Journal for the Education of Gifted Young Scientists, 8(4), 1457-1469, Dec 2020
e-ISSN: 2149- 360X
jegys.org

Young Wise Publishing
youngwisepub.com
© 2020

Research Article

Improving elementary students' mathematical reasoning abilities through sociohumanistic-based learning

Rosidah Aliim Hidayat[1], Wahyudin[2], Jailani[3], Bayu Rahmat Setiadi[4]*

Department of Science Education, Postgraduate Programs, Yogyakarta State University, Indonesia

Article Info

Received: 6 June 2020
Revised: 13 November 2020
Accepted: 1 December
Available online: 15 Dec 2020

Keywords:
Elementary school students
Mathematic education
Mathematical reasoning ability
Sociohumanistic-based learning

Abstract

This study aimed to determine the improvement of students' mathematical reasoning abilities through sociohumanistic-based learning. This research was a quasi-experimental study with a non-equivalent control group design. The population in this study were all class IV in one elementary school in Salatiga. The sample consisted of two classes, namely classes and selected by purposive sampling. The instrument used was a mathematical reasoning ability test. Data analysis used t-test (Independent Sample t-Test) and Mann Whitney. The analysis results show that: (1) based on the results on a limited, medium, and wide-scale try-out, the developed model is easy-practical-effective in its implementation; (2) the improvement in mathematical reasoning skill of the students taught using the model is higher than that of taught using direct instructions; and (3) Sociohumanistic-based learning has several advantages especially can generate endorphins (hormone of happiness) to make the students love math, can foster self-reliance of learners, able to activate the storage capabilities of the human brain into long-term memory. Based on the results of this research and development, it can be concluded that the developed model is easy, practical, and effective to improve the mathematical reasoning skill of elementary school students.

To cite this article:

Hidayat, A.H, Wahyudin, Jailani, & Setiadi, B.R. (2020). Improving elementary students' mathematical reasoning abilities through sociohumanistic-based learning. *Journal for the Education of Gifted Young Scientists*, *8*(4), 1457-1469. DOI: http://dx.doi.org/10.17478/jegys.750033

Introduction

Mathematical reasoning is the foundation of constructing mathematics (Ball, Lewis, & Thames, 2008). In the same line, Adegoke (2013) states that mathematics is an excellent vehicle for developing and improving a person's intellectual competence in logical reasoning, spatial visualization, analysis, and abstract thought. Students develop numeracy, reasoning, thinking skills, and problem-solving skills through mathematics learning and application. Brodie (2010) said that reasoning is a "basic skill" of mathematics and is necessary for some purpose-to understand mathematical concepts, to use mathematical ideas and procedures flexibly, and to reconstruct understood but forgotten mathematical knowledge.

The Government of Indonesia, through the Ministry of Education and Culture, responds through the 2013 Curriculum, which emphasizes the modern pedagogical dimension in learning, which uses a scientific approach that includes observing, asking, trying, reasoning, presenting, and creating. Thus, students do not merely memorize the information obtained without connecting with other things in their cognitive structure (Ifenhatler et al. 2020).

Indonesia's student's mathematical reasoning ability is still low (Sukirman, Darhim, & Herman, 2018). It is based on learning outcomes research at the international level organized by Trends in International Mathematics, and Science

[1] Lecturer, Department of Sciences Education, Postgraduate Program, Yogyakarta State University, Indonesia. E-mail: rosidahaliim@yahoo.co.id, Orcid No: 0000-0001-8655-2030
[2] Professor, Department of Mathematics Education, Faculty of Mathematics and Natural Sciences, Indonesia University of Education. E-mail: wahyudin.mat@upi.edu, Orcid No: 0000-0003-1167-5655
[3] Assoc. Prof., Department of Mathematics Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Indonesia. E-mail: jailani@uny.ac.id, Orcid No: 0000-0001-5552-255X
[4] *Corresponding Author: Lecturer, Department of Vocational and Technology Education, Postgraduate Program, Yogyakarta State University, Indonesia. E-mail: bayursetiadi@uny.ac.id, Orcid No: 0000-0002-4564-389X

Study (TIMSS) conducted every four years in grades four and eight. The percentage of Indonesia's students results in TIMSS 2011 for each cognitive domain compared with other countries can be seen in Table 1. The average ability of Indonesia's students in each domain is still below the international average. The lowest average at cognitive reasoning is 17%. The TIMSS results show that the reasoning abilities of Indonesia's students are still low.

Table 1.
Average Correct Problem in TIMSS 2011 (%)

Country	Knowing	Applying	Reasoning
Singapore	82 (0.8)	73 (1.0)	62 (1.1)
Korea Ref.	80 (0.5)	73 (0.6)	65 (0.6)
Japan	70 (0.6)	64 (0.6)	56 (0.7)
Malaysia	44 (1.2)	33 (1.0)	23 (0.9)
Thailand	38 (1.0)	30 (0.8)	22 (0.8)
Indonesia	31 (0.7)	23 (0.6)	17 (0.4)
Int. average	49 (0.1)	39 (0.1)	30 (0.1)

Resource: (Mullis, Martin, Foy, & Arora, 2012, p. 462)

The low ability of mathematical reasoning and communication is also strengthened by research interviews with some of the mathematics teacher who joined the Mathematics *MGMP (Mathematics Subject Teacher Deliberation)*. Interviews showed that mathematical reasoning and other mathematical abilities had not been much attention in the classroom's learning activities. Direct instructions are often used rather than interactions. The instruction is mostly repetitive, while interactions promote critical questions that improve their mathematical reasoning (Sunggingwati & Nguyen, 2013). This indicates that the ability of students' mathematical reasoning has not been adequately accommodated.

