Somatic, auditory, visualization, intellectually learning assisted by GeoGebra to improve student's mathematical representation skills

A Septian, R F Suwarman, E Monariska, R Sugiarini
Universitas Suryakancana, Jl. Pasirgede Raya, Cianjur, Indonesia
E-mail: ariseptian@unsur.ac.id

Abstract. The purpose of this research was to determine the improvement of student’s mathematical representation skills and student’s attitudes towards learning using SAVI learning assisted by GeoGebra. This research is a quasi-experimental research with the object of research of students of SMP Negeri 3 Cianjur. Students in class VIII-5 will be the experimental class and students in class VIII-7 will be the control class. The method used in this study is quasi-experimental research methods with non-randomized control group pretest - post-test design. Data processing will be executed with the normality test, Mann Whitney test, and the percentage of achievement indicators. Based on the results of data processing and interpretation, it is shown that SAVI learning assisted by GeoGebra better than ordinary learning in improving student’s mathematical representation skills. Then the attitude of students towards SAVI learning assisted by GeoGebra is generally positive.

1. Introduction
The world of education today has developed rapidly. Educators and school infrastructure are designed to make learning easier [1–3]. The teaching and learning process continues to be designed to optimize the potential of each student. So that the current learning process more innovative and variation which results in changes in student learning processes [4,5]. Old model learning has become obsolete because it is seen only struggling with the lecture method that causes students to be uncomfortable and bored while studying. Students today will be more comfortable with learning that is suitable for his personality. As a result, innovation and variation in teaching become a must for a teacher [6].

The teaching and learning process is a series of communication activities between students and teachers [7,8]. The activity is said to be effective if the subject matter presented by the teacher can be well understood into a student’s cognitive structures [9–13]. Learning mathematics in schools allows students to understand mathematical material and mathematical abilities [14]. In the old model of learning, the dominance of teachers in learning certainly does not give freedom to students to convey their mathematical ideas in solving a problem. Students tend to solve problems in the way given by the teacher. As a result, mathematical abilities possessed by students do not develop optimally. Whereas, a mathematical ability that develops optimally can improve the quality of mathematics learning that has an impact on improving the quality of Indonesian education [15–18].

According to the National Council of Mathematics Teachers (NCTM), there are 5 (five) basic skills that students must possess and one of them is mathematical representation skills [19,20]. The Government of Indonesia through the Minister of National Education Regulation No. 23/2006 listed in the Competency Standards Graduates determine the mathematical skills or skills of students from elementary to secondary school that are expected to be achieved in mathematics learning, including...
students expected to have the ability to communicate ideas with symbols, tables, graphs or diagrams to clarify situations of a problem [21–23]. Thus, mathematical representation skills are abilities that students must have.

Representation is an interpretation of student’s thoughts on a problem that is used as an assist tool for finding solutions to those problems [24–26]. The representations made by each student can be different. These representations can be in the form of words, sentences, pictures, tables, graphs, mathematical symbols, etc. [27,28]. Mathematical representation is very important because it can help students organize their thoughts when solving a problem [29]. The importance of mathematical representation also matching the National Council of Teachers of Mathematics (NCTM), that representation is central to learning mathematics. Students can develop and deepen their understanding of mathematical concepts and the relationships they make, compare, and use varied representations. NCTM has determined that the standard of representation in learning programs ranging from kindergarten to high school must make students able to do the following: (a) create and use representations to organize, record, and communicate mathematical ideas, (b) choose, apply, and translating between mathematical representations to solve problems, and (c) using representations to model and interpret physically, socially, and mathematical phenomena [30].

Based on the results of observations at school, an average score below the completeness criteria of teaching is 75. The results show that students’ mathematical representation is still low. The main weakness of students lies in making everyday problems that exist in the problem of the story to the form of visual representation in graphical form and form of mathematical expression in the mathematical model. Therefore, the need to increase the ability of mathematical representation. The ability of representation is part of communication skills. In general, the ability of representation is always used when students learn mathematics. This can be seen from 70% of mathematical communication characteristics related to representation [15,16]. Mathematical representation is also one of the cognitive abilities that affect student learning outcomes in mathematics. This is consistent with Saputra's research results which state that students' mathematical representations determine whether the strategies used in solving problems are correct or not. When the representation presented is right, so the strategy used to find the answer is also right. Vice versa, if the representation presented is wrong, then the strategy and the final answer found is also inaccurate [23].

