, Indonesia
[3]STKIP Andi Matappa, Pangkep, Indonesia
* Corresponding Author. Email: muhammadmuzaini@unismuh.ac.id
Received: 5 Juli 2023; Revised: 5 Agustus 2023; Accepted: 30 September 2023

ABSTRAK

Penalaran kuantitatif memiliki peran penting dalam bidang pendidikan matematika. Tujuan utama yang dimiliki oleh banyak pendidik matematika di seluruh dunia adalah untuk memfasilitasi hubungan antara kemampuan mental siswa dan kapasitas mereka untuk mengatasi masalah kehidupan nyata melalui sarana matematika. Aspek mendasar dari upaya ini melibatkan pembinaan pemahaman siswa tentang kuantitas, khususnya yang berkaitan dengan karakteristik benda. Tujuan utamanya adalah untuk memberdayakan siswa untuk memanfaatkan kemampuan penalaran kuantitatif mereka. Dalam konteks penelitian ini, penalaran kuantitatif menunjukkan proses kognitif yang digunakan oleh individu ketika mereka mengidentifikasi, menghubungkan, dan merumuskan kuantitas baru. Aljabar, sebagai suatu disiplin ilmu, kini dikenal luas sebagai salah satu disiplin ilmu yang menyelidiki struktur, hubungan, dan kuantitas dalam matematika. Untuk meningkatkan pemahaman siswa tentang aljabar dan kemampuan mereka untuk menggeneralisasi, pendekatan pembelajaran khusus digunakan. Penelitian ini menargetkan siswa perempuan yang terdaftar di sebuah Sekolah Menengah Pertama di Makassar dan berupaya untuk meneliti kemampuan penalaran kuantitatif mereka dalam konteks generalisasi sambil mempertimbangkan potensi kesenjangan gender. Untuk mencapai tujuan ini, metodologi kualitatif diadopsi, memberikan wawasan tentang kemampuan penalaran kuantitatif siswa sebagaimana tercermin dalam tindakan mereka ketika menyelesaikan tugas yang diberikan. Pada akhirnya, temuan penelitian ini akan memberikan gambaran komprehensif tentang bagaimana siswa terlibat dalam penalaran kuantitatif selama proses generalisasi, yang mencakup tahapan seperti menghubungkan besaran, mengidentifikasi besaran, dan merumuskan besaran baru.

***Kata Kunci**: Penalaran Kuantitatif, generalisasi, dan gender*

ABSTRACT

Quantitative reasoning holds a significant place in the realm of mathematical education. A primary objective shared by many mathematics educators worldwide is to facilitate the connection between students' mental faculties and their capacity to address real-life problems through mathematical means. A fundamental aspect of this endeavor involves nurturing students' comprehension of quantity, particularly in relation to the characteristics of objects. The central aim is to empower students to harness their quantitative reasoning capabilities. In the context of this study, quantitative reasoning denotes the cognitive process employed by individuals when they identify, interconnect, and formulate novel quantities. Algebra, as a discipline, is now widely recognized as one that investigates the structures, relationships, and quantities within mathematics. To enhance students' grasp of algebra and their ability to generalize, a specific instructional approach is employed. The study targets female students enrolled in a Junior High School in Makassar and seeks to scrutinize their quantitative reasoning proficiency in the context of generalization while considering potential gender disparities. To attain this objective, a qualitative methodology is adopted, providing insights into students' quantitative reasoning abilities as reflected in their actions when completing assigned tasks. Ultimately, the study's findings will provide a comprehensive portrayal of how students engage in quantitative reasoning during the process of generalization, which encompasses stages such as connecting quantities, identifying quantities, and formulating new quantities

Keywords: Quantitative Reasoning, generalization, and gender.
How to Cite: Nasrun, Muzaini, M., & Kamaruddin, R. (2023). INVESTIGATION OF STUDENT QUANTITATIVE REASONING IN GENERALIZING (CASE STUDY ON FEMALE JUNIOR HIGH SCHOOL STUDENTS). *Histogram : Jurnal Pendidikan Matematika, 7*(2), 85-95.

I. PENDAHULUAN

Reasoning is an important process in mathematics teaching. National Council of Teachers of Mathematics or NCTM (2000), states that reasoning is a part of learning mathematics and the ability in reasoning is essential to understand the mathematics. This is in line with the opinion of Raid (2002) which states that "Developing mathematical reasoning is central to mathematics education, it is one of the five process standards in the principles and standards for school Mathematics". If the reasoning ability is not developed, then for the mathematics students will only be the material in the series of procedures and the students simply imitate the examples without knowing the meaning. Ball and Bass (2003) reveal that understanding of mathematics is meaningless without any special attention to the reasoning. So it can be said that "something" that can be used to understand math is reasoning.

In daily life we often encounter problems related to the quantity. Quantity is defined as the quality of something formed from a measurement process. Developing relationships between the minds and real-life problems of students that can be solved mathematically is the main goal of many teachers of mathematics in the worldwide (Karim, 2007). This happens in schools when teaching mathematics, when students are directed to do the calculations, they are required to think hard then get the results, so many people think mathematics is difficult. This is because there is no attention that is given to the development of student's concept of quantity through the calculation based on the nature of the object, but there should be more ways to look into the nature of the object to be counted. Therefore, this goal can be achieved by improving students' attitudes toward the mathematics. Karim (2007) states that the improvement of students' attitudes toward the mathematics will occur if students can use quantitative reasoning.

Today, algebra is known as one of the materials that study about structure, relationship, and quantity. The learning program up to eleventh grade should enable all students to: understand patterns, relationships and functions that represent and analyze mathematical situation and structure using algebraic symbols, using mathematical models to represent and understand quantitative relationship, analyze the changes in various contexts (NCTM, 2000).

Patton and Santos (2016) in their research state that some students can not represent the numerical form to the algebraic form contained in it the use of letters that commonly called as a variable representing a number. The use of symbols that cannot be interpreted properly by students

on the algebra material become the difficulty that faced by the students. One of the factors influencing the students' inability to overcome the problem is due to the emphasis that is only focus on strategies to manipulate symbols, simplify expression, and solve equations so it produces bad output in overcoming difficulties experienced by students at the time to understand algebra.

Patton and Santos (2016) in their research state that some students can not represent the numerical form to the algebraic form contained in it the use of letters that commonly called as a variable representing a number. The use of symbols that cannot be interpreted properly by students on the algebra material become the difficulty that faced by the students. One of the factors influencing the students' inability to overcome the problem is due to the emphasis that is only focus on strategies to manipulate symbols, simplify expression, and solve equations so it produces bad output in overcoming difficulties experienced by students at the time to understand algebra.

The activity in learning algebra should be better not only in manipulating the symbols but also focusing on reasoning with quantity patterns, and in real world situations. It can be reflected in the development of a curriculum that supports such activities on algebra subjects (Ellis, 2007).

One alternative approach that can be used to introduce the idea of algebra is through quantitative explorations and relationships (Kaput, 1995). This quantitative reasoning is important in introducing the students to the algebraic material in learning process, by means of quantitative explorations and relationships when compared to just focusing on strategies for manipulating symbols, simplifying expressions, and solving equations. Furthermore, the most important thing is on the generalization aspect. The generalization aspect involves the investigation to the various quantities and explanation of relationships that occur between cases in certain situations. In mathematical generalization activities, students think to change the quantity based on an activity performed (Carraher, 2008). This means that someone will try to find rules that change certain numbers and see whether the rules be valid when used in a wider context. Strengthening students' ability to make strong generalizations is supported by the National Research Council which notes that in addition to manipulate symbols, algebra should also include representational activities, generalizations and justifying activities (Kilpatrick, 2001).

This research will analyze the students' quantitative reasoning in generalizing in terms of gender differences. Quantitative reasoning in this research is the mental activity undertaken by a person in identifying quantities, connecting quantities, and building new quantities. To see the students' quantitative reasoning in generalizing ability can be observed through the table 1.1 below:

TABLE 1.1 QUANTITATIVE REASONING IN GENERALIZING

Generalization Types	The Activity of Quantitative Reasoning in Generalizing
Relating	**How students:** Find a similar problem with a given problem previously. Relate of mathematical problems that are given.
Searching	**How students:** Detect a fixed relationship between two or more objects. Search the strategies and procedures to detect the relationship between two or more objects. Test whether the detected pattern is the same for the given problem (looking for the same pattern). Test whether the solutions obtained are the same.
Extending	**How students:** Repeat the existing pattern to obtain a common equation. Find a new situation based on the situation that are given.

II. METODE PENELITIAN

Subjects in this research are students of Junior High School in Makassar City, Indonesia who have the ability to communicate well and female gender. This research is case study research with qualitative approach analysis which aims to describe deeply about the quantitative reasoning of junior high school students in generalizing. To achieve that goal, subjects are given a mathematical task to be completed. This research was conducted at SMPN in Makassar City, Indonesia, involving 120 students who are in grade IX. After solving the problem, 120 students were given a questionnaire regarding their quantitative reasoning abilities in generalizing. From the questionnaire results, the researcher is selected students with female gender, ability in mathematics equivalent and good communication skills both to be the subject of research and interviewed to get the data. To get the valid data, then the researcher does the data validation. One of the validation procedures in qualitative research that can be done is triangulation. Validation of data in this way is done by checking repeatedly in different times. This is called time triangulation. Data from the interview results are analyzed and then described in written words. During the interview, the researcher encourages students to explain their thoughts in order to get a picture of their quantitative reasoning process in generalizing.

The researcher is the main research instrument in this research. This research also uses supporting instruments to obtain the subject, namely: (a) pre-test which is taken from the UN (National Exam), (b) to obtain the data, this research used a guideline of structured interview which consists of questions to explore aspects of quantitative reasoning subject; (c) the task as a mathematical problem is presented as below:

A traditional cake shop Makassar wants to produce delicious Barongko. To produce 12 packs of Barongko cake need the following ingredients:

No	Ingrediants	Amount
1.	Kepok Banana	10 seeds
2.	Eggs	6 grains
3.	Sugar	300 gram
4.	Coconut Milk	ml (1 coconut)

Determine the number of Kepok banana, eggs, sugar and coconut milk, if it will be make n-packs of Barongko?

III. RESULTS AND DISCUSSION

A. Result

In this section, we will discuss the results obtained from female subjects related to the students' quantitative reasoning in generalizing and will be described as follows:

The first stage is relating: the ability to find a similar problem with a given problem previously. Here the subject is seen trying to rediscover information related to a similar problem, here the subject is able to write down a similar problem but not completely what the subject has obtained. For more details, this can be described based on the interview results conducted by researcher to the subjects of women below:

Researcher : have you ever got a problem like this??? in daily life or ever studied....
Subject : I have ever.
Researcher : could you mention the examples Nurul ...come on Nurul
(long enough time to mention)
try to write here Nurul,, the examples of problems that you ever got...

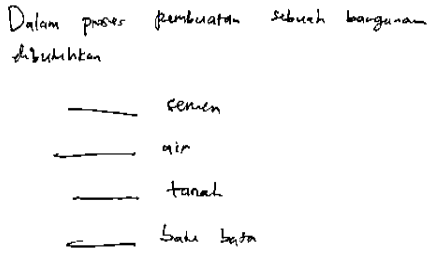

Fig 1. Examples of problems that have been obtained by the subject

From the interview above, it can be stated that at the stage of relating a similar problem to the previous problem, the subject was able to remember and write down the problem according to the problem given. The problem is related to daily life in the process of making a building. Furthermore, the ability of subject to make the relationship of the mathematical problem/situation that is given. At the stage of mentioning the numbers or materials contained in the given situation, the subject was able to recount all the information contained in the assigned task by using her own words in sequence and the subject could name the main points of the given task. When the student

is oriented with the problem given, the subject is able to write down the problem in algebraic form. This can be seen from the results of answers made by the subject.

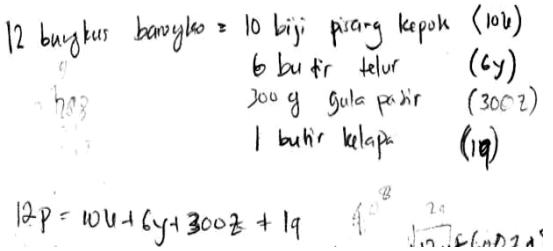

Fig 2: The subject writes problems in algebraic form

Still in the stage of Relating, the subject is able to identify the relationship between the values contained in the given situation, the subject is able to explain the relationship between those values by saying that if we change the amount of cake to be made it means the ingredients, we need to make the cake Barongko will also change. For more details, this can be illustrated by interviews from female subject with the following research:

Researcher : how many would it be, if 6 packs of Barongko will be made?

Subject : hmmm.... the 5 seeds of banana, 3 eggs, 100 gram of sugar, and 125 ml of coconut milk

From the interview above, according to the subject, there is a relation between the ingredients used in making Barongko cake with the number of cakes that produced. This can also be seen from the answers made by the subject below:

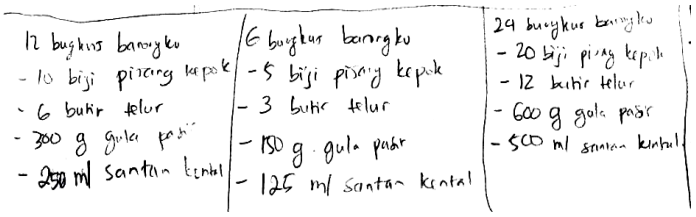

Fig 3: Subject answers find a relationship between quantities

The second stage is searching: the first detects a fixed relationship between two or more objects. At this stage, the subject is able to identify a fixed relationship. Furthermore, by reasoning the relationship between the quantities that exist in the problem given the subject is able to guess and imagine without performing numerical operations. This can be seen from the interview with the subject:

Researcher : if I want to make 48 packs of Barongko, how many ingrediants will be needed??

Subject : four…the ingrediants for 48 packs of Barongko are 40 seeds Kepok banana, 24 eggs, 1200 gram of sugar, and 100 ml of coconut milk.

Researcher : why can you guess...owww... 40 seeds of kapok banana, naaa 24 eggs…
Subject : I multiply...
Researcher : how many you multiply.
Subject : four
Researcher : so...if there are 24 packs of Barongko, how many you multiply for the ingrediants?
Subject : two

Furthermore, in the stage of searching for strategies and procedures to detect the relationship between two or more objects, here the subject has its own strategy to see the relationship between some objects. The subjects halve the number of cakes and halve all the necessary ingredients, the reason is to obtain the smallest part of the cake and the calculation is rounded. To know what strategy used can be seen from the result of interview and settlement done by subject:

Reseracher : What strategies do you use to do this task?
Subject : Here... there are ingrediants for 12 packs of Barongko, (pointing to the task), so I have to look for the smallest number.
Reseracher : What is the smallest?
Subject : I try to halve 12.
Reseracher : what did you halve?
Subject : So for 6 packs of Barongko must have changed the ingredients as well.

The conclusion in this stage, the strategy used by the subject is to change quantites contained in the task given. By the change of the quantities, the subjects realized that it would be easier to find solutions numerically.

The third is to test whether the detected pattern remains the same for the problem given (look for the same pattern). Here the subject sees the existence of a pattern formed by this mathematical task given that can be seen from the result of the subject's answer in Figure 2 and can also be seen from the transcript of interviews conducted by researcher and subject as follows:

Researcher : Is there any pattern that you obtained when you solve the problems?
Subject : like this (pointing her work for 6 packs of Barongko).. 5 packs, if 12, it is 10 packs, 24 20 packs.
Researcher : it’s from the ingrediants, is there also a pattern from the number of cake???
Subject : yes, there is...
Researcher : could you mention it...
Subject : here.. 6 packs
Researcher : yes...
Subject : then.. 12 times 2, and 24 times 2...
Researcher : was the pattern still same??? (waiting). 6,12,24…. it was from 6 yeaaa.,then for 12,,,,,what did you do???
Subject : it times two
Researcher : yes, times 2, if the Barongko times 2, then the ingrediants are changed too???
Subject : yes

Researcher : why change?
Subject : because from 6 to 12...it is a lot....
Researcher : then what did you do with the ingrediants?
Subject : I times 2

From the results of interview, it can be concluded that the subject finds a pattern of the results obtained. To identify the patterns that occur always remain the subject using her reasoning by connecting the quantity.

Then the fourth stage is to test whether the solution or the results obtained is still the same. At this stage female subject doing test by trial first. The illustration is as follows: the subject multiplies with two Barongko cake then the ingredients used to make the Barongko cake are multiplied by two as well. After that from the patterns created by the subject, the subject finds a formula, to test whether the solution obtained is correct then test through the formula that has been formed, and the subject says the result remains the same. So, the strategy that done is right, this also happens to the male subject that is testing the truth by using the formula that has been obtained.

The third stage is extending: how the subject repeats the existing pattern to obtain a general equation. At this stage, students are able to write the general form that the subject calls the formula of the result or pattern obtained. This can be seen from the work of the subject as follows:

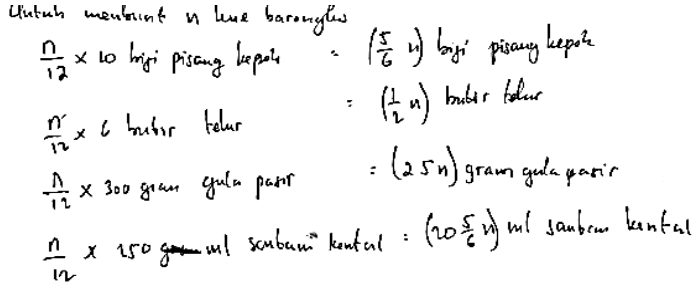

Fig 4: Subject answers find a general form

From the general form obtained by the subject to check whether the answer that subject did is correct, then the subjects test it again.

IV. Conclusion

in the success of students in generalizing. When students work with quantitative reasoning it significantly affects the students' ability in generalizing. This is seen from the results obtained from the analysis of subject above. And not only that when students are able to identify the relationship quantitatively to obtain results numerically will be easier. So, it is expected that teachers should also be aware that quantitative reasoning is very important for students especially in teaching

algebra material. If students are encouraged to develop their knowledge of quantity, then they will be prepared to produce a true and strong generalization, ini didukung oleh hasil penelitian (Ellis, 2007; Muzaini, 2019; Lobato, 2002; Thompson, 2011).

REFERENCES

Ball, D. L., & Bass, H. (2003). Making mathematics reasonable in school. A research companion to principles and standards for school mathematics, 27-44.

Carraher, D. W., Martinez, M. V., & Schliemann, A. D. (2008). Early algebra and mathematical generalization. ZDM, 40, 3-22.

Ellis, A. B. (2007). Connections between generalizing and justifying: Students' reasoning with linear relationships. Journal for Research in Mathematics education, 38(3), 194-229.

Ellis, A. B. (2007). The influence of reasoning with emergent quantities on students' generalizations. Cognition and Instruction, 25(4), 439-478.

Kaput, J. J. (1995). Long-term algebra reform: Democratizing access to big ideas.

Karim, N. (2007). Quantitative Reasoning Applications and Modelling in The Real World at Zayed University. In Proceedings of the Ninth International Conference-The Mathematics Education into the 21st Century Project (pp. 348-352).

Kilpatrick, J., Swafford, J., & Findell, B. (2002). Adding it up: Helping children learn mathematics. The National Academies Press. The book is available free on the Web. Accessed, 2(4), 04.

Lobato, J., & Siebert, D. (2002). Quantitative reasoning in a reconceived view of transfer. The Journal of Mathematical Behavior, 21(1), 87-116.

Muzaini, M., Juniati, D., & Siswono, T. Y. E. (2019, February). Exploration of student's quantitative reasoning in solving mathematical problem: case study of field-dependent cognitive style. In Journal of Physics: Conference Series (Vol. 1157, No. 3, p. 032093). IOP Publishing.

Muzaini, M., Juniati, D., & Siswono, T. Y. E. (2019, March). Profiles quantitative reasoning and students' generalization ability on topic of direct proportion. In Journal of Physics: Conference Series (Vol. 1188, No. 1, p. 012034). IOP Publishing.

National Council of Teachers of Mathematics [NCTM]. (2000). Principles and Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics

Patton, B., & De Los Santos, E. (2012). Analyzing algebraic thinking using "guess my number" problems. International journal of instruction, 5(1).

Reid, D. A. (2002). Conjectures and refutations in grade 5 mathematics. Journal for research in mathematics education, 33(1), 5-29.

Thompson, P. W. (2011). Advances in research on quantitative reasoning. Mayes, R., Bonillia, 143-148.