Morris's (1994) states the science advancement currently is only centered on logic, mathematics, and physics so that it needs studies related to social, humanistic, and psychological in learning. Learning stands a chance to bridge those two, so educational competence can be achieved optimally. So far, educational efforts involving social and humanistic learning are still far from expectations. Teaching practice in elementary schools still uses many indoctrination approaches in which the teacher orders and directs students (Grant, 1992). In the meantime, learning through sociohumanistic is still limited to a theoretical level, not yet applicable.

Characteristics of learning mathematics is a science that only remains with knowledge, so it needs to be integrated with the psychology of learning. This approach can be solved by establishing a bridge between psychological learning and science, which uses a humanistic social-based learning model. The humanistic social-based learning model is a slice of social learning theory and humanistic learning theory. The confusion of these two aspects impacts learning that is no longer dry with meaning and can directly activate students' mathematical reasoning abilities.

Mathematical Reasoning Ability

Bragg & Herbert (2018) states that reasoning is very important for students to understand mathematics. Without reasoning, it causes failure in understanding mathematical instructions (Battista, 2016). Activities that include proofing through effective mathematical reasoning abilities are taught to elementary students (Flegas & Charalampos, 2013). Teaching programs ranging from kindergartens to sixth grade of elementary school must enable students to form reasons and evidence as a fundamental aspect of mathematics, make and match, check truth and error, and choose and use various strategies. In third and fourth grade, mathematical reasoning abilities are more on comparing and differentiating (Vale, 2017).

When students use their mathematical reasoning ability, they develop experiences or ideas, which aim; a) to convince others or ownself of the experience that has been formed; b) to solve problems; or 3) to integrate a number of ideas into a more comprehensive experience (Brodie, 2010). Two important processes for reasoning; first, different steps or movements shape experiences; and second, there are reasons for steps in experience to solve problems (Ball & Bass, 2003). Reys et al. (2009) states that mathematical reasoning includes observing patterns, thinking about patterns, and giving reasons about those patterns. Thus, mathematical reasoning is needed to determine whether mathematical knowledge is true or false and used to build mathematics experience, while Lithner (2000) states that mathematical reasoning is an essential skill that allows students to use all other mathematics skills.

Mathematical reasoning involves creativity, discovery, and communication (Sumaji et al. 2020). Communication is the key that allows students to make creative and reasonable conceptual leaps (Brodie, 2010). When developing mathematical reasoning among students, teachers need to make connections and change the way they think. NCTM (2000) explains that mathematical reasoning is a habit of mind, and like all habits, it must be consistent in many contexts. Mathematical reasoning is a habit of the mind, and this habit must be developed through consistent use in many contexts. Learning that develops reasoning needs to be continuously trained and applied in learning both in the mathematical context or in other contexts. Van de Walle et al. (2010) explain that reasoning and evidentiary standards emphasize logical thinking, which helps decide whether answers make sense or can be accepted and understood by others. Thus, students need to develop the habit of giving a rationale as an integral part of each answer.

Brodie (2010) states that the key to teaching mathematical reasoning is teaching other aspects of mathematical ability, namely by giving the assignment to students and directly involved, also the interaction of students with teachers. Exploration learning makes students take much information about certain aspects of a scenario globally and draw conclusions about other aspects of the scenario based on the common sense of reasoning. Mueller (2006) explains that reasoning using common sense is a process that involves taking information about certain aspects of a scenario in the world and making conclusions about other aspects of a scenario based on human reasoning. Reasoning with common sense is an important thing to foster student behaviour and intelligent thinking. This was also expressed by Attridge & Inglis (2013), who stated that in mathematics learning, students' mathematical reasoning abilities have increased.

The students are said to use their mathematical reasoning abilities to use patterns and traits, make generalizations, compile evidence, or explain mathematical ideas and statements. Related to this, in the technical explanation of the Ministry of Education's Director General of Elementary Education Regulation Number 506/C/Kep/PP/2004 dated November 11, 2004, the report card explains that the indicators of students who have the ability in mathematical reasoning are submitting allegations, carrying out mathematical manipulations, drawing conclusions, compiling evidence, providing reasons or evidence for the correctness of the solution, concluding statements, examining the validity of an argument, and finding patterns or properties of mathematical symptoms to make generalizations (Arifanti, 2020).

This is supported by the opinion of Permana & Sumarmo (2007) stating that indicators of mathematical reasoning ability in mathematics learning, among others, students can: draw logical conclusions, provide explanations with models, facts, traits, and relationships, estimate answers and process solutions, use patterns and relationships, mention true or false in shaping experiences, formulate counterexamples, follow the rules, compile valid arguments; and construct direct, indirect proof, and use mathematical induction. "The primary goal of school mathematics is mathematical problem solving and amongst the processes specified explicitly for nurturing problem solvers are reasoning, communication and connections" means that the primary goal of mathematics is the ability to solve mathematical problems specifically between processes in solving problems, namely reasoning, communication, and connection (Kaur & Toh, 2012). It was further explained that mathematical reasoning is the ability to form mathematical knowledge and compose reasons in shaping knowledge. Communication is the ability to use mathematical language in expressing mathematical ideas and knowledge precisely, concisely, and logically. In contrast, a connection is the ability to see and make connections between mathematical ideas, mathematics, other subjects, mathematics, and everyday life (Kaur & Toh, 2012).