The progress of education in schools is hope for all parties. Ideally, students actively participate in teaching and learning activities, while the teacher’s task is to arouse student enthusiasm for learning and increase their participation by choosing the right learning methods and models [31]. Especially in subjects, they find it difficult with less interest such as mathematics. This is where the role of the teacher is needed to change little by little the difficult and boring perception of mathematics and instill the perception that mathematics is not as scary as they think. One of them is by choosing the right learning method and model and providing more innovative and varied learning [32,33].

One of the lessons that can be used as an alternative is Somatic, Auditory, Visual, Intellectual (SAVI) learning. Meir argued, that humans have four dimensions namely: somatic (S), auditory (A), visual (V), and intellectual (I). Based on these four human dimensions, a Somatic Auditory-Visual and Intellectual active learning model, abbreviated SAVI, was made. Because all the elements of the SAVI learning model are integrated, so learning will take place more optimally if all four methods are used in learning and carried out simultaneously. The SAVI learning model emphasizes the learning process through physical involvement. The SAVI model emphasizes student learning activities namely, automatic learning (learning by moving and doing), auditory learning (learning by listening and speaking), visual learning (learning by seeing and drawing), and intellectual learning (learning to think and reflect/solve problems). With these four elements, it is expected that students can learn optimally. Based on these explanations, it can be concluded that the SAVI learning model is student-centered, where students are expected to be able to involve all of their senses in the learning process [34].

Although the curriculum is now using the 2013 curriculum, where students are required to be more active during the learning process than the teacher. However, learning in the 2013 curriculum cannot be said to be appropriate or better there are still many teachers who object to the rules in the curriculum assessment system. In 2013 curriculum learning, there were still students who did not yet understand the conditions they were supposed to accept or do. Moreover, by learning mathematics, they are still
difficult to find the material that they must learn, so this is where the teacher's role becomes important in this curriculum [9].

In learning, two aspects stand out the most, namely the learning method and learning media as teaching support. Teachers are expected to be able to design learning that provides opportunities for students to actively interact and communicate, both with fellow students and teachers. One way that can make the process of learning mathematics more fun, useful, and is expected to improve learning outcomes in the learning process is the use of learning media.

Learning media is one component of learning that has an important role in teaching and learning activities. The use of media is a part that must get the attention of the teacher in every learning activity. Therefore, the teacher needs to learn how to make a learning media so that it can effectively adjust the learning objectives in the teaching and learning process. One of the dynamic mathematics software that can be used as learning media is GeoGebra. GeoGebra is a good choice for a variety of presentations of mathematical objects because GeoGebra is a dynamic geometry software that helps to form points, lines, and shapes of curves. With the GeoGebra, abstract geometrical objects can be visualized while being manipulated precisely, accurately, and efficiently [35]. In GeoGebra, we can construct points, vectors, line segments, lines, polygons, and conic sections and can change it dynamically afterward. Learning by using computer technology is one of the learning techniques that can make children more interested in learning mathematics and learning is not monotonous by relying on learning models/methods only [36]. The GeoGebra program allows simple visualization of complicated geometric concepts and helps improve students' understanding of the concept. Students can learn more creatively and actively so that it is hoped that the student's mathematical representation skills can be increased [37].

Some existing research, SAVI serve as a model of learning [34,38]. However, only a few researchers use the combination of SAVI learning models with the help of the GeoGebra tool [34]. Likewise in several previous studies, the majority use other media such as Macromedia Flash and PowerPoint. Some use mathematical tools or Matlab [1]. It is rare to combine student-centered learning models using mathematical applications. Therefore, this research innovates in the development of teaching materials with GeoGebra. The combination of mathematical learning models with the use of GeoGebra is characteristic of this study. The ability of mathematical representation is often enhanced by utilizing existing learning models or using only computer-based learning [39,40]. Learning media is still often overlooked for various reasons, including the limited time to prepare for teaching, difficult to find the right media, the lack of funds, and others [41,42]. This does not need to happen if every teacher has the knowledge and skills regarding learning media [43]. Learning media are still under-utilized optimally in the learning process, so students have not yet benefited from the use of media that they should [44]. Inaccuracies in the use of instructional media can also result in students not understanding the actual concepts. Need guidance from experts regarding the use of learning media.

This has become one of the causes of student mathematics learning achievement is still relatively low. Over time, advances in technology are getting faster and better. Now, this progress is not only enjoyed by adults, even small children have been able to follow the development of this technology. There are so many impacts that facilitate the advancement of technology, especially in learning and more specifically on the learning of mathematics. The use of learning media aims to analyze which is better between the use of SAVI learning assisted by GeoGebra by using ordinary learning in improving student's mathematical representation skills and knowing student's attitudes towards learning using SAVI assisted by GeoGebra.

2. Method
The method used in this study is quasi-experimental research methods. This research was conducted in two different groups of research subjects. The first group received treatment from SAVI learning assisted by GeoGebra and the second group received treatment from ordinary learning. The experimental design that will be used in this study is the Non-randomized Control Group Pretest - Posttest Design.

This research was implemented at SMP Negeri 3 Cianjur, the population taken was Class VIII. While the sampling in this research used a purposive sampling technique, the sample used was class VIII-5 as an experimental class and class VIII-7 as a control class. A total of 7 meetings were held, consisting of five meetings to provide learning materials and two meetings for the pretest and posttest. The instrument
used in this study was a test given in the form of test and non-test instruments and learning instruments. This instrument was given to the experimental class and the control class on the same subject matter and where the tests given to the two classes were the same. Test instruments are tested first to find out which questions will be used in the pretest and posttest, which are processed using Anates 4.0.5 Software to determine the validity and reliability of the instrument. The non-test instruments used were questionnaires and journals. The questionnaire was given as many as 20 statements which were divided into negative and positive statements regarding learning and the journal contained student opinions regarding the learning that had been implemented. Data analysis techniques used normality test, Mann Whitney test, and the percentage of achievement indicators. The questionnaire data processing is by presenting the number of respondents from each answer choice.

3. Results and Discussions

3.1. Gain index analysis of mathematical representation skills

Based on Table 1, it can be seen that the average pretest score of the experimental class is 4.16 with a standard deviation of 1.440, while the average pretest score of the control class is 4.71 with a standard deviation of 1.042. This value shows that the difference in the average value of the pretest of the experimental class and the control class was 0.55. Then based on the standard deviation values, it is known that the initial ability of mathematical representation of the experimental class is greater than the control class.

| Class   | N  | Ideal Score | Lowest Score | Highest Score | Average | Standard Deviation |
|---------|----|-------------|--------------|---------------|---------|--------------------|
| Experiment | 31 | 28          | 2            | 7             | 4.16    | 1.440              |
| Control  | 24 | 28          | 3            | 7             | 4.71    | 1.042              |

Then to find out whether the difference in the average pretest value is significant or not, the assumption test is done first, namely the normality test to find out whether the data obtained is from a normally distributed population and the variance homogeneity test which aims to recognize the similarity of variance between control groups and experimental group [45–48]. If one of the tests is not met then fatherly test the average difference between the control group and the experimental group using non-parametric statistics. The results of the calculation of assumption tests for normality can be seen as table 2.

| Class   | Significance | Information                  |
|---------|--------------|------------------------------|
| Experiment | 0.006        | not normally distributed    |
| Control     | 0.029        | not normally distributed    |

Based on the normality test results of the pretest data contained in Table 2, a significance value of 0.006 was obtained in the experimental class and 0.029 in the control class. Because the significant value in both classes is less than 0.05, it was found that both classes came from populations that were not normally distributed. From these results, the statistics used to test differences in the mean of the control and experimental groups use the Mann Whitney test. The calculation results using IBM SPSS version 20 obtained that Asymp. sig of 0.085. Because the significance value obtained is greater than 0.05, then H₀ is accepted. Thus it can be concluded that both classes have the initial ability of equal mathematical representation.

Based on Table 3, it appears that the average score of the experimental class gain index is 0.7919 with a standard deviation of 0.18433, while the average score of the control class gain index is 0.6159 with a standard deviation of 0.27062. This value shows that the average gain index of the experimental class is greater than the average of the control class.
Table 3. Descriptive statistics of gain index data

| Class     | N  | Lowest Score | Highest Score | Average | Standard Deviation |
|-----------|----|---------------|---------------|---------|-------------------|
| Experiment| 31 | 0.29          | 1.00          | 0.7919  | 0.18433           |
| Control   | 24 | 0.09          | 1.00          | 0.6159  | 0.27062           |

Furthermore, to see the increase in each class of the number of students who have increased mathematical representation ability with an interpretation of the quality of improvement, it can be seen in Table 4.