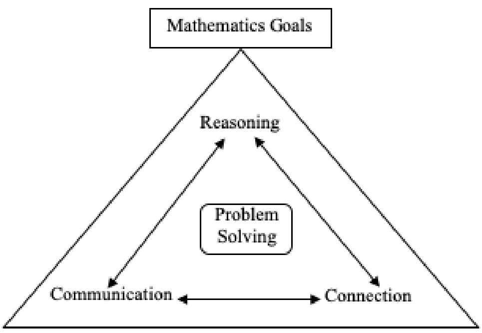


Figure 1.
The Relation of Reasoning, Communication, and Connection in Mathematical Solving Problems

Mathematical reasoning assumes mathematical communication (Ball & Bass, 2003; Douek, 2005; Krummheuer 1995). Communication is an integral part of the reasoning process in generating arguments for both individuals and groups. The text or product of reasoning, as its main purpose, is to communicate reasoning (Brodie, 2010). A similar opinion was stated by Barmby, Bilsbourough, Harries, & Higgins (2009) that "reasoning is how mathematics is communicated." Hadi (2016) mentions that reasoning or the way of thinking is a thinking process that seeks to connect facts to a conclusion. The same idea was conveyed by Brodie (2010), stating the key in teaching mathematical reasoning is the type of assignment given to students, the way students are involved with the task, and the interaction between assignments, students, and teachers (connections). The statement was also supported by Barmby, Bilsbourough, Harries, & Higgins (2009), confirming "reasoning is the process by which the learner articulates and demonstrates connections between representations." Based on these statements, it can be concluded that the main aspects of mathematical reasoning are communication and connection skills. The description of indicators and sub-indicators of the two aspects of mathematical reasoning is presented in Table 1 below.

Table 2.
Indicators of Mathematical Reasoning Ability

	Aspect	Indicators	Sub Indicators
1	Communication	Explaining	1) Express ideas using mathematical sentences 2) Explain the reasons for the answers the students worked on
2	Connection	a. Classifying	1) Classify appropriately 2) Supply examples
		b. Comparing	Explain the details for the comparison the students worked on
		c. Stating true or false	1) Deliver evidence that what is being delivered is true or false 2) show the fact that the rules do the answers.

Sociohumanistic-based Learning

The sociohumanistic-based learning model involves social learning and humanistic theories. Social learning theory is an extension of traditional behavioral learning theories (behaviouristics). Albert Bandura developed this theory in 1969. The principle of learning, according to Bandura (1997), is an attempt to explain learning in realistic situations. The theory of social learning (social learning theory) or observational learning (observational learning), according to Santrock (2017: 19), is learning when someone observes and imitates the behaviour of others.

Table 3.
Characteristics of Sociohumanistic-Based Learning

No.	Component	Sociohimanistic-based Learning Model
1.	Problem	Realistic problems that are structured and adapted to students
2.	Role of the problem	Focus on finding the concept of the material being studied and reasoning strategies
3.	Process	Identifying facts, finding the meaning of learning, finding concepts, conveying concepts, reinterpreting
4.	Role of teacher	Assisting students inhumanely finding concepts (scaffolding) and giving awards to students
5.	Collaboration	Negotiation of students' ideas brings new knowledge to the group in finding concepts
6.	Learning Steps	a. Delivery of learning objectives b. Determination of material problems c. Organizing students in groups d. Find the meaning of learning e. Make conceptualization and reinterpretation f. Give awards

Meanwhile, according to Hergenhahn & Olson (2008), observational learning is the process by which information is obtained by observing events in the environment. According to Uno (2012), the social learning model emphasizes individuals' relationships with society or other people. This model focuses on increasing individuals' ability to deal with others, engaging democratic processes, and working productively in society.

Bandura develops a reciprocal Determinism model consisting of three main factors: behaviour, person/cognitive, and environment. As in the figure, these factors can interact with one another to influence learning, i.e., environmental factors influence behaviour, behaviour influences the environment, personal factors (people/cognitive) influence behaviours, etc. Bandura uses the term person but modifies it into the person (cognitive) because many of the people factors described are cognitive factors.

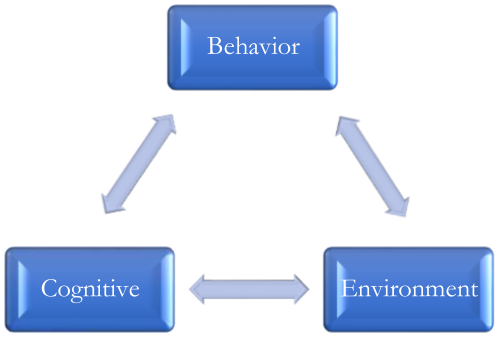


Figure 2.
Main Factor of Bandura's Reciprocal Determinism Model (Adapted from Bandura, 1997)

In the Bandura learning model (Figure 2), the person factor (cognitive) has an important role. The personal factor (cognitive) emphasized by Bandura (1997) in recent times is self-efficacy, namely the belief that a person can put a situation under control and produce positive results. Bandura states that self-efficacy had a significant influence on behaviour. A student who has low self-efficacy may not try to learn to do the exam because he does not believe that learning will help him work on the problems.

The theory of humanistic learning means that learning must be able to humanize human beings, which involves students' full activeness. Humanistic learning theory arises because of the lack of learning theory that views students as less active learning subjects. This is expressed in humanistic psychology, namely criticism of behaviorism, who views humans as machines. Humanistic changes the paradigm to be more humane and valued as an integrated whole (Supriyadi, 2011).