Table 4. Percentage of gain index data

| Gain index | Sum | Experiment Class | Percentage | Control Class | Interpretation | Percentage |
|------------|-----|-----------------|------------|---------------|----------------|------------|
| \( g \geq 0.70 \) | 23  | High            | 74%        | 11            | High           | 46%        |
| 0.30 < \( g < 0.70 \) | 7   | Average         | 23%        | 8             | Average        | 33%        |
| \( g < 0.30 \)    | 1   | Low             | 3%         | 5             | Low            | 21%        |

Based on Table 4, in the experimental class, the number of students who experienced a high increase in mathematical representation was 23 students, 7 students were average, and 1 student was low. In the control class, the number of students who experienced a high increase in mathematical representation was 11 students, 8 students were average, and 5 student was low. Based on these results, the initial conclusion was obtained that SAVI learning assisted by GeoGebra could improve student's mathematical representation skills in the subject geometry plane. A more objective result to see the difference in the average increase in mathematical representation skills in the two classes is done by statistical test analysis. First is the normality test and the variance homogeneity test.

Based on the normality test results of the gain index data contained in Table 5, the significance value for the experimental class is less than 0.05, which is 0.010, so it can be said that the sample gain index obtained from the experimental class comes from populations that are not normally distributed. While the significant value for the control class is greater than 0.05, which is equal to 0.200, so it can be said that the sample gain index obtained from the control class comes from a normally distributed population.

Table 5. Results of gain index data normality test

| Class     | Significance | Information     |
|-----------|--------------|-----------------|
| Experiment| 0.010        | not normally distributed |
| Control   | 0.200        | normally distributed |

Based on Table 5, it is known that the experimental class comes from populations that are not normally distributed and the control class comes from populations that are normally distributed, hence homogeneity tests are not carried out. The next statistical test is a non-parametric test using the Mann Whitney test with the help of the IBM SPSS version 20 software. The Mann Whitney test was carried out to find out whether the improvement in mathematical representation skills of students in the experimental class was better than the ability of mathematical representation in the control class. From the results of the Mann Whitney test it was found that the significance value of 0.017, because it uses a one-sided test, the significance is divided into 2 to 0.0085. This value is smaller than 0.05, so \( H_0 \) is rejected. Thus it can be concluded that increasing the mathematical representation of students through SAVI learning assisted by GeoGebra is better than students who learn by using ordinary learning. From the results of the research that have been described, compared to ordinary learning, learning using SAVI assisted by GeoGebra shows a meaningful role in increasing student's mathematical representation skills.

Based on the Mann Whitney test, students learn through worksheets that are working in groups with SAVI learning assisted by GeoGebra which is presented in front of the class using infocus, this kind of learning is new for students. At the beginning of the meeting, the learning activities were less effective because students were not accustomed to learning in groups especially with the more students compared
to the control class, students still seemed hesitant in asking questions about the material especially to
the teacher [34]. Even like that, it seems that from the beginning to the end of the learning, students
enthusiastically participated in SAVI learning assisted by Geogebra and after being given some
instructions and motivation of learning activities became interactive and dynamic activities [49].

Aside from that, the drawing of a plane in geometry that has been designed using GeoGebra software
provides opportunities for students who in the process involve all student's senses, such as the physical
movements of certain limbs, speaking, listening, seeing, observing, and using intellectuals to think,
describe and make conclusions [50]. This is following the characteristics of SAVI learning because the
role of students in learning is a learning subject that requires students to learn independently and in
groups and then students will find the meaning of learning that has been done through movement,
hearing, observation, and problem-solving or analyzing [51]. Ordinary learning that has been taught is
procedural, can be one of the factors causing the low mathematical representation skill of junior high
school students and it can also make students bored and unhappy with mathematics. In contrast with
SAVI learning assisted by GeoGebra, where the teacher guides students and all five senses students are
involved when learning takes place. The teacher is no longer the only information center, instead,
students will find all the material information that they are learning through the help provided by the