The humanistic learning model is understood as a learning model that leads to humanizing humans, as Freire (2011). In learning, teachers and students become subjects and are united by the same object. Nobody else thinks and lives, but they think together. Right knowledge demands discovery and rediscovery through constant investigation of the world, with the world and with others. Teachers and students must simultaneously become students and teachers where dialogue is an essential element in education. This was also expressed by Arbayah (2013), stating that humanistic learning emphasizes that learning is how to establish personal communication and relationships between individuals and between individuals and groups within the school community. The relationships develop rapidly and bear the fruits of education is based on affection.

Furthermore, Haglun (2004) says that in humanistic learning, students can learn inductively, find their own experiences, and be actively involved in the learning process. This was also added by Arbayah (2013), who states that the learning process was considered successful if the students understand their environment and themselves. Students in the learning process need to keep trying so that they can achieve self-actualization.

According to Selznick (2008), "Four mainstays, or pillars, of humanist science are; a concern for the quality of experience, the interdependence of morality and wellbeing, normative theory, and the prevalence and efficacy of ideals or standards," which means, the four pillars of humanistic learning are focusing on the quality of experience experienced, an interdependence between morality and positive behaviour, a normative theory, and an evenness and efficacy of the ideal and standard. The steps of the humanistic learning model according to Burhanuddin (2014), namely; determining learning objectives, determining learning materials, identifying the initial abilities of students or students, identifying possible learning topics that involve students to be able to learn actively, designing learning facilities, such as the environment and learning media, guiding students in applying new concepts to real situations, guiding students to be able to understand the nature and meaning of learning experience, and evaluating learning processes and outcomes. The humanistic social-based learning model is a combination of social and humanistic learning theories.

The steps of the humanistic social-based learning model are summarized as follows. Step 1: delivering of learning objectives, Step 2: determining problems in the material, Step 3: organizing students into several learning groups which the members according to students' desires, Step 4: guiding students to think critically and find meaning in group learning, Step 5: each group makes conceptualize the learning experience and explain to other groups and so do other groups by connecting the results of their conceptualization (reinterpreting), and Step 6: giving appreciations.

Problem of Study

Based on the problems and literature review, alternative models or approaches are required by the objectives of learning mathematics. Learning mathematics is a science that mostly struggles with knowledge; thus, it needs a psychological approach. This approach can be resolved by connecting paths between psychological learning and science, which, in this case, uses a sociohumanistic-based learning model. A sociohumanistic-based learning model is a combination of social learning theory and humanistic learning theory. The formulation of the problem in this study is to know whether elementary students who are taught with sociohumanistic-based learning have better improvement in reasoning ability than those taught with direct instruction?

Method

Research Model

This research was a quasi-experimental study with a non-equivalent control group design (Leppink, 2019). In this study, there were two sample groups: the experimental group (sociohumanistic-based mathematics learning model) and the control group (conventional learning). Both groups were given pretest and post-test using the same test instrument. This study used the pretest-posttest control group design. An overview of research designs was in Table 4.

Table 4.
Research Design

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O3	-	O4

X= Treatment (sociohumanistic-based learning model) O1, O3 = Pretest O2, O4 = Posttest

Data Collection Tools

Mathematical Reasoning Ability Test (MRAT)

The assessment instrument used in this study was an essay test of reasoning ability. The Mathematical Reasoning Ability Test (MRAT) used an assessment scale of 1-100 with various percentage weights and a total of six essay questions. The validity used is the content validity by expert experts, all of which stated validity. The reliability obtained is 0.640> 0.50; the reasoning ability test is reliable. Before collecting data, the test was first tested at another school with the same students' level. These questions were given at the pretest and post-test. A pretest was given to see the equality of the initial abilities of the two-class groups. In contrast, the post-test was given to determine whether there is an increase in students' mathematical reasoning abilities after learning with the sociohumanistic-based learning model. The rubric used to research test questions consisted of several criteria for evaluating mathematical reasoning abilities, as in Table 4 below.

Table 5.
Mathematical Reasoning Assessment Ability Criteria

Category	Score	Statements
Correct	5	The statement received is completely correct
Partially Correct -A	4	The statement/explanation is incomplete, but the answer is correct
Partially Correct -B	3	Some statements/explanations are true for the right reasons but wrong answers
Partially Correct-C	2	Some statements/explanations are correct for false reasons but wrong answers
Incorrect	1	Statement/explanation that is wrong and not related to the question
No Answer	0	There are no statements/answers

Label: Score 3: *Mistake*: Mistakes were made unconsciously due to carelessness, do not occur repeatedly.
Score 1: *Misconception*: Mistakes made consciously, because they think they are right, occur repeatedly.

Data Analysis

The data analysed in this study were quantitative data from the pretest and N-gain of mathematical reasoning abilities of experimental class with 22 students from SDN Ledok 02 and control classes with 20 students from SDN Gendongan 02. The data was obtained from the pretest and post-test results given in each class with an ideal score of mathematical reasoning ability is 100. Pretest data was used to determine whether there are differences in the experimental class students' mathematical reasoning abilities with the control class. N-gain data were the data used to analyze the improvement in mathematical reasoning abilities. While the post-test data results were used to find the N-gain value, here was the formula for determining the N-gain value:

$$\text{Normalized Gain (g)} = \frac{\%\,score\ (posttest) - \%score(pretest)}{100 - \%\,score\ (preetest)} \quad \text{(Hake, 1999)}$$

The improvement of students' reasoning abilities was interpreted using the classification table's criteria for the N-gain values below.

Table 6.
Classification of Normalized Gain

Normalized Gain Score	Interpretation
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Medium
$g < 0,3$	Low

The normality test of pretest and N-gain score data used the Kolmogorov-Smirnov statistical One Sample t-Test. Then it proceeded to the homogeneity test of the variance of the pretest score and the N-gain to see the similarity of the variance or homogeneity of the data both from the experimental class and the control class. The next step was the parametric test to determine whether there is an average difference between the two data in the experimental and control classes. To find out the improvement of mathematical reasoning abilities between the experimental and control classes, both overall and groups of students used the ANOVA test by analyzing the N-gain value in which the prerequisite tests were met.