After knowing that the mathematical representation ability of the experimental class is better than
the control class, then the gain index will be seen for all indicators of mathematical representation skill
obtained by the two class groups in this study. The table below presents the student's gain index values
in the experimental class and the control class for each number that includes indicators of mathematical
representation skill. The average of the gain index score can be seen in the following table 6.

| Indicators     | Experiment Class | Control Class |
|----------------|------------------|---------------|
| Mathematical Expression | 0.90             | 0.76          |
| Visual Image   | 0.80             | 0.60          |
| Written Text   | 0.60             | 0.60          |

In table 6, it can be seen that the gain index value of each indicator in the experimental class is greater
or equal than the control class. The experimental class gains index value indicators of the ability of
written text with the moderate interpretation that gets 0.60 and the other are high interpretation that gets
0.80 and 0.90. In the control class, some interpretations are mostly medium that gets 0.60 and those that
have a high interpretation that gets 0.76, so it can be concluded that the increase in the indicators of
student's mathematical representation skill in the experimental class is more than the increase of the
indicators of student's mathematical representation skill in the control class.

Based on Table 6, the dominance of the increase occurred in several indicators. including the
indicators of a mathematical expression, students can represent from the form of words (everyday
problems) and visually to the form of mathematical expression. The combined effect of the learning
model used with GeoGebra tools has changed the paradigm of students that visualizing from story
problems into mathematical expressions and in the form of images is not as difficult as thought [40].
GeoGebra according to its function as a tool makes it easy for students to draw graphics and see
mathematical expressions [35]. The results shown are in line with several studies, including the fact that
improvement in students' representation ability can be increased by using GeoGebra-assisted SAVI
learning models in topic material at various levels of education [52–54].

3.2. Attitude scale analysis

The attitude of students towards learning models that use SAVI learning, GeoGebra Software, and
problems of mathematical representation skills can be seen in Table 7. Based on Table 7, student's
attitudes towards the first indicator about learning using SAVI were almost entirely positive with a
percentage of 89.84%. Student's attitudes toward the second indicator about learning assisted by
GeoGebra were almost entirely positive with a percentage of 88.72%, and student's attitudes toward the
third indicator about problems of mathematical representation ability were almost entirely positive with a percentage of 93.09%. In addition to analyzing student's mathematical representation skills, this research also analyzed student's attitudes towards mathematics learning using SAVI assisted by GeoGebra which can be seen from the analysis of a questionnaire that has been filled out by all students as many as 20 statements with 11 positive statements and 9 negative statements. Based on student responses through the questionnaire, it was found that in general student's responses to learning using SAVI learning assisted by GeoGebra were generally positive, this was inseparable from the learning design and the way the teacher presented and packaged the learning, resulting in positive responses from students.

Table 7. Percentage of overall student attitudes

| Indicators                                  | Average percentage | Information      |
|---------------------------------------------|--------------------|------------------|
| Attitudes towards SAVI learning             | 89.84%             | Generally positive |
| The use of GeoGebra as a learning media     | 88.72%             | Generally positive |
| The problems of mathematical representation ability | 93.09%             | Generally positive |
| Average (%)                                 | 90.55%             | Generally positive |

To be able to see student's attitudes more specifically, an analysis is implemented on each statement indicator. In the first indicator of student's attitudes towards SAVI learning, on this indicator, the average student gives a positive attitude with a percentage of 89.84%. This means that students almost all responded well to the use of SAVI learning in mathematics learning. In the second indicator of student's attitudes towards the use of GeoGebra as a learning media, the average student gives a positive attitude with a percentage of 88.72%. This means that almost all students respond well to the use of GeoGebra as learning media in learning mathematics. In the third indicator of student's attitudes towards the problems of mathematical representation ability given, the average student gives a positive attitude with a percentage of 93.09%. This means that almost all students also respond well to the problems of mathematical representation given to them during the learning process [23]. From the results of the discussion above it can be seen that the attitude of students is almost entirely positive towards the three indicators. So it can be concluded that the attitude of students towards SAVI learning assisted by GeoGebra software is generally positive.