Results and Discussion

The analysis of students' mathematical reasoning abilities before learning and after learning and their improvement for discovery learning groups with scientific approaches and ordinary learning groups are descriptively presented in the following Table 7.

Table 7.
Result of Students' Mathematical Reasoning Abilities

Statistics	Group					
	Sociohimanistic-based Learning Model			Direct Instruction		
	Pretest	Posttest	N-gain	Pretest	Posttest	N-gain
(N)		22			20	
Mean ($\bar{x}$)	69.82	83.86	0.46	51.00	54.25	0.04
Standard Deviation (SD)	13.45	8.85	0.24	8.19	11.15	0.31

Maximum score of pretest and posttest is 100
The maximum N-gain value is 1

Based on Table 6, it can be seen that the average N-gain value of mathematical reasoning ability of experimental class students with the sociohumanistic-based learning model in the medium category is 0.46, whereas in the control class with direct instruction has an average N-gain at the low category is 0.04. Furthermore, it can be seen that the average experimental class with a sociohumanistic-based learning model is higher than the control class with direct learning. From the standard deviation, the control class has a higher value than the experimental class. It can be interpreted that the data distribution in the experimental class is denser than in the control class.

Here is one of the answers of students who answers the question correctly the about students' mathematical reasoning ability on post-test number 2, namely:

"It is known that the height of the equilateral triangle is the height of the isosceles triangle. Which is wider, is the triangle is equilateral or isosceles?"

Answer: Since the height is the same, the area of the triangle depends on the size of the base. The formula for the area of a triangle is A = 1/2 base x height.

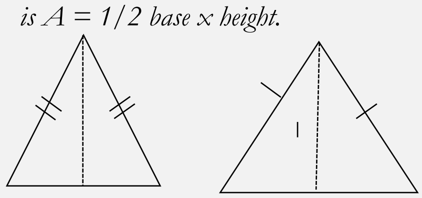


Figure 3.
Correct Answer

Answer: Cannot be determined because there is no size.

Figure 4.
Incorrect answer

It can be seen in the picture the results of students who answer correctly in the post-test questions. The figure tells how the student can answer by estimating data without analytical calculations; what students do in the picture is to analyse the likelihood that can occur with answers included in the open-ended category. Then he makes a picture of two triangles, namely isosceles triangle, and an equilateral triangle, to show the argument's results. Whereas in the picture, students' answers that answer incorrectly on the post-test questions can be seen that students deduce from the problems given to the questions. This indicates that students have not understood the main problems and how to solve a problem. Also, it shows that students are not familiar with how to answer mathematical problems using reasoning because the learning process and practice questions emphasize the final results of the calculation. This has led to an insignificant improvement in students' mathematical reasoning abilities.

Both research samples have experienced an improvement in mathematical reasoning ability after learning, even though they are in different categories. Based on the Hake category, the improvement of students 'reasoning abilities with a sociohumanistic-based learning model is included in the medium category, and the improvement of students' mathematical reasoning abilities with direct learning is in a low category. To find out the significance of increasing the two sample groups' mathematical reasoning ability, a hypothesis test is performed, but before the hypothesis test is carried out, the prerequisite test is a normality test and a homogeneity test.

The significance test of the students' improvement in mathematical reasoning ability from the two groups uses the Mann Whitney test, the significance value for the normalized gain data of one-party reasoning ability (1-tailed) less than 0.05 (0.000), meaning that H_0 is rejected. This means that students' mathematical reasoning abilities through the sociohumanistic-based learning model are significantly better than students who get direct instruction. This is in line with the research conducted by Jedemark (2019) on improving the reasoning ability of junior high school students through discovery learning with a scientific approach. Learning that involves active students in the classroom using an appropriate learning model has better learning outcomes than direct instruction.

The difference in the improvement of students' mathematical reasoning abilities of the experimental class with the control class can also be seen from the percentage of students' learning outcomes where the N-gain score of the percentage of artistic accomplishment, the experimental class with the control class is 0.81 and 0.28, respectively. From the two values, it can be seen that there is a significant improvement in classical accomplishment in the experimental class, while the control class in classical accomplishment is relatively low. Haglun (2004) argues that teaching mathematics with a humanistic approach could generate student motivation which has an impact on increasing the ability to solve mathematical problems.

In the sociohumanistic-based mathematics learning model, teachers and students become subjects in learning and put together by the same object. There is no longer the dominance of learning in the classroom, but the emergence of active discussion between teachers and students to unite thinking. As a result, students can easily understand the material, and through the application of intensive learning, teachers can train students to reason. In line with Maharani & Sukestiyarno 's (2017) research that the humanistic approach to teaching mathematics encourages students to think creatively and tends to be more flexible in expressing problem solving from another perspective.

The difference in the results for each school is influenced by several factors, including the conditions of the learning environment, such as educators' ability to analyse their students' learning difficulties, understanding learning media, and class management. Also, internal factors influence this, including motivation and interest or interest in learning. This is in line with the theory developed by Widodo et al. (2018) regarding teacher competence, where the educator factor is crucial so that one's expertise is needed in carrying out tasks to educate students to produce good performance.