The attitude of students towards SAVI learning assisted by GeoGebra has had a positive impact [40]. In the process, students work together, there is a transfer of knowledge provided, and get maximum results [55]. Psychologically, student attitudes affect student motivation and learning outcomes [56]. In line with other studies, that the impact of attitude has an important impact on the mindset of students when learning takes place both in the classroom and at home [50]. On average by using a specific application-assisted SAVI learning model can help students and facilitate students in learning [23].

4. Conclusions
Based on the results of measurements, observations, and data analysis obtained during mathematics learning research through SAVI learning assisted by GeoGebra, the researchers concluded that increasing of the mathematical representation skill of students who learn to use SAVI learning assisted by GeoGebra is better than students who learn by using ordinary learning. The results of qualitative data analysis through attitude scale questionnaire showed that in general student's attitudes towards SAVI learning assisted by GeoGebra were generally positive.

5. Acknowledgment
Thank you to Universitas Suryakancana for help and support this research. Hopefully, there are benefits taken from the results of this research.
6. References

[1] Maskur R, Sumarno, Rahmawati Y, Pradana K, Syazali M, Septian A and Palupi E K 2020 The effectiveness of problem based learning and aptitude treatment interaction in improving mathematical creative thinking skills on curriculum 2013 *Eur. J. Educ. Res.* 9 375–83

[2] Takači D, Stankov G and Milanovic I 2015 Efficiency of learning environment using GeoGebra when calculus contents are learned in collaborative groups *Comput. Educ.*

[3] Widodo S A, Dahlaj J A, Harini E and Sulistyowati F 2020 Confirmatory factor analysis sosiomathematics norm among junior high school student 9 448–55

[4] Kartowagiran B, Retnawati H, Sutopo and Musyadad F 2017 Evaluation of the implementation of curriculum 2013 vocational *Int. Conf. Educ. Res. Innov. (ICERI 2017)* 814–9

[5] Kozak S, Ruzicky E, Stefanovic J and Schindler F 2018 Research and education for industry 4.0: Present development *Proceedings of the 29th International Conference on Cybernetics and Informatics, K and I 2018* vol 2018-Janua pp 1–8

[6] Hendriawan M A and Septian A 2019 Pengembangan JiMath Sebagai Multimedia Pembelajaran Matematika Berbasis Android Untuk Siswa Sekolah Menengah Atas *IndoMath Indones. Math. Educ.* 2 45

[7] Dina Z H, Ikhsan M and Hajidin H 2019 The Improvement of Communication and Mathematical Disposition Abilities through Discovery Learning Model in Junior High School *JRAMathEdu (Journal Res. Adv. Math. Educ.*)* 1 11–22

[8] Olowe P and Kutelu B 2014 Perceived Importance of ICT in Preparing Early Childhood Education Teachers for The New Generation Children *Int. J. Eval. Res. Educ.* 3 119–24

[9] Sutama S, Narimo S and Samino S 2015 Management Of Curriculum 2013 Mathematic Learning Evaluation In Junior High School *Int. J. Educ.* 7 164

[10] Astunngtias K I and Appulembang O D 2017 Penerapan Metode Drill Untuk Meningkatkan Hasil Belajar Kognitif Siswa Kelas IX Materi Statistika di SMP Kristen Rantepao [The Implementation of The Drill Method To Improve Cognitive Learning Outcomes Of Grade 9 Students Studying Statistics At A Christian JOHME J. Holist. Math. Educ.] 1 53

[11] Trisnaawati, Muanifah M T, Widodo S A and Ardiyaningrum M 2019 Effect of Edmodo towards interests in mathematics learning *J. Phys. Conf. Ser.* 1188 012103

[12] Krisdiana I, Masfingatin T, Murtafiah W and Widodo S A 2019 Research-based learning to increase creative thinking skill in mathematical Statistic *J. Phys. Conf. Ser.* 1188 012042

[13] Krisdiana I, Masfingatin T, Murtafiah W and Widodo S A 2019 Worksheet-Based Learning Research to Improve Creative Thinking Skills *Journal of Physics: Conference Series*

[14] Sari D S, Kusnandi K and Suhendra S 2017 A Cognitive Analysis of Students’ Mathematical Communication Ability on Geometry *J. Phys. Conf. Ser.* 895

[15] Kolodin I and Ryabinin M 2019 Mathematical representation of pressure regulator with variable characteristic *IOP Conference Series: Materials Science and Engineering* vol 589