In essence, mathematics is an activity of tracing patterns and relationships (Zaini & Marsigit, 2014). This shows that mathematics learning really requires the reasoning abilities of students in tracing patterns and their relationships. In school mathematics, it is suggested that the process of reasoning and proof be present throughout the Mathematics

Curriculum process (NCTM, 1998). This is in line with the results of research which states that mathematics learning in elementary schools is related to students' reasoning (de Groot-Reuvekamp, Ros, Anje, & Boxtel, 2018).

Based on the problems described, it is necessary to look for alternative models or approaches that are considered in accordance with the objectives of learning mathematics. Characteristics of mathematics learning is a science that usually only deals with knowledge, so it needs to be closer to the psychology of learning (Obersteiner, Reiss, & Heinze, 2018). This approach can be solved by the existence of a bridge between psychological learning and science, which in this case uses a social-humanistic learning model. The social-humanistic based learning model is a slice of social and humanistic learning theories.

The combination of social and humanistic theories is based on several supporting facts and research results including Illeris (2018) which states that the Bandura learning model can have a positive effect on science learning outcomes. This shows that social learning can be used in improving the learning outcomes of some students in science. In addition, research has shown that modelling activities are effective for almost all of the students (Ärlebäck & Doerr, 2017). For the humanistic mathematics learning model, Taormina & Gao (2013) stated that the application of Maslow's Theory can improve mathematics learning outcomes for some students.

Combining the two theories is based on the similarity of characteristics of the expected result related to the environment, interaction, and behaviour. In social learning, the main focus is the modelling of a teacher in shaping meaning, whereas, for humanistic learning, it is more on the existence of freedom and independence to students in shaping meaning. The nature of the sociohumanistic-based learning model provides opportunities for students to act as if they are forming knowledge, but there is still the participation of educators and directed instruction in showing students what to experience. The role of educators does not mean more dominant but manage students in finding concepts (Joseph, Murphy, & John Holford, 2020). Students are allowed to engage themselves in the process of discovering concepts.

Theories of social learning and humanistic learning are interrelated. The sociohumanistic-based learning model takes relationships, environment, communication, student experience, direct observation, student experience, and the teacher's role in a fundamental aspect. In social learning, the role of the teacher is essential to produce a model. In modelling, it becomes one of the weaknesses of social learning theory because students can imitate negative things (Nabavi, 2011). The weaknesses of social learning theory can be overcome if combined with humanistic learning models. The humanistic learning model aims to guide students towards freedom, and they are free to choose what is right, what is bad, and what they are responsible for. Thus, the merging of social learning theories and humanistic social learning models is not contradictory but complementary towards independent education. The learning model developed is a humanistic social-based learning model in improving students' mathematical reasoning abilities, which also has the following specific characteristics.

Conclusion and Recommendations

Based on the results of research and discussion presented in advance, it can be concluded that the improvement of mathematical reasoning ability of students who use socio-humanistic-based learning models in higher than students who use direct instruction. Through a combination of social and humanistic learning in mathematics, students will gain the freedom to learn and understand mathematics in other aspects. Based on the results of research, the authors recommend that sociohumanistic-based learning be used as alternative learning in the classroom because sociohumanistic-based learning can foster students 'mathematical abilities such as students' mathematical reasoning abilities. The sociohumanistic-based learning model to improve students' mathematical reasoning abilities also have advantages, including:

- Social humanism is the work of the right brain, while reasoning is the left brain. Combining the right brain and the left brain will activate the hormone of happiness (endorphins). The humanistic social-based learning model has strengths in how to generate endorphin hormones among students, namely elementary school children so that they love mathematics; (Obersteiner, Reiss, & Heinze, 2018)
- The humanistic social-based learning model has elements or character values: communication, connection, relation, democratic, creative, independent, and curiosity. Independent elements or values in social humanism are in line with the educational revolution 4.0 (self-determined learning), which is called heutagogy so that using a humanistic social-based learning model can foster the learning independence of students; (Joseph, Murphy, & John Holford, 2020)
- The humanistic social-based learning model is in line with the Ministry of Education and Culture's new policy, which is called Freedom Learning. Independent learning will be able to activate the human brain's storage

capacity into long term memory. The impact is that if knowledge can enter into long term memory, the knowledge can be called at any time.

Based on the results of this development research, the following points can be recommended.

- The findings of model development can improve students' mathematical reasoning abilities. Therefore, further learning designs that are not related to mathematics need to be developed again.
- In learning, it is necessary to explore the characteristics of students so that in carrying out learning there is more emphasis on the habits or learning methods of students.
- Learning activities to foster students' mathematical reasoning abilities are still general. Therefore, it is necessary to carry out more in-depth research to study the characteristics of mathematical reasoning abilities and how to improve these mathematical reasoning abilities.
- Some suggestions that must be considered by the teacher or the next researcher who wants to implement this developed model are that teachers and researchers must understand this model and plan a schedule of activities at the data collection location. In addition, awareness as a teacher in the learning process is important so that it can be effective and efficient.

Acknowledgment

We express our deep gratitude to the dissertation promoter, the Yogyakarta State University of post-graduate program, and the management of Universitas Sarjanawiyata Tamansiswa to complete my doctoral studies in the field of Teacher Education and Elementary Education.