[16] Utami C T P, Mardiyan and Triyanto 2019 Profile of students’ mathematical representation ability in solving geometry problems *IOP Conference Series: Earth and Environmental Science* vol 243

[17] Purnami A S, Widodo S A and Prahmana R C I 2018 The Effect Of Team Accelerated Instruction On Students’ Mathematics Achievement And Learning Motivation *Journal of Physics: Conference Series* vol 948

[18] Widodo S A, Prahmana R C I, Purnami A S and Turmudi 2017 Teaching materials of algebraic equation *J. Phys. Conf. Ser.* 943 1–6

[19] National of Council Teacher of Mathematics 2000 *Principles and Standards For School Mathematics* (Virginia: NCTM)

[20] Widodo S A, Istiqomah, Leonard, Nayzik A and Prahmana R C I 2019 Formal student thinking in mathematical problem-solving *J. Phys. Conf. Ser.* 1188 012087

[21] NCTM 2006 *Curriculum Focal Points for Pre-K-Grade 8 Mathematics: A Quest for Coherence* vol 13

[22] Warsito, Darhim D and Herman T 2018 Improving students’ mathematical representational ability through RME-based progressive mathematization *Journal of Physics: Conference Series*
Orozco C and Morales-Morgado E M 2017 Geometric representations built with geogebra for improving the visualization and reasoning cognitive process J. Inf. Technol. Res. 10 39–58

Ifanda A R and Septian A 2019 Peningkatan Kemampuan Representasi Matematis dan Self-Confidence Siswa Melalui Model ARIAS (Assurance, Relevance, Interest, Assessement, Satisfaction) UNION J. Ilm. Pendidik. Mat. 7 285–97

Delima E T, Tana L, Halim F S, Lannywati Ghani, Hadi Siswaoyo, Sri Idaiani A L, Widowati1 L, Gitawati1 R, Sihombing1 M, Tjahja I, Notohartojo1, Sintawati1, Tince Arniati Jovinal1 M K, Nugroho2 P, Djoko, Wibisono3, J. Sarwono4, Heidy Agustin5, Suhardjono2 S S and Siswaanyo1 S 2014 Risk Factors for Chronic Kidney Disease: A Case Control Study in Four Hospitals in Jakarta in 2014 Bul. Penelit. Kesehat.

Nugroho I D and Widodo S A 2018 Pembelajaran Matematika Dengan Metode Penemuan Terbimbing Untuk Meningkatkan Kemampuan Representasi Dan Pemecahan Masalah Matematis Siswa SMK Prosiding Seminar Nasional Pendidikan Matematika Etnomatnesia

Kusuma D A 2019 Peningkatan Komunikasi Matematis Siswa Menggunakan Pembelajaran Kontekstual Berbasis Ethnomatematika Dengan Penerapan Mozart Effect (Studi eksperimen terhadap siswa Sekolah Menengah Pertama) TEOREMA Teor. dan Ris. Mat.

Kusuma D A 2020 Peningkatan Representasi Matematis Menggunakan Pembelajaran Ethnomathematics dengan Penerapan Mozart Effect Indomath Indones. Math. Educ.

Lestari, Andinasari A and Retta A M 2020 Model Pembelajaran Generatif Untuk Meningkatkan Kemampuan Representasi Matematis Peserta Didik Indomath Indones. Math. Educ.

NCTM 2014 Executive summary principles and standards for school mathematics Natl. Counc. Teach. Math. 1–6

Inayah S, Septian A and Suwarman R F 2020 Student Procedural Fluency in Numerical Method Subjects Desimal J. Mat. 3 53–64

Tarigan F A and Surya E 2017 The Application of Cooperative Learning Model of Jigsaw Type to Increase Activity And Student Learning Results In Learning Phytagoras Theorem IJARIE Int. J. Adv. Res. Innov. Ideas Educ. 3 882–91

Warner S and Kaur A 2017 The Perceptions of Teachers and Students on a 21st Century Mathematics Instructional Model Int. Electron. J. Math. Educ. e-ISSN 12 193–215

Wijayanti S and Sungkono J 2017 Pengembangan Perangkat Pembelajaran mengacu Model Creative Problem Solving berbasis Somatic, Auditory, Visualization, Intellectually Al-Jabar J. Pendidik. 101–10