Biodata of Authors

Rosidah Aliim Hidayat is a currently studying as Science Education doctoral program student at Yogyakarta State University, Indonesia. Currently, she has developed and published researches related to sociohumanism for mathematics learning. Her interest in the combination of social and humanistic learning is based on the institution she works at Universitas Sarjanawiyata Tamansiswa which has branding in the *Among* learning system method. **Email:** rosidahaliim@yahoo.co.id **Phone:** +6282138686246 **Scopus ID:** -

Prof. Dr. H. Wahyudin, M.Pd, is a professor in Mathematics Education. He is professor and researchers at Indonesia University of Education, Indonesia. Several research and publications discuss mathematical thinking skills, the development of mathematical research methods, and reforms in effective mathematics teaching methods. **Email:** wahyudin_mat@yahoo.com **Phone:** +628122180725 **Scopus ID:** 57203080467

Dr. Jailani, M.Pd is a lecturers and researchers at Yogyakarta State University, Indonesia. He is an expert in ethnomathematics and solving mathematical problems in learning. As a graduate school lecturer, he actively promotes master and doctoral students specifically in developing mathematics learning models. **Email:** jailani@uny.ac.id **Phone:** +628161839206 **Scopus ID:** 57204033371

Bayu Rahmat Setiadi M.Pd is a lecturers and researchers at Yogyakarta State University, Indonesia. He is active in researches on product engineering through applied mathematical analysis. As a teacher of applied mathematics, he also assists junior high school teachers in the implementation of classroom action research. **Email:** bayursetiadi@uny.ac.id **Phone:** +6285640907690 **Scopus ID:** 57202054939

References

Adegoke, B. A. (2013). Modeling the Relationship between Mathematical Reasoning Ability and Mathematics Attainment. *Journal of Education and Practice*, *4*(17), 54–61.

Arifanti, D.R. (2020). Mathematical reasoning in problem-solving in three dimensions. Ahmad Dahlan International Conference on Mathematics and Mathematics Education. *Journal of Physics: Conference Series*, 1613 (2020) 012077. doi:10.1088/1742-6596/1613/1/012077.

Attridge, A & Inglis, M. (2013.) "Advanced Mathematical Study and the Development of Conditional Reasoning Skills." *Plos One*

Journal. 8(7), July 2013, e69399.

Arbayah. (2013). Humanistik Learning Model. *Jurnal Dinamika Ilmu*, 13(2).

Ärlebäck, J. B., & Doerr, H. M. (2017). Students' interpretations and reasoning about phenomena with negative rates of change throughout a model development sequence. ZDM-Mathematics Education, 50(1–2), 187–200. https://doi.org/10.1007/s11858-017-0881-5

Ball DL & Bass H. (2003). *Making mathematics reasonable in school. In: Kilpatrick J, Martin WG, Schifter DE (eds) A research companion to principles and standards for school mathematics*. National Council of Teachers of Mathematics, Reston, VA, pp 27–44.

Ball, D. L., Lewis, J., & Thames, M. H. (2008). Making Mathematics Work in School. *Journal for Research in Mathematics Education*, *14*(2008), 13–44.

Bandura, A. (1997). *Self-efficacy: The exercise of control* (pp. 3-604). New York: WH Freeman.

Barmby, P., Bilsbourough, L., Harries, T., & Higgins, S. (2009). *Primary Mathematics: Teaching for Understanding. McGraw-Hill* Education. https://doi.org/10.2307/3615672.

Battista, M. T. (2016). Reasoning and Sense-Making in the Mathematics Classroom: Grades 3–5, Virginia: National Council of Teachers of Mathematics.

Bragg, L., & Herbert, E. (2018). What can be learned from teachers assessing mathematical reasoning: a case study. *Mathematics Education Research Group of Australasia*, 178-185.

Brodie, K. (2010). Teaching Mathematical Reasoning in Secondary School Classrooms. New York: Springer.

de Groot-Reuvekamp, M., Ros, A., van Boxtel, C. (2018). A successful professional development program in history: What matters? *Teaching and Teacher Education*, 75, 290-301. https://doi.org/10.1016/j.tate.2018.07.005.

Douek. (2005). Communication in the mathematics classroom: argumentation and development of mathematical knowledge. In: Chronaki A, Christiansen IM (eds) Challenging perspectives on mathematics classroom communication. Information Age Publishing, Greenwich, CT, pp 145–172.

Flegas, K., & Charalampos, L. (2013). Exploring Logical Reasoning and Mathematical Proof in Grade 6 Elementary School Students. *Canadian Journal of Science, Mathematics and Technology Education, 13*(1), 70–89. https://doi.org/10.1080/14926156.2013.758326

Freire, P. (2011). Education of the Oppressed. Jakarta: LP3ES.

Grant, B. C. (1992). Integrating sport into the physical education curriculum in New Zealand Secondary School. *Quest*, 4(4), 304 – 316.

Hadi, W. (2016). Improving the reasoning abilities of junior high school students through discovery learning with a scientific approach (Quasi-experimental study at a junior high school in West Jakarta). *Kalamatika*, I(1), 93–108.

Haglund, R. (2004). Using Humanistic Content and Teaching Methods to Motivate Students and Counteract Negative Perceptions of Mathematics. *Humanistic Mathematics Network Journal*, 27(4). http://scholarship.claremont.edu/hmnj/vol1/iss27/4

Hake, R. R. (1999). Analyzing change/gain scores. Unpublished.[online] URL: http://www. Physics. Indiana. Edu/~ sdi/AnalyzingChange-Gain. pdf.

Hergenhahn, B.R., Olson, Matthew H. (2008). Theories of Learning, 7th edition. Jakarta: Kencana Prenada Media Group.

Illeris, K. (2018). An overview of the history of learning theory. *European Journal of Education*, 53(1), 86–101. doi:10.1111/ejed.12265

Jedemark, M. (2019). A scientific approach in the assessment of the school-based part of the teacher education programme in Sweden, Journal of Curriculum Studies, 51 (3), 420-436, DOI: 10.1080/00220272.2019.1567820.