Tasman F and Ahmad D 2018 Visualizing Volume to Help Students Understand the Disk Method on Calculus Integral Course IOP Conference Series: Materials Science and Engineering vol 335

Septian A 2017 Penerapan Geogebra untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Mahasiswa Program Studi Pendidikan Matematika Universitas Suryakancana PRISMA 6

Hallal R, Hellmann L, Sandmann A, Carvalho A P, Reinaldo F and Hotz C 2016 Geogebra in teaching of Differential Integral Calculus 1 Espacios 37

Agustina F N, Yurniati and MS Z 2019 Pengaruh Model Pembelajaran Savi (Somatis, Auditory, Visualization, Intellectual) Terhadap Kemampuan Koneksi Matematis Siswa di Kelas V Sekolah Dasar Din. Mat. Sekol. Dasar I 1–11

Little C 2011 Approaches to Calculus Using Geogebra Model-Centered Learning pp 191–204

Korenova L 2017 GeoGebra in teaching of primary school mathematics Int. J. Technol. Math. Educ. 24 155–60

Widodo S A, Darhim and Ikhwanaudin T 2018 Improving mathematical problem solving skills through visual media Improving mathematical problem solving skills through visual media J. Phys. Conf. Ser. 948 1–6

Widodo S A, Dahlan J A and Turmudi 2019 Can Sociomathematical Norms Be Developed With Learning Media? J. Phys. Conf. Ser. 1315

Widodo S A 2018 Selection of Learning Media Mathematics for Junior School Students Turkish
Online J. Educ. Technol. - TOJET 17 154–60

[44] Hakim L L, Alghadari F and Widodo S A 2019 Virtual manipulatives media in mathematical abstraction Journal of Physics: Conference Series

[45] Hopkins K D and Weeks D L 1990 Test for Normality and Measures of Skewness and Kurtosis: Their Place in Research Reporting Educ. Psychol. Meas. 50 717–29

[46] Liliefors H W 1967 On the Kolmogorov-Smirnov Test for Normality with Mean and Variance Unknown J. Am. Stat. Assoc. 62:318 399–402

[47] Glass G V 1966 Testing Homogeneity of Variance Am. Educ. Res. J. 3 187–90

[48] Glass G V, Peckham P D and Sanders J R 1972 Consequences of Failure to Meet Assumptions Underlying the Fixed Effects Analyses of Variance and Covariance Rev. Educ. Res. 42 237–88

[49] Nopiyani D, Turmudi T and Prabawanto S 2018 Penerapan Pembelajaran Matematika Realistik Berbantuan GeoGebra untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa SMP Mosharafa J. Pendidik. Mat. 5 45–52

[50] Rahmadian N, Mulyono and Isnarto 2019 Kemampuan Representasi Matematis dalam Model Pembelajaran Somatic, Auditory, Visualization, Intellectually (SAVI) | PRISMA, Prosiding Seminar Nasional Matematika Prism. Pros. Semin. Nas. Mat. 2 287–92

[51] Ulvah S and Afriansyah E A 2016 Kemampuan Pemecahan Masalah Matematis Siswa ditinjau melalui Model Pembelajaran SAVI dan Konvensional J. Ris. Pendidik.

[52] Hohenwarter M, Hohenwarter J, Kreis Y and Lavicza Z 2008 Teaching and calculus with free dynamic mathematics software GeoGebra 11th Int. Congr. Math. Educ. 1–9

[53] Machromah I U, Purnomo M E R and Sari C K 2019 Learning calculus with geogebra at college Journal of Physics: Conference Series vol 1180

[54] Granberg C and Olsson J 2015 ICT-supported problem solving and collaborative creative reasoning: Exploring linear functions using dynamic mathematics software J. Math. Behav.

[55] Istiqomah A N, Kurniawati I and Wulandari A N 2020 The implementation of somatic, auditory, visualization, intellectually (SAVI) learning approach to improve students’ attention toward mathematics learning J. Phys. Conf. Ser. 1563 012033

[56] Sepriyanti N, Remiswal R, Fauziah D and Nelwati S 2019 Comparative study on using SAVI versus VAK to improve students’ mathematical concepts ability J. Phys. Conf. Ser. 1155