Joseph, S., Murphy, D. & Holford, J. (2020): Positive education: A new look at Freedom to Learn. *Oxford Review of Education*, 46(5), 549-562. https://doi.org/10.1080/03054985.2020.1726310.

Kaur, B., & Toh, T. L. (2012). Reasoning, Communication and Connections in a-Level Mathematics. Reasoning, Communication and Connections in Mathematics, 127–147. https://doi.org/10.1142/9789814405430_0007

Krummheuer, G. (1995). 'The ethnography of argumentation,' in Cobb, P and Bauersfeld, H (eds), The Emergence of Mathematical Meaning Interaction in Classroom Cultures, Hillsdale, NJ, Lawrence Erlbaum, pp 229-269

Leppink, J. (2019). *Statistical Methods for Experimental Research in Education and Psychology*. Switzerland AG: Springer.

Lithner, J. (2000). Mathematical reasoning in school tasks. *Educational Studies in Mathematics*, 41(2), 165-190.

Maharani, H. R., & Sukestiyarno. (2017). Learning Analysis based on Humanism Theory and Mathematics Creative Thinking Ability of Students. *International Conference on Mathematics: Education, Theory, and Application*, 01(2017).

Morris, C.W. (1994). Norm, Values, and Society. Wien: Kluwer Academic Publisher.

Mueller, E. T. (2006). Commonsense Reasoning. San Fransisco: Morgan Kaufmann.

Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). TIMSS 2011 international results in mathematics. International Association for the Evaluation of Educational Achievement. Herengracht 487, Amsterdam, 1017 BT, The Netherlands.

Nabavi, R. T. (2011). Bandura's Social Learning Theory & Social Cognitive Learning Theory. Teheran: University of Science and Culture.

NCTM. (2000). Principles and standards for school mathematics. Reston, VA: NCTM.

Obersteiner, A., Reiss, K. & Heinze, A. Psychological Theories in Mathematics Education. *J Math Didakt* 39, 1–6 (2018). https://doi.org/10.1007/s13138-018-0134-3

Permana, Y. & Sumarmo, U., (2007). Developing of high school students' mathematical reasoning and connection skills through problem-based learning. *Educationist*, 1(2), p. 116.

Reys, R., Lindquist, Marry M., & Lambdin, Diana V., (2009). Helping children Mathematics (9th ed), USA: John Wiley & Sons, Inc.

Santrock, J. W. (2017). Educational Psychology, 6th Edition. New York: McGraw-Hill Education.

Selznick, P. (2008). A Humanist Science Values and Ideals in Social Inquiry. California: Stanford University Press.

Sharp, A. (2012) Humanistic Approaches to Learning. In: Seel N.M. (eds) Encyclopedia of the Sciences of Learning. Boston, MA: Springer, https://doi.org/10.1007/978-1-4419-1428-6_530

Sunggingwati, D., & Nguyen, H. T. M. (2013). Teachers' questioning in reading lessons: A case study in Indonesia. Electronic *Journal of Foreign Language Teaching*, 10(1), 80–95.

Supriyadi, E. (2011). Education with a Humanistic Approach, Cianjur.
Taormina, R.J. & Gao, J.H. (2013). Maslow and the Motivation Hierarchy: Measuring Satisfaction of the Needs. *American Journal of Psychology*, 126 (2), 155-177. DOI: 10.5406/amerjpsyc.126.2.0155
Uno, H.B. (2012). Learning Model to Create a Creative and Effective Teaching and Learning Process. Jakarta: PT. Bumi Aksara.
Vale, C., Widjaja, W., Herbert, S., Bragg, L. A., & Loong, E. Y. K. (2017). Mapping Variation in Children's Mathematical Reasoning: The Case of 'What Else Belongs?' International Journal of Science and Mathematics Education, 15(5), 873–894. https://doi.org/10.1007/s10763-016-9725-y
Van de Walle, J. A., Karp, K, S., & Bay-Williams, J. M. (2010). Elementary School Mathematics: Teaching developmentally (7th ed). Boston: Allyn & Balcon.
Widodo, S., Rahayu, P., Adjie, N., Widodo, S.A., & Setiadi, B.R. (2018). The Development of Arithmetic Gamification Using Digital Dice. *International Journal of Engineering & Technology*, 7 (3,2), 751-755.
Zaini, A., & Marsigit, M. (2014). Comparison of the Effectiveness of Learning Mathematics with Realistic and Conventional Mathematical Approaches in terms of Students' Mathematical Reasoning and Communication Ability. *Jurnal Riset Pendidikan Matematika*, 1(2), 152. https://doi.org/10.21831/jrpm.v1i2.2672

Appendix 1.

Mathematical Reasoning Ability Test

Subjects : Mathematics
Material : The area of the triangle
Class/Semester : IV / Even
Time : 60 minutes

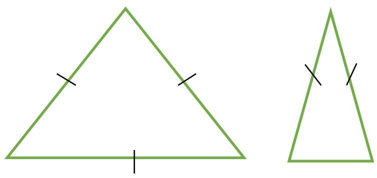
Do the questions below!

Problem 1. A cloth in a rectangular shape with an area of 20 m^2. How many triangular shapes can you make from

Answer:

the cloth? Explain using a drawing sketch!

Problem 1. It is known that the height of the equilateral triangle is the height of the isosceles triangle. Which is wider, is the triangle is equilateral or isosceles?



Answer:

Problem 1. If there is a triangle in a square with the height of the triangle equal to the square's sides, then the area of the triangle is equal to half the area of the square. Is that true?

Answer:

Problem 1. If the base and height of the triangle are the same as the square's side lengths, what happens to the area of the two shapes? What can you conclude from that!

Answer: