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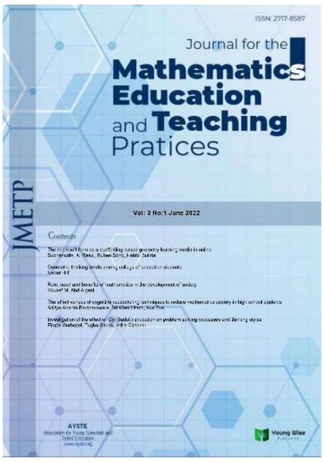

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Research Article

The Microsoft form as a scaffolding-based geometry learning media in online learning

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Abstract

Geometry learning outcomes are lower than other mathematical fields, so media are needed to overcome students' difficulties solving geometry problems. This study aims to produce a product in online learning media for scaffolding-based geometry materials using Microsoft Form. There are three stages of Research and Development research, namely preliminary research, prototyping, and assessment. The validation results show that the scaffolding-based media developed is valid with a percentage of 76%. Field notes show that the scaffolding-based media developed can be used easily and practically by lecturers and students. A positive response was also given by 30 third semester students who used media in learning circle material. The test results showed that 73% of the total number of students scored no less than 70. Therefore, the scaffolding-based media developed was declared valid, practical, and effective in learning circle material.

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Introduction

Geometry is essential to master because itis one of the fields that connect mathematics with real life, becomes a form of representation of mathematical ideas, and provides non-single examples of mathematics (Hadiyanto & Wulandari, 2019).

As an essential scientific branch in mathematics, Geometry is not supportedby good learning outcomes by students. The test results in geometry are the lowest compared to other mathematics fields(Kresna et al., 2017; Mulyadi & Muhtadi, 2019). The observations also show thatstudent learning outcomes in Analytical Geometry lectures in the Mathematics Education Study Program are still dominated by average scores. This low learningoutcome can be caused by many mistakesmade by students, both conceptual, procedural or technical errors (Mulyadi & Mu-htadi, 2019). Conceptual errors and calculation errors are the types of errors that are most often made in solving mathematical problems (Utami et al., 2019).

Giving scaffolding or assistance suit-able for student's abilities and needs can minimize students' errors (Prayitno et al., 2018; Widjajanti et al., 2019). Wood, Bruner and Ross stated that the concept of scaffolding is to describe how studentscan have more ability to solve problems with someone's help (Reiser & Tabak, 2014). Furthermore, Reiser &

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Tabak(2014) state that there are several forms or techniques of scaffolding, including direct interaction with other people and data sources or by providing an environment or facility that supports problem-solving. The state of scaffolding or assistance provided to students can be in the form of instructions, encouragement, warnings, giving examples, and other ac- tions that can make students think about the process to achieve results (Fatahillah et al., 2017; Prayitno et al., 2018; Intan & Masriyah, 2020). Lecturers need to pro- vide scaffolding to help students solve problems on their own. However, there are not many studies that discuss the pro-vision of scaffolding in online mathematics learning.

The provision of scaffolding inonline mathematics learning can be provided through synchronous meetingsthrough zoom meetings or other meetingapplications so that students get a direct response from the lecturer (Salyers et al., 2014). However, financial problems andthe availability of networks in online learning in Indonesia do not allow the dominance of synchronous learning whenlearning online (Agus & Hadi, 2020; Lubis et al., 2020; Puspitasari, 2020). Another alternative in providing guidance or scaffolding to students is through learning media in the form of modules. The mod- ule is one of the teaching materials with specific criteria (Yasa, 2018) that can as- sist the implementation of learning activities. Fonna & Mursalin (2018) said that themodule could help students both individually and in groups. Ekawati et al., (2019) also stated that the module is designed systematically and contains informationabout materials, methods, limitations, and evaluations to help students achieve the competencies set. However, there arenot many modules or electronic media containing scaffolding to help students learn mathematics in online learning.

Previous research related to scaffolding learning media has been carried out. Pratama & Saregar's (2019) study de veloped scaffolding-based worksheets on heat material used in classroom learning. However, worksheets are still designed for online learning and physics material. Avalid, practical and effective e-scaffoldingmedia was developed by Ayu et al., (2017)by using a website, but the media still has weaknesses which include writing relatively complicated mathematical physics equations on the website. Therefore, the researcher sees the need for the develop ment of scaffolding-based learning mediausing Microsoft Form. One of these Microsoft facilities is developed and used online through the website (Microsoft, 2021a) by logging in first. One of the Microsoft Form facilities is a branching menuthat can link one question to another (Microsoft, 2021b) according to the need for providing scaffolding.

Media use in learning has an essential role for students and teachers to achieve learning success (Junaidi, 2019). Learning media can also be an alternativesource of learning to provide more opportunities for students to play an active rolein learning (Hardjito, 2019). The use of learning media is still needed at the university level. Inganah & Zukhrufur-rohmah, (2020), in their research, stated that the use of printed worksheets characterized by guided discovery could help students find ways to solve systems of linear equations n variables. Utilization ofmedia in learning in higher education has various forms and benefits in learning in higher education; use of GeoGebra mediato increase interest in learning (Wondo etal., 2020) and problem-solving abilities (Dwijayani, 2020), use of learning management systems (LMS) (Pratiwi & Silalahi, 2021; Mardiana & Faqih, 2019), and use evaluation applications to improve student learning outcomes and valuation (Wijayanti et al., 2021).

Learning media is increasingly visible in learning during the COVID-19 Pan- demic due to the implementation of online learning. At the university level, theuse of media is essential, especially in mathematics. Media that are often used during online learning are podcast Sortify(Susilowati et al., 2020), google classroomor WhatsApp (Agus & Hadi, 2020), google form (Lestari & Putra, 2020) or Quizizz(Wijayanti et al., 2021) for learning evaluation, and learning videos (Ario et al., 2020). In addition, for face-to-face virtual meetings, zoom meetings or google meetare used (Hadiyanto & Wulandari, 2019).

Research related to Microsoft Form for mathematics learning media has not been widely developed, especially in online learning. Therefore researchers are interested in developing valid, practical and effective learning media containing scaffolding using Microsoft Form. In addition, this article also conveys the characteristics of the scaffolding-based learningmedia developed. The results of this studyare expected to be a reference for studentself-study in improving problem-solvingskills related to the field of geometry, especially in the Analytical geometry course. The development of this scaffolding-based media can also be a reference for learning analytical geometry and otherlessons in providing scaffolding and variations of online learning activities or distance learning to students.

Method

The development of Microsoft Form as a scaffolding-based learning medium ongeometry material is carried out through 3 stages of development (Plomp et al., 2010): Preliminary research, prototyping, and assessment stage. Preliminary re- search begins by making observations on learning activities, problems with learningoutcomes of geometry, then reviewing the literature to find alternative solutions to problems and determine the differentiator of the research carried out. At this stage, the researcher prepared research's instruments in the form of media validation sheets, student response questionnaire sheets, field notes on the implementation of learning, and test sheets to test the effectiveness of the developed media.

The next step is prototyping. Avideo link for learning circle material isprepared at this stage, which includes equations, elements, and tangents to circle families. The section on the media contains student identities and problems as well as scaffolding prepared according to the student's ability to solve the problems given. After the circle material learning media is complete, validation and re- vision are carried out until it is ready to learn. The validation of the learning mediadeveloped was carried out through 2stages: validation to media experts who are lecturers in the field of developing mathematics learning media and small group testing on 40 students in different classes with research subjects.

The last stage is a summative assessment where the revised learning media according to the validator's suggestionand the lecturer uses small group test in analytic geometry. The subjects in this study were 30 students of the 3rd-semester mathematics education study pro- gram taking Analytical Geometry courses.The subject of using learning media using Microsoft Form is different from the subject of the small group test. Media is said to be practical if the results of field notes by observers show a positive response. Atthe same time, the learning media is effective if not less than 70% of all students get a minimum score of 70.

Analyzing data from the validation sheet and student response questionnairefollows some steps: 1) adding up the scores for each indicator given by the respondents, 2) dividing the total score (each indicator) with the maximum score, and 3) concluding based on the scores obtained. Researchers analyzed the field observation results by considering the out- line of the implementation of learning andimportant notes of the observer. At the same time, the test sheet is analyzed by determining each student's score and then counting the number of studentswho get a minimum score of 70.

Results and Discussion

The results of observations related to learning activities in analytical geometry lectures show that lectures are carried out online. While adjusting to the conditions of the COVID-19 pandemic, learning is carried out online or remotely. The supporting application used by lecturers and students during the teaching of analytic geometry course is the learning management system (LMS), elmu.ac.id, with a discussion feature (question and answer) related to learning materials, a video up- load feature of learning materials made by researchers and task or quiz collection.During learning activities, evaluation is carried out by technically sending questions that the lecturer has made to the LMS, then students send the answers thathave been typed or scanned through the LMS.

The problem observed during learning activities is that most of the student learning outcomes during distance learning have not reached the minimum standard. This is because students make mis- takes in solving problems and students still have difficulty choosing the right problem-solving steps. Therefore, learning media is needed that can also aid students in solving problems.

The literature study results show that providing assistance or scaffolding tostudents can help solve problems and still give students an active role as problem solvers (Wijayanti et al., 2021). The provision of scaffolding is given according to students' errors or responses (Intan & Masriyah, 2020). In this design, scaffolding is given if the student gives the wrong answer to the given problem. The scaffolding given is a question of guiding questions related to the basic conceptsneeded to solve the problem. If in the firstscaffolding the student answers incorrectly, then a question is given as the second scaffolding. If students can answerthe scaffolding correctly, students are asked to answer the problems given again.

Based on literature studies, the media that are widely used as evaluation media are Google Form (Susilowati et al., 2020), Quizizz (Wijayanti et al., 2021) andEdmodo (Pratama & Ismiyati, 2019). How-ever, on Google Form, writing mathematical symbols can be an obstacle in choosing Google Form and Quiziz as the media used in this study. At the same time, Ed- modo does not have the facility to displaythe scaffolding that has been implemented. So the Microsoft Form application was chosen which can display mathematical symbols correctly and has branching facilities to adjust the location of the given scaffolding.

The instrument consists of a media validation sheet, a student response questionnaire sheet, a learning observation sheet, and a test sheet. The media validation sheet measures the suitability of the material presented with learning outcomes, clarity of images and sound of learning videos attached to MicrosoftForm, clarity of images and correctness of symbols and answer keys to questions on Microsoft Form. The student response questionnaire sheet measures students' responses and impressions after using Microsoft Form media through aspects ofproblem sentence clarity and the scaffolding provided, the suitability of the scaffolding provided with problem-solving, the benefits of scaffolding and learningvideos, and clarity of instructions on the media. Aspects that are measured from the implementation of learning using the media are the flow of learning activities, the smooth use of media and the implementation of tests after using the media. Lecturers provide direction through LMS related to the flow of learning activities and the duration of each activity that students need to pay attention to. Student activities begin by accessing online mediaon the link provided and then listening to learning videos whose links are presentedon the media. After watching the video material, students returned to the Microsoft Form link to fill in their identities and solve existing problems. After using the Microsoft Form media, the lecturer directed the students to fill out a student response questionnaire in a Google Form. The lecturer asks students to study the material through the provided learning videos and practise solving problems on Microsoft Forms again. At the next meeting, there will be a test. The question sheet contains four analytic geometry questions, which include the equation of acircle, a family of circles, the equation of acircle that passes through the intersectionof two or more circles. Students upload questions and collect answers via LMS. Processing time is 75 minutes.

Prototyping Phase

The design of scaffolding-based learning media contains work instructions, studentidentities, problems, and scaffolding. Thelearning video provided includes an explanation of lecture material about the equation of a circle to determine the equation of a circle through the intersection of twocircles. Learning videos are made by the lecturer concerned in collaboration with researchers. In the learning video, there isa PowerPoint display and an explanation voice from the lecturer. Students areasked to listen to the learning videos pre- pared via the link written in the work instructions. After watching the learning video, students return to the Microsoft Form link and fill in their identities. After filling in the identity, students are faced with problems that have been prepared. Students can only access the second problem if the first problem is correct, and so on so that if students can answer the scaffolding correctly, students will be directedback to the main problem. Scaffolding in each problem has a different amount de- pending on the difficulty level of the problem. Figure 1 below shows the flow of problems and scaffolding presented in thelearning media.

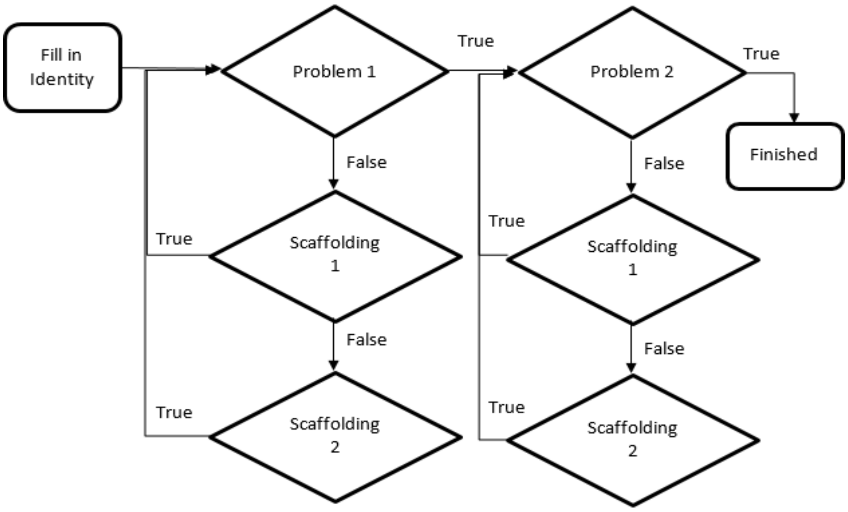
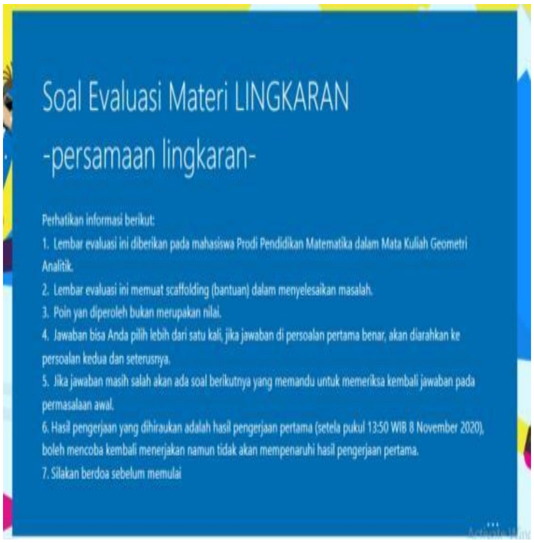


Figure 1. The Flow of Scaffolding Problems in Learning Media

Scaffolding-based learning media is designed based on the circle material in the Analytical Geometry course. Learning media is prepared using the Microsoft Forms online platform. Microsoft Form was chosen to compile this media because it has a branching feature, which can direct students if they choose the wrong answer. The form consists of questions equipped with scaffolding in prompting questions that direct students to the correct concepts and answers. The initial display on the media contains the title, spelling instructions and student identity fields, as shown in Figure 2.



Translation

CIRCLE Material Evaluation Question

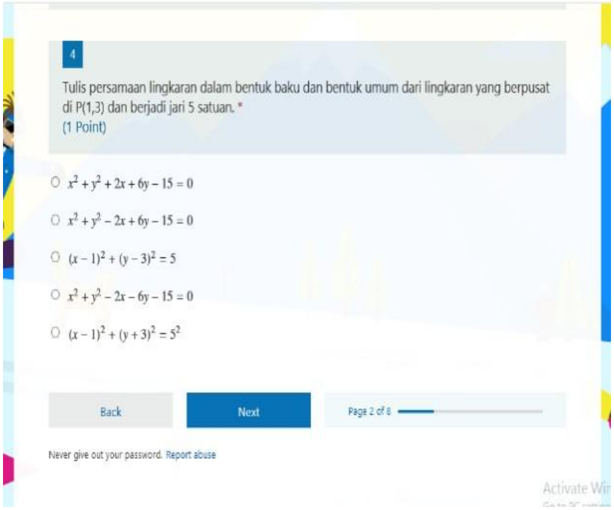
-equation of a circle-

Pay attention to the following information:

1. This evaluation sheet is given to students of the Mathematics Education Study Program inAnalytical Geometry.
2. This evaluation sheet contains scaffolding (as- sistance) in solving problems.
3. Points earned are not grades.
4. You can choose the answer more than once; if the answer in the first question is correct, it will be directed to the second question and so on.
5. If the answer is still wrong, there will be a next question to re-examine the answer to the ini- tial problem.
6. The work results that are ignored are the first work (after 13:50 WIB 8 November 2020); you may try to work again, but it will not affect the results of the first work.
7. Please pray before starting.

Figure 2. Home Page View

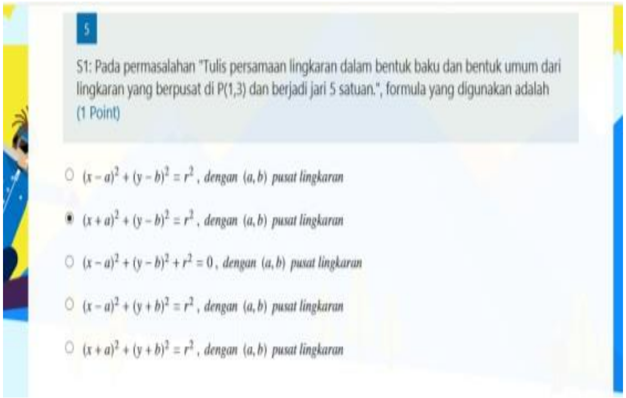
After filling in their identity, students are directed to the first problem. If the student can answer the initial problem correctly, then the student can proceed to the next problem by selecting the next button. The display in Figure 3 shows an example of initial questions on the media. There were seven initial problems which was contained in media with three submaterials: circle equality form, the graph of circle equality and the standard form of circle.



Problem 1: Write the equation of a circle in standardform and the general form of a circle with centre at P(1,3) and radius 5 units. general form of a circle with centre at P(1,3) and radius 5 units. n of a circle in standard form and the general form of a circle with centre at P(1,3) and radius 5 units. the equation of a circle in standard form and the general form of a circle with centre at P(1,3) and radius 5 units.

Figure 3. Example of the Display of Questions on the Media

If students choose the wrong answer to the initial problem, the system will display scaffolding or first aid in guiding questions. If the students' first aid is incorrect, the system will display a second aid where the second aid is a guiding question based on information or concepts in the first aid.

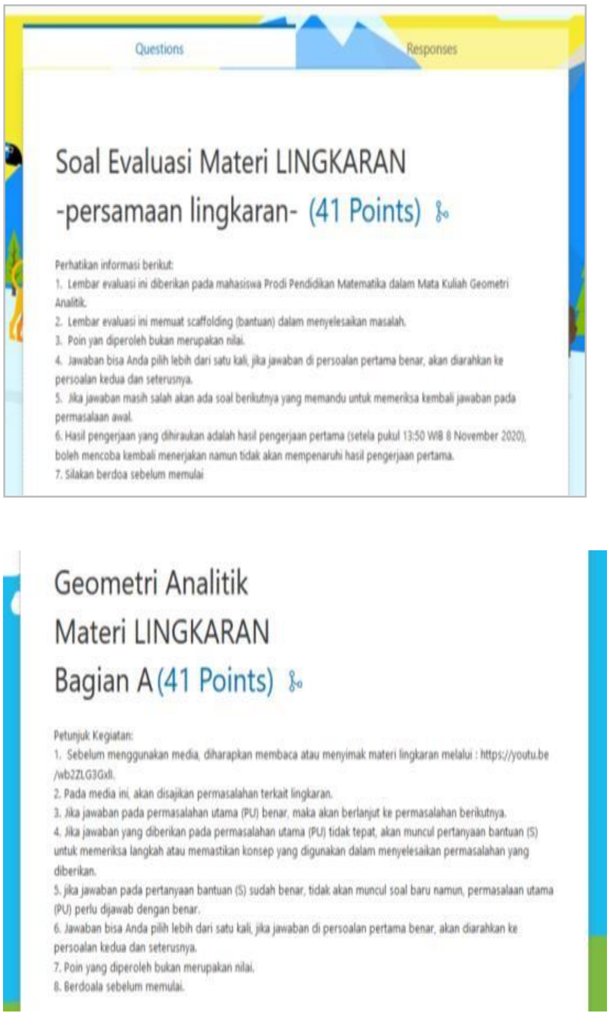


S1: In the problem "Write the equation of a circle instandard form and the general form of a circle withcenter at P(1,3) and radius 5 units.", the formula used is ...

Figure 4. Example of First Scaffolding Display (S1)

Formative Evaluation

Validation is carried out by lecturers of mathematics education study programs who are experienced in the development and manufacture of learning media. The alidation results show that the scaffolding-based media developed is valid, and it is recommended to be tested in small groups. The percentage value of media validation obtained from media experts is 76%. The changes made based on the validation results from media experts are presented in Figure 5.



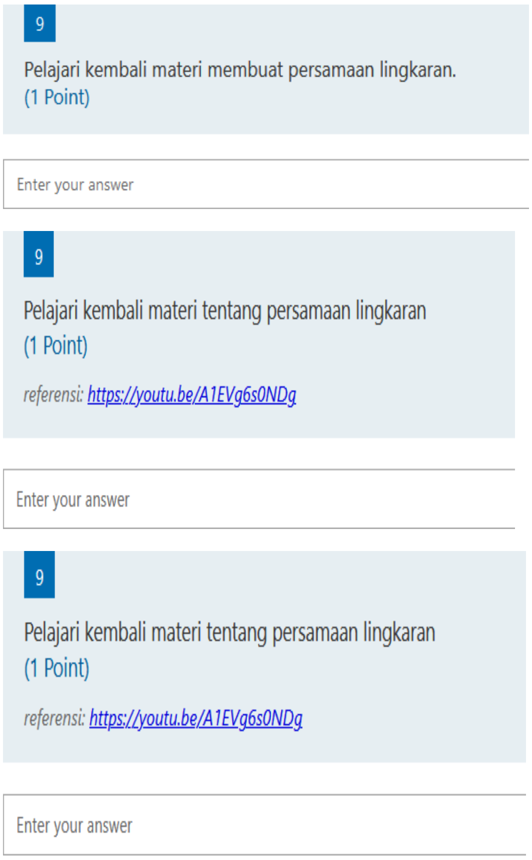
Analytical Geometry
CIRCLE material Part A

Activity Instructions:
Before using the media, it is expected to reador listen to the circle material via: https://youtu.be/wb2ZLG3GxlI.

1. This media will present problems related tocircles.
2. If the answer to the main problem (PU) is correct, it will continue to the next problem.
3. If the answer to the main problem (PU) is not correct, a help question (S) will appear to check the steps or ensure the concept used to solve thegiven problem.
4. If the help question (S) is correct, no new questions will appear. However, the main problem (PU) needs to be answered correctly.
5. You can choose the answer more than once. If the answer in the first question is correct, it will be directed to the second question and so on.
6. Points earned are not grades.
7. Pray before starting.

Figure 5. The Display of media before revision (top) and after Revision (Bottom)

In the last scaffolding for each problem, it is recommended to provide one source as a reference for learning rather than only providing suggestions for relearning. The references were from YouTube Channel which consist of specific materials. This reference videos is open acces so everyone could use it to study. Figure 6 shows the media before and after being revised in the final scaffolding section. Last help is given if the student cannot answer correctly the most uncomplicated service that leads to the basic concepts of circle material.



Review the material about the equation of a circle.

Review the material about the equation of a circle.source: https://youtu.be/A1EVg6s0NDg

Review the material about the equation of a circle. reference:https://youtu.be/A1EVg6s0NDg

Figure 6

Final Scaffolding Display before Revision(Top) and After Revision (Bottom)

Small group trials were conducted on students in other classes to examine media use from the user's (student) point of view. Based on the results of small group trials, there are improvements inthe formula for finding the radius of a circle. Figure 7 shows the improvement in formula writing before and after the revision based on the results of small group trials. The formula to find the radius was written as $r \frac{1}{2}\sqrt{A+B+4C}$ before the correction and became $r = \frac{1}{2}\sqrt{A+B+4C}$ after revision. The vali- dation and small group test results showed that the media was suitable for classroom learning with corrections that the researcher had made. Therefore, the media is used in Analytical Geometry learning after revision.

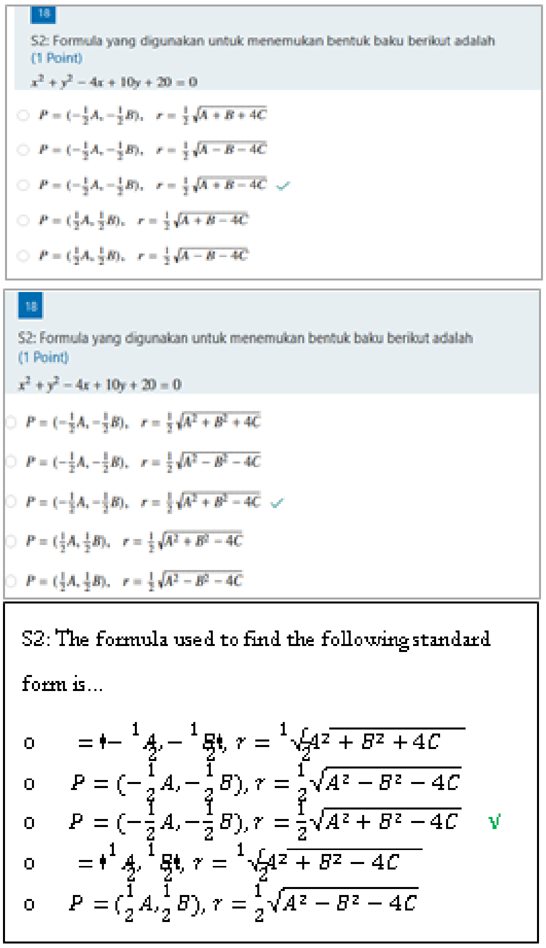


Figure 7 Writing Formulas before Revision (Top) and After Revision (Bottom)

Learning activities show that lecturers and students can use the scaffolding- based learning media developed easily and practically. The lecturer's field notes show that scaffolding-based media is easyto use because there is a link that media can open on a smartphone or laptop. The material contents contained in the learning media are equations of circles, familiesof circles and equations of tangents. If you want to add material or questions, lecturers can do it easily through their existing Microsoft account. The use of media inlearning is by learning conditions that re- quire not face-to-face like during this pan-demic.

A positive response was also given by 30 third semester students who used media in learning circle material. Student responses showed that 78% of 30 studentsstated that this media helped students understand the material well, the media waseasy to understand and the images presented were clearly visible. More than 80% of 30 students stated that the scaffolding provided was suitable for thegiven problem and could help understandthe circle material. In addition, students also said that they could use scaffolding- based media easily online. Existing references and learning videos help explain thematerial and are clear, but students preferto do learning by using zoom meetings in learning mathematics. Another aspectstudents feel is lacking is that the clarity ofthe images displayed is still not large enough. The lacking of clear figures was conveyed by students who use smartphones in using media.

Assessment Phase (Summative Evaluation)

The development of scaffolding-basedmedia aims to help students develop spatial thinking skills in understanding the material in analytic geometry, especially in the circle material. The recapitulation ofstudent test results shows that 73% of students get a score of not less than 70. Figure 8 shows a recap of the number of students based on test scores. The test results show that the media developed is effective to help students in learning ana- lytic geometry of circle material in online learning.

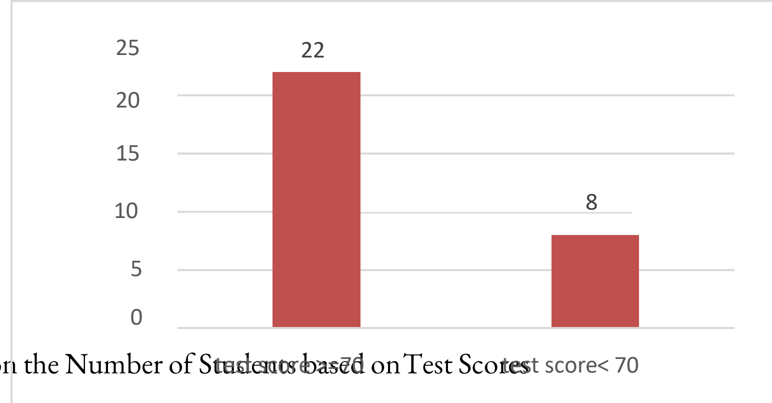


Figure 8. Comparation the Number of Students based on Test Scores

Discussion

The Microsoft Form as an e-survey hasbeen used by Hikmah (2020) in collecting research data regarding the benefits of e-learning. However, the use of Microsoft Form as a learning medium such as this re-search has not been widely carried out. The use of other applications as student worksheets using Google Form has been carried out by Iqbal et al., (2018). How- ever, the facility on Google Forms is not easy to write mathematical equationsproperly and correctly (Lindsay, 2020), so Microsoft Forms facilities can overcome this deficiency of Google Forms (Microsoft, 2021a). The findings of this development research resulted in electronic learning media with scaffolding characteristics that were valid, practical and effective. The scaffolding-based learning media developed can be appropriately used and easily by lecturers and students.Electronic media characterized by scaffolding in a website is also practical and effective in learning (Ayu et al., 2017). The provision of scaffolding helps students solve the main problem by recalling concepts related to the problem (Yunus et al.,2017). In line with Ayu et al., (2017) and Miatun & Khusna (2020), research findings show that providing online scaffolding through learning media can support student learning outcomes in online learning or distance learning.

Conclusion

Scaffolding-based media on analytic geometry circle material was created using existing facilities in Microsoft Form. The development of media in scaffolding-based learning media was declared valid by the validator and the results of small group trials. After being revised based on suggestions from the validator and small group trials, scaffolding-based learning media is used in learning by lecturers whoteach analytic geometry courses. Field notes show that scaffolding-based learning media can be used easily and both by lecturers and students. Student responses indicate that the scaffolding-based learning media used is quite helpful for students in understanding the circle material in online learning. The results of filling in student responses also show that scaffolding-based learning media makes online learning exciting. However, students still feel that the delivery of materialneeds to be done using a web meeting. The tests' results showed that 73% of the 30 students scored no less than 70. There-fore, the scaffolding-based media developed was declared valid, practical, and effective.

The images presented on the mediaare clear enough. Still, it would be better if they were presented in a simulation so that the object of the problem can be observed thoroughly from various sides. In addition, this learning media can be formed into learning applications to beused on smartphones. The provision of scaffolding in this research is based on theproblems given to be different from different problems. In further research, the scaffolding provided can be adapted tothe concept of the material to be studied to be used in general.

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Research Article

Geometric thinking levels among college of education students

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Abstract

Geometry is a key area of math. Reviewing the curriculum of primary and secondary school indicates that geometry is one of the major academic subjects, and it is consider one of the most difficult areas of mathematics to pupils. Quite a few studies conducted in recent decades reported the difficulties encountered by pupils that learning geometry. One of the main reasons for these difficulties is the gap between the level of teaching and learning abilities to the level of pupils understanding. The pupils are low-leveled geometric thinking, while the teachers are trying to provide them their high-leveled knowledge. Students that received in the mathematics department at academic college specialize elementary and junior high School curriculums are committed to studying various courses in geometry. Our experience at college of education, meet us with students that have difficulty at learning geometry. In order to make teaching more effective and efficient, we conducted a study that examining the level of geometric thinking of the students who want to be math teachers and come to learn in college of education. To this end, a questionnaire was comprised of 15 questions that examine the first three levels of geometric thinking by Van Hiele theory. The questionnaire was given to students who specialize in mathematics program primary and secondary school (N=84). The conclusion obtained from the study is that a significant proportion of the students received in the mathematics department at academic college control only at the lowest level. In order to qualify students to the third level, at least, we need to teach them geometric during the first semester of learning.

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Introduction

Quite a few studies conducted in recent decades reported the difficulties encountered by students in learning geometry (Senk, 1984; Usiskin, 1982). One of the main reasons for these difficulties is the gap between the level of teaching and learning abilities to the level of pupils understanding. The pupils are low-level geometric thinking, while the teachers are trying to provide them the high-level of knowledge of their own (Patkin, 1994). The teachers usually teach the higher-level that is not appropriate level of the pupil's abilities and understanding.

Many of the research on geometric thinking focused more on theory of Van Hiele (see Section 2.2.1). A series of studies on the subject were shown that, there are difficulties in learning geometry in Primary school for young pupils (Vinner & Hershkowitz, 1983). These difficulties are reflected in the low geometric thinking of pupils on the basis of the theory of Van Hiele. Usiskin (1982) found that the majority of high school pupils and students at college of education do not control all the levels of thinking of Van Hiele, but until the third level (Ordering), and that is even after learning geometry. Burger and Shaughnessy (1986) found that, a year after completing the study of geometry,

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pupils and students could withdraw from their Van Hiele level. Hershkovitz (1991; 1992) discusses the role played by visualization at acquisition of geometric concepts according to the Van Hiele theory and Piaget's theory.

Tepper (1986) founds that, the use of computer learner integrate effectively, sufficiently the means of stimulation such as color, sound, and animation, promotes the pupils greatly about geometric thinking levels. Patkin (1994) found that, over the time the level of thinking of the pupils who studied with computer-aided (by illustrating the visually sides) is higher than those who studied using worksheets.

Hershkowitz and Vinner (1984) reported about teachers in eighth grades who have difficulty understanding the geometric concepts as much as their pupils do. In another study (Hershkovitz, 1987), that was made about the perception of simple geometric concepts in three different groups: pupils in fifth grade to eighth grade, student in college of education and seminars, and teachers in primary school, were found similar definitions of geometric shapes in the three populations. Barbash (2003) argues that the lack of theoretical knowledge based among primary school teachers is one of the problems in teaching geometry. If one of the goals of teaching it is creating rich mental structures, such base is needed. She (ibid.) adds that enabled the construction of theoretical knowledge relevant for future teachers, and enables a comprehensive view of the subject. Euclidean geometry theoretical mathematical fields of knowledge can be a great didactic, if building the appropriate course by trying to achieve this goal. As part of the discussions on the role of knowledge-disciplinary training for teachers to teach math in primary school, emphasizes, Barbash (2003) that, creating structures mental wealthy is at least one of the goals of mathematics teaching and studying it in all age groups, it is impossible to be satisfied with an empirical-instrumental approach teaching geometry, even in primary school. Since that is, a developmental continuum of learning geometry that begins to emerge steps of its deductive structure. Preparation of these steps involves proper mental ripening of pupils, which requires teachers to be trained to be able to provide them that.

This brings us to the next question (Barabash, 2003): "What is the desired level of geometric knowledge among future teachers of mathematics in primary school?" When it comes to theoretical knowledge in the field of Euclidean geometry, there is no intention of teaching the entire system of axioms and theorems. This is for two main reasons: one is the student population that comes to be math teachers, is not ripe for studying such a system, at least not to the knowledge base upon, which to construct the didactics of teaching geometry; The second reason is familiarity with a number of axioms and sentences generally does not guarantee quality teaching and quality of knowledge.

Vinitzky and Reis (2003), also describe a study of the perception of concepts in geometry among teachers, that in the teaching of courses for student at college of education who specialize in teaching mathematics in primary school, had difficulty resulting from prior knowledge content related to the curriculum of the primary school. Main conclusion from the results of this study was that the students have only a partial view of the scope and space concepts.

David (2007) argues that, the mathematical knowledge that we want to instill in pupils is based on concepts, definitions, axioms, and sentences. According to her argues, learner achieves the concepts through examples or definitions, he builds himself the concept of image that usually relies on a number of typical examples, using different representations and connects between the concept and other concepts.

Vinner (1991) referred to the distinction between image and concept definition. He describes the definition of the concept as a formal representation of the concept as it appears in the definition. Image representation concept is in the learner mind as a typical example, visual representation, collection of attributes, relationships with other concepts, associations.

We hypothesize that many difficulties which student encountered in was as a result of the level of geometric thinking which they have. Therefore, this background is a good base to carry out this study and analysis of results.

Theory of Van Hiele – levels of Thinking

From Rise, Van Dormoln-Brahmi and Patkin (1997): "To do math, Van Hiele theory and teaching geometry": a pair of Dutch mathematicians – Dina and Pierre Van Hiele, developed the theory of Van Hiele. The theory attempted to explain the fact that many students have difficulty in cognitive processes the highest order, especially when they have to deal with the provision of evidence. According to this theory, the development of thinking in mathematics, especially geometry, arrange on hierarchical spindle of five levels.

Level 1 – Recognition

At this level, the student can learn a set of geometric shapes. He can recognize and distinguish between different forms. The shape is perceived as a whole (no attention to its components) as it seems. The student's reasons for acting at this level rely on the classification of the forms by the general shape. At this point, the student does not yet know the features of the same geometric shape. If the student is asked why he reads the image rectangle, he might answer: "because it looks like a rectangle. It is similar to the window or door" (the use of visual features).

Level 2 – Analysis

At this level, the student can identify and analyze the characteristics of forms. The student knows and is familiar with the properties of geometric shapes he sees, but he does not know and understand each feature separately, does not know the relationship between various features, and cannot explain how one derives from the other feature. That is, he still does not know and does not understand the relationship between features. The arguments of the children at this level rely on the analysis characteristics of the geometric shape. If a student is asked why the picture is a rectangle, he can say: "opposite sides parallel, opposite sides equal, it has four right angles".

Level 3 – Ordering

The student understands the logical arrangement of shapes, the relationship between shapes and their properties, and the importance of precise definitions. The student still does not grasp the significance of deductive structure as a whole. He is able to understand how one trait arises from the other, but cannot prove the properties of geometric shapes. Example: The student will understand why a square is a rectangle, but may not be able to explain why the diagonals of a rectangle are equal.

Level 4 – Deduction

The student understands the significance of deduction as a means to develop a geometric theory, he understands the role of basic terms, definitions, axioms, theorems, and proofs (link in the chain of deductive structure). At this point, he can use discounts to prove theorems, and understand the meaning of necessary and sufficient conditions. A student at this level can give reasons and explanations proof steps. However, the student still does not understand the importance of accuracy. He does not understand the formal aspect of quantifiers. At this level, for example, a student can use the trials to prove theorems overlap the rectangle.

Level 5 – Rigor

The student understands the importance of accuracy. When dealing with different structures, he is able to perform abstract deduction, while he understood the formal shift of deduction. This level can exploring the consequences of replacing the system of axioms second. He knows and can compare different strategies of proof. He can "discover" new law and methods of proof, and can think about the problem of identifying a broader context, in which a sentence may be applicable. At this level a student understands, for example, how the parallel postulate (Euclidean) is related to the existence of a rectangle, and Non-Euclidean geometry there are other axioms, and therefore no bricks is exists".

Methodology

This quantitative study was conducted to examine geometric reasoning levels among the students from the first year in mathematics department at academic college of education in Israel. In this section of the paper, the participants, instruments, procedures and data analysis of the study were explained.

Participants:

Participants of the study were all of the students from the first year in mathematics department at one selected academic college who learn in the first semester of the academic year. 9.5% of the sample were male (N=8) and 90.5% female (N=76). Moreover the sample consisted from two nationalities; 41.7% were Jewish (N=35) and 58.3% were Arabs (N=49). Table 1 shows the distributions of the subjects according to study's variables.

Table 1. The Distributions of the Subjects according to Study's Variables

z	The categories of the variables	Frequencies	Percentages
Educational Path	Primary	39	46.4
	Above Primary	45	53.6
Begrut Mathematics	Five Units	18	21.4
	Four Units	41	48.8
	Three Units	25	29.8
Nationality	Jewish	35	41.7
	Arabs	49	58.3
Gender	Male	8	9.5
	Female	76	90.5
Total		84	100

Instruments and Procedures:

The scale was administered to the students from the first year in mathematics department at one selected academic college. The instrument for the data collection was a test that developed by the researcher based on Van Hiele levels of geometric thought (Usiskin, 1982). The Van Hiele test designed as part of the Cognitive Development and Achievement in Secondary School Geometry project (ibid.), to test the ability of Van Hiele theory to describe and predict performance in geometry. The test has been widely used for both diagnostic and research purposes to test subjects of various ages (Usiskin & Senk, 1990).

The test consists of fifteen multiple-choice questions. The instrument was divided into three groups each of which contains five questions. Each group of five questions corresponds to a Van Hiele level. Scoring was done according to the following criteria:

- A Van Hiele level was considered attained if either “3 out of 5” or “4 out of 5” questions are answered correctly (Usiskin, 1982, p. 24).
- If a participant met the criterion for passing each level up to and including level N and failed to meet the criterion for all levels above, then the participant was assigned to level N.
- If a participant passed a higher level (N+1), but failed to pass the preceding lower level (N), this participant would not be assigned Van Hiele level (N+1). This participant would be assigned level according to rule 2 (Usiskin, 1982, pp. 22-26).

Although the test was originally administered as a paper-and-pencil test, participants were not allowed to draw or write to aid their thinking process while answering questions. In this study participants were asked to answer questions by selecting a multiple choice response; however, just as in the original test, participants were not allowed to do any writing or drawing to aid their thinking process.

Data Analysis

Means and standard divisions of upper 27% (N=22) and lower 27% scores and P value and t-tests between items' means of upper 27% and lower 27% points in item analysis of the scale were calculated in order to validity of the test items. Table 2 presents means, standard divisions, P value and t-tests between items' means of upper 27% and lower 27% points in item analysis of the test. As seen in table 2, the t-test results showed significant differences between each item's means of upper 27% and lower 27% points. According to this result, all items in the test is appropriate to measure students' geometric reasoning.

Table 2. Students' Geometric Reasoning

Item No	Upper		Lower		T value	P value
	Means	SD	Means	SD		
.1	0.91	0.29	0.61	0.49	2.34	0.024
.2	0.82	0.39	0.25	0.44	4.38	0.000
.3	0.86	0.35	0.09	0.29	7.91	0.001
.4	0.95	0.21	0.54	0.50	3.47	0.002
.5	0.68	0.47	0.22	0.42	3.32	0.000
.6	1.00	0.00	0.36	0.49	6.06	0.000
.7	1.00	0.00	0.31	0.47	6.70	0.000
.8	0.91	0.29	0.45	0.50	3.62	0.001
.9	1.00	0.00	0.50	0.51	4.58	0.000
.10	0.86	0.35	0.36	0.49	3.87	0.000
.11	0.91	0.29	0.61	0.49	2.34	0.024
.12	0.95	0.21	0.20	0.41	7.57	0.000
.13	0.54	0.50	0.10	0.30	3.38	0.002
.14	0.82	0.39	0.25	0.44	4.38	0.000
.15	0.68	0.47	0.25	0.44	3.02	0.004

Moreover, the researcher calculated the test reliability using the Kuder-Richardson-20 coefficient to determine internal consistency, which was 0.75.

Results

In which level of the geometric reasoning the students in the mathematics department at academic college are categorized?

To answer this question, the researcher computed the frequencies and percentages for the three levels, then testing the differences among these levels using χ^2-test to discover how the students are distributed in these levels. As seen in table 3, about 54% of students are assigned in level 3, about 23% are assigned in level 2, and about 24% are assigned in level 1. The χ^2-test results showed significant differences among these levels in benefit to level 3.

Table 3. Frequencies and Percentages for Geometric Reasoning Levels and χ^2 Value

The Levels	Frequency	Percentage	χ^2 Value	df	p
Level 1	20	23.8	.15.50	2	0.000
Level 2	19	22.6			
Level 3	45	53.6			
Level 4	84	100			

Is there a significant association between the educational paths and geometric reasoning levels?

To answer this question, cross-tabulation and chi-square test were calculated to investigate if there was a significant association between educational path and geometric reasoning levels. As seen in table 4 the χ^2-test results showed insignificant association between educational path and geometric reasoning levels. Moreover to compute correlation coefficient between educational path and geometric reasoning levels, the researcher used Spearman test (r=0.09).

Table 4. Frequencies and Percentages according to Educational Paths and Geometric Reasoning Levels and χ^2 Value

		Educational Paths		Total	χ^2 Value	df	P Value
		Primary	secondary				
The levels	Level 1	12 (14.3%)	8 (9.5%)	20 (23.8%)	2.25	2	0.324
	Level 2	7 (8.3%)	12 (14.3%)	19 (22.6%)			
	Level 3	20 (23.8%)	25 (29.8%)	45 (53.6%)	**Correlation coefficient**		**P Value**
Total		39 (46.4%)	45 (53.6%)	84 (100%)	0.09		0.423

Is there a significant association between the Bagrut mathematics (number of units) and geometric reasoning levels?

To answer this question, cross-tabulation and chi-square test were calculated to investigate if there was a significant association between Bagrut mathematics (number of units) and geometric reasoning levels. As seen in table 5 the χ^2-test results showed significant association between Bagrut mathematics (number of units) and geometric reasoning levels, which means the students who studied more than three units were likely to be categorized in the third level of geometric reasoning. Moreover to compute correlation coefficient between Bagrut mathematics (number of units) and geometric reasoning levels, the researcher used Spearman test (r=0.37),

Table 5. Frequencies and Percentages According to Bagrut Mathematics (Number of Units) and Geometric Reasoning Levels and X^2 Value

		Begrut Mathematics (number of units)			**Total**			
		Five Units	**Four Units**	**Three Units**		**χ^2 Value**	**df**	**P Value**
The levels	Level 1	1 (1.2%)	6 (7.1%)	13 (15.5%)	20 (23.8%)	18.75	4	0.001
	Level 2	3 (3.6%)	13 (15.5%)	3 (3.6%)	19 (22.6%)			
	Level 3	14 (16.7%)	22 (26.2%)	9 (10.7%)	45 (53.6%)	**Correlation coefficient**		**P Value**
Total		18 (21.4%)	41 (48.8%)	25 (29.8%)	84 (100%)	0.37		0.001

Is there a significant association between nationality and geometric reasoning levels?

To answer this question, cross-tabulation and chi-square test were calculated to investigate if there was a significant association between nationality and geometric reasoning levels. As seen in table 6 the χ^2-test results showed significant association between nationality and geometric reasoning levels in benefit to Jewish students, which means the Jewish students were likely to be categorized in the third level of geometric reasoning compared with Arab students. Moreover to compute correlation coefficient between nationality and geometric reasoning levels, the researcher used Rank-Biserial correlation coefficient (r=0.37).

Table 6. Frequencies and Percentages according to Nationality and Geometric Reasoning Levels and X^2 Value

		Nationality		**Total**			
		Jewish	**Arabs**		**χ^2 Value**	**df**	**P Value**
The levels	Level 1	6 (7.1%)	14 (16.7%)	20 (23.8%)	8.01	2	0.018
	Level 2	4 (4.8%)	15 (17.9%)	19 (22.6%)			
	Level 3	25 (29.8%)	20 (23.8%)	45 (53.6%)	**Correlation coefficient**		**P Value**
Total		35 (41.7%)	49 (58.3%)	84 (100%)	0.27		0.013

Is there a significant association between gender and geometric reasoning levels?

To answer this question, cross-tabulation and chi-square test were calculated to investigate if there was a significant association between gender and geometric reasoning levels. As seen in table 7 the χ^2-test results showed insignificant association between gender and geometric reasoning levels. Moreover to compute correlation coefficient between gender and geometric reasoning levels, the researcher used Rank-Biserial correlation coefficient (r=0.12).

Table 7. Frequencies and Percentages according to Gender and Geometric Reasoning Levels and X^2 Value

		Gender		Total	χ^2 Value	df	P Value
		Males	Females				
The levels	Level 1	3 (3.6%)	17 (20.2%)	20 (23.8%)	1.145	2	0.564
	Level 2	2 (2.4%)	17 (20.2%)	19 (22.6%)			
	Level 3	3 (3.6%)	42 (50%)	45 (53.6%)	**Correlation coefficient**		**P Value**
Total		8 (9.5%)	76 (90.5%)	84 (100%)	0.12		0.30

Is there a significant association between the Bagrut mathematics (number of units) and nationality?
To answer this question, cross-tabulation and chi-square test were calculated to investigate if there was a significant association between Bagrut mathematics (number of units) and nationality. As seen in table 8 the χ^2-test results showed insignificant association between Bagrut mathematics (number of units) and nationality. Moreover to compute correlation coefficient between Bagrut mathematics (number of units) and nationality, the researcher used Rank-Biserial correlation coefficient (r=0.15).

Table 8. Frequencies and Percentages according to Bagrut Mathematics (Number of Units) and Geometric Reasoning Levels and X^2 Value

		Begrut Mathematics (number of units)			Total	χ^2 Value	df	P Value
		Five Units	Four Units	Three Units				
Nationality	Jewish	8 (22.9%)	12 (34.3%)	15 (42.9%)	35 (100%)	6.107	2	0.052
	Arab	10 (20.4%)	29 (59.2%)	10 (20.4%)	49 (100%)	**Correlation coefficient**		**P Value**
Total		18 (21.4%)	41 (48.8%)	25 (29.8%)	84 (100%)	0.15		0.18

Discussion

This quantitative study was conducted to examine the level of geometric thinking of the students who want to be math teachers and came to learn in colleges of education. The researcher based on Van Hiele levels of geometric thought (Usiskin, 1982). The aim was to test the ability of Van Hiele theory to describe and predict performance in geometry in the first three levels of 84 students at mathematics primary and secondary school teaching department: 35 Jewish students, 49 Arabs students.

The study confirmed the discovery that preceded it in its main findings. That means it has showed that the majority of students learning math teaching at colleges of education do not control all the level of thinking of Van Hiele, but until the third level. As stated, 54% of the tested students in this study are assigned in level 3 – Ordering, about 23% of them are assigned in level 2 – Analysis, and about 24% of them are assigned in level 1 - Recognition. The findings approved the research of Usiskin (1982) that found out, that even after learning geometry, the majority of students do control until the third level of thinking of Van Hiele. In addition, also Vinitzky and Reis (2003) found out in their study, that the students have only a partial view of the scope and space concepts.

Another conclusion of this study is that there is insignificant association between educational path and gender to geometric reasoning levels. There was another insignificant association between Bagrut mathematics (number of units) and nationality.

Despite this, the study has showed significant association between nationality and geometric reasoning levels in benefit to Jewish students. Simultaneously, the study has showed significant association between Bagrut mathematics (number of units) and geometric thinking levels. Which means, that Jewish student managed to study more than three units Bagrut other than Arabs students.

From this study we are highly recommended that secondary school will operate program of enhanced geometrics in particularly and math in generally lessons in order to assist pupils raising their Bagrut units. We also recommended that this program will focus more on Arab society in order to minimize the gap. We also highly recommended that students who come to learn math teaching in colleges of education will be accepted to study only if they have three or more units of math Bagrut. We found it very essential.

At studies math teaching in colleges of education we highly recommended perform visual geometry studies program as early as first year of study, and give the future teachers minded toolboxes to make studies like this in the primary and secondary school. We found that essential to teach them using the computerization in their teaching class to give the pupils visual illustration invention as found out at Tepper (1986) research.

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Research Article

Role, need and benefits of mathematics in the development of society

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Abstract

The history of mathematics indicates that whenever a civilization placed a high value on mathematical ability, it made remarkable progress. Mathematics contributes to technology and scientific advancement. Mathematics belongs to all of humanity and is not the unique domain of any country, tribe, or nation. What we have now in the set of mathematical understanding is the result of all humans' collective efforts. As a result, it is not hyperbole to claim that the history of mathematics was the history of civilization. Mathematics is at the heart of the business since all economic processes rely on knowledge: how mathematics functions, connects with realities, and how some equations should have a simple solution are never-ending. Learning mathematics supplies our thoughts with a multitude of incredibly beneficial effects. It helps us think more clearly, helps analytical thinking, quickens our thoughts, encourages practicality, and may be applied in everyday life. The primary goal of this paper is to examine the function of mathematics in societal evolution. This research was based on secondary material from various sources, including books, journals, blogs, and papers. The influence of human role, needs, and advantages on the use of mathematics is demonstrated in this article. It goes through the impacts of social demands and how they play a part in applying mathematics.

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Introduction

Mathematics reveals underlying knowledge that helps explain the world. Mathematics has become a varied subject that works with: information, surveys, observation from science, inference, reasoning, and evidence, and numerical simulations of natural events, human behavior, and social systems. Basic math skills include counting, adding, subtracting, multiplying, and dividing (Ashlock and Herman, 1970).

Mathematics is closely related to the details of daily human life and its activities. Man uses mathematics in its many applications and forms without being directly aware, whether in the kitchen, office, study place, or places of play and entertainment, where mathematics organizes human life. It rids him of chaos and randomness, develops a person's ability for logical reasoning, critical thinking, spatial and spatial thinking, and establishes in him the necessary and practical communication skills in his life.

Most people take mathematics as a given way to solve problems. Scientists can create mathematical formulas to describe subatomic events, and engineers can calculate spacecraft trajectories. We accept the view initially espoused by Galileo that mathematics is the language of science, and we expect its rules to explain empirical results and even predict

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new phenomena. So the power of mathematics is impressive. Thus, it is essential to see the impact of Mathematics on Human life, development, and evolution.

Mathematical Importance

The literal significance of mathematics is: "things which can be counted" You may now believe that numbering plays an essential role in our everyday lives; If there were no mathematics, how would we be able to rely on relatives, amount of kids in a class, rupees in our pockets, runs in a cricket game, days in a week, months, or years?. On a fundamental level, you have to be able to rely on add, subtraction, multiplication, and division.

On a psychological level, mathematical education aids in developing an analytical mind, as well as the more significant arrangement of ideas and precise communication of views. The value of mathematics for an ordinary person was maintained on a broader level, apart from engaging with higher mathematical concepts. The significance of mathematics has been reinterpreted as the ordinary man becomes highly dependent on science and technology in daily life activities: we are surrounded by mathematics. It can take many forms, such as managing money, Trying to verify the miles of your automobile when halting at the petrol pump, or transferring money at a ticketing agency. We perform quick arithmetic in the back of our minds virtually every second. Of course, all of this is done instinctively, with no consideration given to using mathematics in all situations (Abd Algani, 2019; National Curriculum Framework 2005).

Even though we consider the importance of mathematics in our leisure activities, the list is astonishingly long: computer games, video games, kabaddi, riddles, cricket, puzzles, hockey, kho-kho, soccer, and volleyball, to name a few. A cricket captain once stated that when he gets his outfield position right, he would have done half to get the opposing team out. What are the requirements for field placement? An acute feeling of the game and space; all the games listed above necessitate an instinctual knowledge of and use of space. When doing crossword puzzles, we must depend on the distance of the phrases we fill in and the pairing of similar letters. What about chess and other board games? It would be best if you devised a successful strategy while playing. You must create the probable movement at every given time, specifying the circumstances under which the lots of pieces were permitted to move. Players in games like Ludo, Trade, and Chaupad, are now using much math. It is frightening to consider a life without any understanding of calculating or computation, or in other terms, mathematics. Mathematics aids in the precise understanding of a person's ideas and findings. The aspect of man's life and understanding deals with numbers and calculations. It has become a vital aspect of the advancement of our modern world because it plays such a prominent role in our daily lives (Roy Hollands, 1990). Nature, too, is entirely enamored with mathematics. We are surrounded by symmetry and clearly understand pattern appreciation and recognition. Examine any natural object and look for symmetry or a pattern. There are countless cases of symmetry, forms, patterns, and other characteristics in plants. The sun begins to set at the same time every day. The stars look at predetermined intermissions. Mathematics pervades natural sciences, including astrophysics. This topic was intrinsically linked to the planet and natural events (Abd Algani, 2019; Thomas, 1993).

The significance of mathematics could be appreciated through Galileo's definition. "Mathematics as a language in which God has written the world – Galileo."

Objective of the Study

This research explores the conceptual and everyday meanings of mathematics; Literature review on Needs of Mathematics, Role of Mathematics, Benefits of Mathematics aims to create a scientific discussion.

Method

Among the important topics of the philosophy of mathematics are the daily life aspect of mathematics and the subject of mathematics as a field of study for an elite group. Recently, one of the qualitative research methods, document analysis method has been used to make the discussions on the aspect of mathematics regarding human life from a scientific point of view. Identification of relevant documents was searched with keywords.

The Need for Mathematics in Society Development

The demand to comprehend and apply mathematics in daily life and at work was never stronger, and it would keep growing (Figure 1) (Barnes, 1977). For sample:

Mathematics for Life

Knowing mathematics could give you a sense of accomplishment and power. Everyday life's foundations are becoming progressively quantitative and technical. Making purchase decisions, selecting health or health plans, and casting informed votes, for example, necessitate mathematical understanding.

Mathematics as a Part of Cultural Heritage

People should gain gratitude and consider mathematics, such as its aesthetic and sometimes even pleasurable components, as one of humanity's greatest intellectual and cultural accomplishments.

Mathematics for the Workplace

The amount of mathematical thinking and problem solving required in the job, from medical care to web design, has risen considerably in tandem with the level of mathematics required for intelligent citizenship.

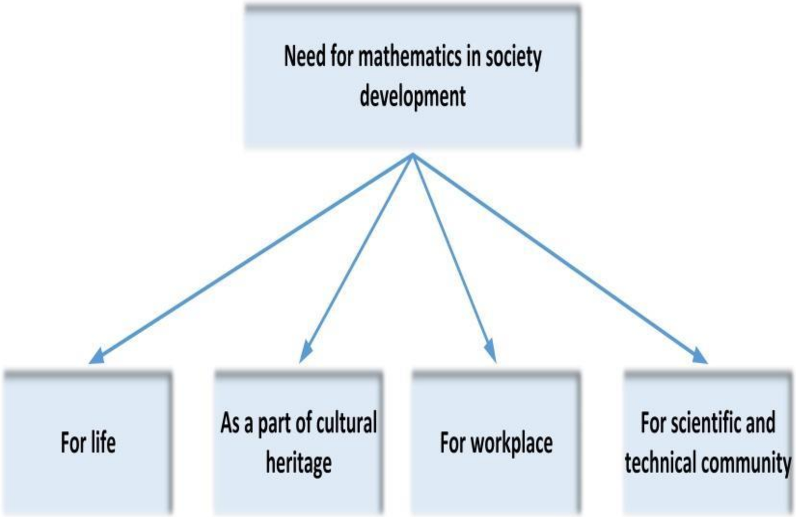

Figure 1. Schematic representation of Need for Mathematics in Society Development

Mathematics for the Scientific and Technical Community

Even though all jobs necessitate a basic understanding of mathematics, a few are mathematics-intensive. Many children need to choose an academic plan that will qualify them for a career as a mathematician, statistics, architect, or scientist for the rest of their lives. Those who know and can do mathematics will have much more possibilities and options for defining their careers in this dynamic world. The mathematical ability offers the way to a prosperous future. Those doors remain shut due to a lack of mathematical ability.

It is commonly assumed that mathematics is just for a chosen few. Everyone, on the other hand, requires a basic understanding of maths. All children should be incentivized to understand essential mathematics in detail and with the help they need. Equity and excellence are not mutually exclusive. According to the Guidelines and Norms, all children must study a basic framework of mathematics. However, this method does not imply that all pupils are the same. In mathematics, students demonstrate various talents, abilities, accomplishments, demands, and passions. All kids, however, must have access to the top mathematical instruction. To do so, students who are passionate about pursuing a profession in mathematics or science must use their hobbies and skills. Meanwhile, students with unique educational needs must be provided with the chances and assistance to be thoroughly aware of essential mathematics. A community where only a few humans exhibit the maths skills needed to perform critical economic, social, and technological duties is incompatible with the objectives of a just representative democracy and the requisite number.

Effects of Social Needs in the Uses of Mathematics

Sponsorship

There must be finances available to support the implementation of mathematics into practice. Massive institutions, such as the governments, large money organizations, enterprises, and large producing sectors, such as puma, have bailed out cash. For this corporation to support the use of the region, it must first analyze the benefits it will derive from it. As a result, they will sponsor in their region of need. The government will fund projects that would promote economic growth and the smooth operation of its parastatals and citizens and will thus focus on this area. Manufacturers and companies will primarily focus on maximizing earnings and lowering costs. As a result, they employ formulas such as industrial engineering. Money lending institutions and others will also support mathematical applications in the development of their businesses and encourage their interest (Bos and Mehrtens, 1977).

Agreement by Members of the Society

Individuals are what makeup society. This group has a significant impact on how mathematics is used and applied. They significantly impact the types of goods and services produced in a given location, as well as the types of enterprises that exist in that area. They also determine for their children what field to specialize in, which significantly impacts mathematical applications. If they allow for efficient banking, investors will be interested in the economic side of mathematics. If they allow for data collecting, they will be allowing for the use of statistical data collection and data analysis tools.

Professionalization

Individuals who can intervene decisively in mathematical subjects will always be decisive. They will always pick regions that provide a pleasant working atmosphere. These circumstances are based on elements including income and salary, job hierarchy, and a strong reputation in the field of work. This can be shown in the decision to become an aeronautical engineer rather than a math teacher (Collins and Restivo, 1983).

Male Gender Domination

The idea and perception that males could only solve most mathematical difficulties have persisted in culture. This is founded on the concept that arithmetic necessitates a manly, hardworking individual who can persevere in various situations. These include spacecraft and other engineering disciplines, technology fields, and others.

This view is amplified by the fact that males control vast implications in significant areas of life such as government, big corporations, and all other connected areas of dominance. This allows them to dominate in the most important aspects of math, influencing how mathematics is used.

Specialization

Specialization occurs as a result of education and other sorts of training. This significantly impacts an individual's field of study because diverse persons use various methods of study. For example, a few people would then study financial mathematics. In contrast, others investigate physical mathematics, while others study technical mathematics, and many others will investigate biological mathematics (MacKenzie, 1978). Banks hire only people who are experts in financial mathematics. However, research organizations hire people who are experts in specific fields (Bos and Mehrtens, 1977).

Role of Mathematics

Role of Mathematics in Social Development

Human life is essential to the effectiveness of others because man is a social animal. Working in a group improves social abilities. The ability to collaborate on activities with others could help develop various social abilities. Due to the apparent start-giving procedure, mathematical knowledge is required to live in a social circle. Industry and business also rely on mathematical understanding. This is only due to mathematics that the structure of society has changed with modern amenities such as modes of transportation, means of communication, and advancements in science and technology. As a result, mathematics has played a critical part in studying and developing society.

Role of Mathematics in Intellectual Development

Maths instruction is critical for intellectual development; no other discipline in the syllabus engages children's minds as much as mathematics. The growth of cognitive capabilities is aided by problem-solving. Solving math problems necessitates mental effort. When a youngster is faced with a mathematical challenge, his or her brain gets active in attempting to solve the difficulty. Each mathematical issue has a sequence required for the constructive and creative process. Math is used to develop all of a child's mental talents in this way.

Furthermore, mathematics allows a leader to be highly calculative, allowing them to save time, money, speech, and thinking. It strengthens one's willpower, tolerance, and self-confidence. It also helps to improve the opportunity to know and create.

Role of Mathematics in Vocational Development

The primary goal of education was to aid students in earning a living and becoming self-sufficient. Mathematics is the most critical subject for achieving this goal: It assists students in preparing for professional and other vocations where mathematics is used, such as engineering, construction, accounting, finance, business, and even agriculture, sewing, woodwork, surveys, and desk jobs.

Role of Mathematics in Moral Development

Morality is a vital aspect of life that is influenced by time, people, situations, and places. Mathematics, as a discipline, could contribute to a student's moral growth because mathematical knowledge aids in forming personality and character. It cultivates all qualities a person of pleasing personality must-have. Cleanliness and realism are attributes that a child acquires (D'Ambrosio, 2003).

Role of Mathematics in Spiritual Development

The most excellent chance of mathematics appears to be in the development of reflection abilities and, for the more receptive, a feeling of the beauty of a solution. Solving math problems is enjoyable, mainly when one obtains the correct answers to one's difficulty. Every child feels fulfilled, secure, and self-reliant at that moment. A determined "mathematics hater" may be oblivious to the aesthetic appeal of an effective solution. As a result, the child receives support, contentment, and joy from his or her outstanding accomplishments. As a result, mathematics aids in developing their aesthetic sense caters to their diverse interests, and assists students in making the most of their free time.

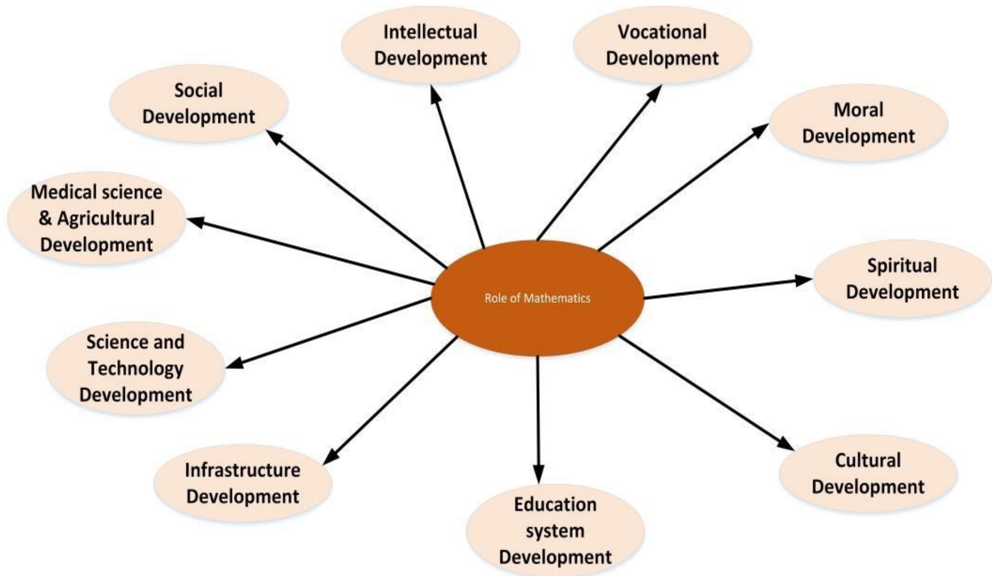

Figure 2. Schematic Representation of Role of Mathematics in Various Societal Developments

Role of Mathematics in Cultural Development

This aids the student in comprehending math's role in advancing cultivation and culture. It has helped her or him see the importance of mathematics in the visual arts and the sanctification of human existence (Roy Derrick Hollands and Blackwell 1983).

Role of Mathematics in the Development of Education System

Mathematics has a significant part in molding young people's prospects in the educational system. Education is designed to promote a person, start making her or his identity bright and a socio-economic contributor, and in our educational system, we are required to continue studying for almost every topic we research in college and uni, such as physics, chemistry, life sciences, economics, business and accounting, geographic location, heritage, psychology, architecture, design, computations, statistics, and commerce. Mathematical expertise is also required in tailoring, carpet, culinary, cosmetologists, sportspersons, and farming occupations. Simple mathematical ideas are used in various occupations, including conductors, shopkeepers, drivers, composers, magicians, and bank tellers (D'Ambrosio and Ubiratan, 2007).

Role of Mathematics in Development of Infrastructure

Mathematics has significantly helped the development of science and technology for thousands of years and will continue to do so now. It has uses in commerce, business, culture, government, athletics, medicine, farming, architecture, and the natural and social sciences, among other things. In a society, facial attractiveness and the growth of infrastructure are critical. Thus, in mechanical engineering, civil engineering, electrical, and other fields, for building highways, houses, stadiums, flyovers, airports, dams, tunnels, automobiles, airplanes, and so on.

Role of Mathematics in Development of Science and Technology

The significance of the nature of Technology, Science, and Engineering, as well as their function in their development, gives it a "functional" element. This engagement is as old as mathematics, and it might be claimed that science and technology cannot exist without mathematics. Mathematical techniques have been quickly adopted throughout the social, medicinal, and physical sciences in recent years. It reaffirms mathematicians as essential to all teaching and learning and creates a high need for university-level mathematical education. The requirement for mathematical and statistical modeling of phenomena accounts for a large portion of the requirement. Modeling is fundamental to all engineering disciplines, plays a critical part in all physical sciences, and considerably impacts biology, medicine, psychology, finance, and commerce. In the twentieth and twenty-first centuries, mathematics was already successfully applied to the advancement of science and technology (Fatima and Roohi, 2012).

Role of Mathematics in Development of Medical Science and Agricultural Field

Farming, ecology, tumor, epidemiology and cardiac models, DNA sequence, and gene technologies all use mathematics. It is employed in the production of medical equipment and diagnostics, as well as sensor technologies. There are some ways in which mathematics is unique. First, mathematics must have an essentially different status from most other subjects due to its core character as a universal informal language and its foundation in the disciplines, science, and architecture. Second, as previously said, mathematics is crucial in every aspect of life, both in the job and for individual citizens (Ball et al., 2005).

Benefits of Mathematics in Society Development

If we learn mathematics, we can gain several very beneficial uses for our economic growth and thinking. It improves our critical thinking, aids logical thinking, improves our minds, encourages practicality, and could be used in daily situations. The following are some of the advantages of mathematics (Bos Utrecht and Mehrtens, 1977). They are

- Math enables us to think analytically
- Analytical thinking improves one's opportunity to travel and discover the reality of the world around them.
- The capacity to think is developed through mathematics
- Mathematics could help you understand how things work

- Mathematics encourages introspection
- Our thoughts are stimulated by mathematics
- Mathematics improves a child's intelligence
- Money could be made with mathematics
- If you don't want to lose money, you'll need to know how to do math
- Mathematics could provide a child a passport to the rest of the world
- In a world that is constantly changing, mathematics is crucial.
- In the future, mathematics would be better portrayed. Mathematics is an important component of our daily lives.

Conclusion

The history of mathematics indicates that whenever a civilization placed a high value on mathematical knowledge, it made remarkable progress. Mathematics offers a commitment to technology and science development. Mathematics has an essential and distinctive effect on human communities and a strategic part in the growth of humanity as a whole. The geometrical understanding of time and space, which was the physical reality and its variety of forms, and the ability to compute is linked to the strength of technologies and the ability of social organization, validating the implication of Mathematics in the development of a society. The members of society form the government and arrange natural resources to generate technology. Humans are the ones that propel society forward. As a result, we will analyze mathematics's importance in individual and societal growth. Mathematics aids in the precise understanding of a person's ideas and findings. The aspect of man's life and understanding deals with numbers and calculations. It has become a vital aspect of advancing our modern world because it plays a prominent role in our daily lives.

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Yousef Methkal Abd Algani was born in Nahif, Israel, on June 2, 1981. He graduated from the Department of Software Engineering, Technion in 2002, and another degree in Mathematics and Computer Science in 2008, Haifa University, Israel. In addition, he graduated with an M.Sc. in Mathematics and Computer Science with a thesis in Algebraic Topology, Haifa University, Israel, in 2012. Abd Alghani completed his Ph.D. in Mathematics education in 2021. Now he is a student of Post-Doctoral in Bar-Ilan Uni'. He has also completed his teaching certificate and a certificate in Measurement and Evaluation in Education from Oranim College. Abd Algani has worked as a lecturer in Sakhnin College for Teacher Education, in the Department of Mathematics, and a lecturer in The Arab Academic College for Education in Israel, in the Department of Mathematics. He participated in several international conferences and published articles in mathematics and mathematical education.

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Research Article

The effectiveness of cognitive restructuring techniques to reduce mathematics anxiety in high school students

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Abstract

Mathematics is an important element in life. It is even said that all activities or things that exist in our daily life require mathematics in it. However, mathematics is often considered a difficult subject for students because the characteristics of mathematics are abstract, logical, systematic and full of symbols and confusing formulas. Students often feel frustrated and raise anxiety about mathematics. Cognitive restructuring techniques can be used to reduce anxiety by changing irrational and non-adaptive views into rational and adaptive ones. Therefore, this study aims to determine the effectiveness of cognitive restructuring techniques to reduce anxiety in high school mathematics subjects. The hypothesis of this research; cognitive restructuring technique is an effective to reduce anxiety about mathematics in high school students. The research was conducted using a quasi-experiment one-group pretest- posttest design. Anxiety towards mathematics was measured using the Anxiety Scale Against Mathematics (ASAM) developed by the researcher. The total subjects used in this study were 6 students. For each subject, the cognitive restructuring technique was carried out for 3 sessions, each session lasting 1-1.5 hours. Based on the results of the study, it was found that p(0.028)<0.05 so it can be concluded that cognitive restructuring techniques are effective for reducing anxiety about mathematics in high school students.

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Introduction

Mathematics is an important element in life. It is even said that all activities or things that exist in our daily life require mathematics in it (Riski, Indiana, & Isna, 2019). In line with this, in order to measure the mathematical ability of students in various countries internationally, several studies were carried out, one of which was Trends in International Mathematics and Science Study (TIMSS). This research is conducted every 4 years by the TIMSS & PIRLS International Study Center of Boston College. In 4 research periods, namely 2003, 2007, 2011 and 2015 it is known that Indonesia's mathematics achievement score is still below the international average (Hadi & Novaliyosi, 2019).

Mathematics is often considered a difficult subject because the characteristics of mathematics are abstract, logical, systematic and full of confusing symbols and formulas (Syafitri, 2017). Students often feel frustrated and have negative

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attitudes towards mathematics. This usually occurs when students have difficulty solving questions or during exams. If this condition occurs repeatedly, the negative attitude will turn into an anxiety towards mathematics (Syafitri, 2017).

The difficulty of students in understanding mathematics lessons is also getting worse with the outbreak of the COVID-19 pandemic. This pandemic causes learning that is usually carried out in schools to be carried out online. When the transition from face-to-face learning to distance learning occurs, students are required to adapt quickly (Suhendra, 2020). Many students felt unprepared, uncomfortable, and shocked by this sudden big change. Therefore, it was found that many students experienced anxiety during the online learning period (Oktawirawan, 2020).

So far there is still debate about whether anxiety about mathematics is an independent object of study independent of the study of anxiety in general. There is evidence that there is a correlation between general anxiety and test anxiety, and math anxiety (Dowker, Sarkar, & Looi, 2016). However, it was found that anxiety about mathematics was more correlated with anxiety about tests/exams. No treatment has been found that is considered appropriate enough to deal with anxiety about mathematics. However, there are some findings from recent research that seem promising for dealing with math anxiety. One of these findings is about the influence of cognitive factors on math anxiety so it is possible that cognitive interventions can help reduce anxiety (Dowker, Sarkar, & Looi, 2016).

This opens up the possibility for techniques that involve cognitive reappraisal of situations that cause anxiety. Research conducted by Ramirez et al (2011) involved people with anxiety doing a reappraisal of the source of anxiety and the consequences of anxiety on their math performance. It was found that by doing a reappraisal before carrying out the test, it will reduce the negative effects that arise as a result of anxiety and increase test scores, especially for students who often experience test anxiety (Ramirez & Beilock, 2011).

There are several treatments with a cognitive approach that can be given to students to reduce academic anxiety, especially anxiety in mathematics. One of the treatments that can be given is cognitive restructuring. Cognitive restructuring techniques are included in cognitive therapy (Beck, 2011). In its application, cognitive restructuring techniques can help students who have academic anxiety by making them reject irrational and maladaptive thoughts into more positive and adaptive thoughts.

This technique has begun to be widely studied in the field of education because it has proven to be quite effective in overcoming psychological problems experienced by students and increasing the locus of control of students. One of the studies conducted by Nikmaturohmah (2015) proves that cognitive restructuring techniques can improve the locus of control of high school students in class XI. In line with this, research conducted by Erfattini, Purwanto, & Japar (2016) proves that counselling with cognitive restructuring techniques has proven to be effective in reducing academic procrastination.

According to Beck (2011), the cognitive restructuring technique has several advantages compared to other techniques that both aim to reduce anxiety. These advantages include: 1) Simple and does not require a lot of money. 2) The stages carried out will make the subject evaluate and explore themselves a lot. This encourages the emergence of a better self-understanding for the subject. 3) Cognitive restructuring techniques are carried out verbally and are often referred to as talk therapy. This technique is still quite possible to do during the current pandemic.

Although there have been many studies on cognitive restructuring techniques in the field of educational psychology, there is still little research on cognitive restructuring techniques aimed at reducing academic anxiety. More specifically, anxiety about mathematics. Therefore, in this study, researchers were encouraged to conduct experimental research with the title "Cognitive Restructuring Techniques to Reduce Anxiety on Mathematics Subjects for High School Students". The purpose of this study was to determine the effectiveness of cognitive restructuring techniques to reduce anxiety about mathematics in high school students. The hypothesis of this study is that cognitive restructuring techniques are effective in reducing math anxiety in high school students.

Mathematics Anxiety

Anxiety about mathematics is a feeling of pressure, worry, anxiety, dislike, or fear of everything related to mathematics (Riski, Indiana, & Isna, 2019). According to Luttenberger and colleagues (2018), mathematics anxiety is defined as a feeling of fear and increased psychological activity when someone is dealing with mathematics, such as when they have to manipulate numbers, solve mathematical problems, or when faced with evaluative conditions (tests/exams) related to mathematics. with math.

Students who have math anxiety tend to avoid situations where they have to study and work on math problems (Syafitri, 2017). Anxiety about mathematics was also found to be correlated with problem solving math problems. If anxiety about mathematics is lower, one's mathematical problem solving ability will be higher and if anxiety about mathematics is higher, then one's mathematical problem solving ability will be lower (Riski, Indiana, & Isna, 2019).

According to Alexander and Martray (in Hunt, 2011) there are three types of anxiety about mathematics. The three types are mathematics test anxiety, numerical task anxiety, and math course anxiety. According to Haralson (2002) anxiety towards mathematics has symptoms that are divided into two aspects. These two aspects are physical symptoms and psychological symptoms.

- Physical Symptoms
  Physical symptoms that appear when a person experiences math anxiety are nausea, increased heart rate, sweaty palms and soles, cold sweat, dry mouth, irregular muscle tension, clenched hands more often, stiff and tight shoulders. In more severe conditions, a person may feel short of breath, have a headache and feel faint.
- Psychological Symptoms
  Psychological symptoms that arise when experiencing anxiety about mathematics are in the form of negative thoughts, panicking, feeling afraid, worried, anxious, wanting to run away and avoiding mathematics, feelings of helplessness and inability to solve problems related to mathematics, mental disorganization, thinking coherently, feeling failure and worthlessness, extreme tension, and an inability to remember the material being studied.

Cognitive Restructuring Technique

Cognitive restructuring technique is a treatment in which subjects are asked to realize and change negative, irrational, or maladaptive thought patterns that can be destructive and self-defeating into positive, rational and adaptive thoughts (Beck, 2011). Cognitive restructuring techniques can be done individually or in groups.

Cognitive restructuring techniques depend on the subject's ability to recognize thoughts that cause negative feelings to arise and interfere with mental well-being. Beck (2011) further explained that in its implementation, cognitive restructuring techniques will target automatic thoughts that are distorted from the subject and as much as possible stop and eliminate those automatic thoughts. According to Beck (2011) there are five main divisions in cognitive restructuring techniques. Here are the five steps in using cognitive restructuring techniques.

- Self-monitoring
  To change negative, distorted, and unrealistic thought patterns, the first step needed is to find out what wrong thinking is being done. It is even better if the subject can be aware of what kind of situation, when and where can usually bring up negative thoughts.
- Evaluating Assumptions
  The next stage is to make the subject able to rethink thoughts and assumptions, especially thoughts and assumptions that can hinder life productively. At this stage, the counsellor can teach the subject how to use Socratic questioning to help spot biased, distorted and illogical automatic thoughts.
- Gathering Evidence
  The key step in the cognitive restructuring technique is gathering evidence. Subjects can find events that elicit negative responses, including with whom and what the subject was doing at that time. It would be better if the

subject knows how strong each response that appears and what memories arise as a result of the incident. The evidence that emerges can contradict the thoughts, assumptions and beliefs of the subject. Cognitive distortion is biased and does not match the evidence (facts), but can be deeply ingrained in a person's mind.

- Analysing the Benefit

  At this stage, the subject will be asked to consider the advantages and disadvantages of each of the negative automatic thoughts that have been identified. Knowing the advantages and disadvantages will help the subject to consider the need to replace the wrong mindset.
- Bringing Up Alternatives

  The last stage is helping individuals to find new perspectives to look at mathematics. At this stage, the subject is expected to be able to generate rational and positive alternative thoughts to replace the cognitive distortions that have been embedded from time to time.

There are several things that can hinder or thwart the efforts of cognitive restructuring techniques. Some of these are as follows.

- The presence of other automatic thoughts that have not been identified or explored.
- Evaluation of automatic thoughts is still too shallow, or inadequate.
- The person does not show sufficient evidence that he or she has automatic thoughts.
- Automatic thoughts are also core beliefs of the person.
- The person intellectually understands the existence of distorted automatic thoughts, but do not believe it has an impact on their performance.

Cognitive Restructuring effects on Mathematics Anxiety

According to research conducted by Adetola & Oladunmoye (2017) on high school students in two provinces in Nigeria, it was found that cognitive restructuring techniques were effective in reducing math anxiety. This research is a quasi-experimental study in the form of pretest-posttest control group. In this study, it was also moderated by gender, with the result that gender had a significant effect on changes in mathematics anxiety after treatment.

In line with the results of this study, a quasi-experimental study conducted by Anyamene & Ogugua (2019) found that cognitive restructuring techniques were effective in reducing anxiety on mathematics test anxiety. Mathematics test anxiety itself is one type of anxiety about mathematics proposed by Alexander and Martray (in Hunt, 2011). Therefore, researchers are interested in conducting research to determine the effectiveness of cognitive restructuring techniques to reduce anxiety about mathematics in high school students.

Cognitive restructuring technique is carried out by changing irrational and non-adaptive thoughts and views on mathematics into rational and adaptive thoughts. More specifically, the cognitive restructuring technique will stop the subject's flow of anxiety towards mathematics.

Problem of Study and Hypothesis

From the preceding information, the following research question can be derived: How effective cognitive restructuring techniques can help to reduce mathematics anxiety in high school students. Therefore, the research hypothesis is:

H1: cognitive restructuring techniques have a significant impact to reduce mathematics anxiety in high school students

H0: cognitive restructuring techniques have no significant impact to reduce mathematics anxiety in high school students

Methods

Research Model

The research design used in this study was a quasi-experiment. The experimental research design used was the One-Group Pretest-Posttest Design all participants administered a pre- and post-test. Below is the illustration of the research model.

Figure 1. One-group pretest-posttest experimental research model

Pre-Test		Treatment		Post-Test
O_1	⟶	X	⟶	O_2

Description

O_1 : *Pre-test* (Measurement of anxiety on mathematics of subjects prior to treatment)

X : Treatment (Provision of Cognitive Restructuring Techniques)

O_2 : *Post-test* (Measurement of anxiety on mathematics of subjects after treatment)

Participants

Pre-test was conducted on 132 students of senior high school, varying from first year student to the final year student. After their anxiety on mathematics measured, 6 students were selected to be research participants. These six students were chosen because they had very high anxiety scores on questions about mathematics. Based on the informed consent that were agreed and signed by participant of this research, any information that might revealed the participant identities is removed. Names of the participants of this research is replaced with an alias. Below is the information on each research participants.

Table 1. Research Participant Information

No.	Initial	Gender	*Pre-test Score*	Math. Anxiety Classification
1.	MAT	Male	173	Very High
2.	NFA	Female	162	Very High
3.	DFI	Female	157	Very High
4.	SER	Female	153	Very High
5.	NAS	Male	153	Very High
6.	SFA	Female	152	Very High

Data Collection Tool

Anxiety Scale Against Mathematics (ASAM)

This study uses the instrument "Anxiety Scale Against Mathematics" to conduct pre-test and post-test. The scale was developed by researchers from the types of anxiety about mathematics proposed by Alexander and Martray (in Hunt, 2011). Then the indicators of anxiety towards mathematics are compiled based on the theory proposed by Haralson (2002). This scale was greatly assisted and consulted with Dr. Sri Weni Utami, M.Si (Psychologist).

The validity test was carried out using the construct validity test to determine the validity of each item. The researcher used a significance level of 5%. Based on the calculation results, it is known that from 48 items, 44 items are valid because $p<0.05$ and 4 items are invalid because $p>0.05$. The following is a final blueprint for the "Anxiety Scale Against Mathematics".

Table 2. ASAM Blueprint

No.	Types of Anxiety	Anxiety Indicators	Item Number		Total
			Favorable	Unfavorable	
1.	Mathematic Test Anxiety	Physical	5,6,7,8	29,30,31,32	8
		Psychological	17,18,19,20	37,38,39	7
2.	Numerical Task Anxiety	Physical	41,42,43,44	21,22,23,24	8
		Psychological	33,34,35,36	13,14,15,16	8
3.	Maths Course Anxiety	Physical	45,46,47,48	10,11,12	7
		Psychological	25,28	1,2,3,4	6
Total			22	22	44

The internal consistency (Cronbach's Alpha) technique was used to determine the research tool's reliability, with the value of (alpha) determined for each paragraph in each study axis, as shown in the table below.

Table 3. The Internal Consistency Coefficient (Cronbach's Alpha) between the Items of the Scale

Scale	Cronbach's alpha	Number of Items
ASAM	0.904	44

Based on the calculation results, from 44 valid items, Cronbach's alpha results were =0.904. It can be concluded that the reliability of the "Anxiety Against Mathematics" scale is very high based on the reliability categorization according to Guilford (in Sugiyono, 2011).

Results

To understand the effectivity of cognitive restructuring technique to reduce mathematics anxiety, first we need to look at how each participant thought, feelings, and behaviour towards mathematics. Three counselling session is conducted for each participant, and below are the details of every counselling session on each research participant.

Subject MAT

Subject MAT is a 19-year-old male. At the time of the experiment, the subject is a final year senior high school student. Subjects do not have a specific schedule for study. Usually, the subject will study only when there is homework or exams. In his daily life he does not study even though there is nothing that takes time to study. This causes the subject's mathematical value to be less good.

Based on the pretest data, the subject has a score of 173 anxiety towards mathematics. This score is the highest score of all researched participants. The implementation of cognitive restructuring on MAT subjects was carried out in 3 sessions.

The first session was held on March 28, 2021. The first session was the introduction stage, approval of informed consent, development of rapport, delivery of research objectives, and explanation of anxiety about mathematics. The subject pays attention to the researcher's explanation and is willing to follow a series of experiments that will be given.

The second session was held on March 31, 2021. In this session, the subject explained that he often felt anxious and afraid when dealing with mathematics. These feelings make the subject want to avoid mathematics. Further investigation revealed that the subject was worried that he would not be able to do the test. In addition, dealing with mathematical formulas makes the subject feel more anxious.

The third session will be held on April 7, 2021. This session is an extension of the second session. The subject explained that anxiety about mathematical formulas peaked when the formula was needed in a math test. The subject is afraid of not being able to do the exam and getting bad grades. However, the subject explained that the anxiety experienced by him had a positive impact, namely encouraging the subject to be more active in learning. Conversely, if the subject feels too anxious then he really wants to run away from lessons or math exams. After realizing the anxiety about mathematics experienced by the subject, he stated that he was willing to look for alternatives in dealing with mathematics. The subject said that mathematics must be faced because it is useful. Therefore, the subject realizes that he must study harder.

After cognitive restructuring was carried out on the subject, it was obtained a score of 137 on mathematics anxiety in the post-test. So it can be seen that there was a decrease of 36 points.

Subject NFA

Subject NFA is a 19-year-old female. At the time of the experiment, the subject was a final year senior high student. Subjects have a certain schedule for studying, which is d after usk time. If she study too late, she has difficulty understanding the lesson. However, the study schedule that has been set by the subject itself is more likely to be carried out when facing exams. The place where the subject wants to study must be quiet and comfortable and snacks are needed to accompany the subject learning.

Based on the pretest data, the subject has a score of 162 on mathematics anxiety. This score is a very high score in the classification. The implementation of cognitive restructuring on subject NFA was carried out for 3 sessions.

The first session was held on March 28, 2021. The first session was the introduction stage, approval of informed consent, development of rapport, delivery of research objectives, and explanation of anxiety about mathematics. The subject pays attention to the researcher's explanation and is willing to follow a series of experiments that will be given. Occasionally the subject asks the researcher related to the implementation of the experiment.

The second session was held on March 29, 2021. In this session, the subject explained that he was afraid and could not face mathematics. The research conducted by the researcher revealed that the subject was afraid because the mathematics teacher made the subject less comfortable to study. Subjects also have difficulty understanding mathematical formulas.

The third session will be held on April 5, 2021. This session is an extension of the second session. The subject explained that the fear and feeling of being unable to face mathematics was caused by less effective study time. The subject feels that the mathematics teaching teacher does not pay attention to whether the students really understand the material being taught or not. Subjects have not found the benefits of anxiety about mathematics. More subjects explained that the anxiety they experienced prevented them from being able to understand mathematics. The subject does not want to maintain negative thoughts towards mathematics. The researcher then helps the subject to find a new perspective on mathematics. The subject thought that she should study more and manage his study time. Therefore, the subject feels no need to worry too much about mathematics if he has studied well.

After cognitive restructuring was carried out on the subject, it was found that the anxiety score for mathematics was 129 in the post-test. So, it can be seen that there is a decrease of 33 points.

Subject DFI

Subject DFI is an 18-year-old female. At the time of the experiment, she is a final year senior high school student. DFI have a desire to learn mathematics and usually take the time to study mathematics after dusk. The duration of studying the subject is uncertain, sometimes 2 hours and sometimes less than that. In one week, subjects usually study mathematics a maximum of 2 times. Sometimes the subject only studies if there is a math test the next day. Based on the pretest data, the subject has an anxiety score of 157. This score is a very high score for mathematics anxiety in the classification. The implementation of cognitive restructuring on subject DFI was carried out for 3 sessions.

The first session was held on March 28, 2021. The first session was the introduction stage, approval of informed consent, development of rapport, delivery of research objectives, and explanation of anxiety about mathematics. The subject pays attention to the researcher's explanation and is willing to follow a series of experiments that will be given.

The second session was held on April 2, 2021. In this session, the subject explained that he had difficulty with mathematical formulas. The difficulty made him feel worried about his bad math grades. The subject further explained that the anxiety she experienced was caused by a formula that was difficult to memorize. In addition, she said that the subject teacher could not explain well so he felt bored when studying mathematics.

The third session will be held on April 9, 2021. This session is an extension of the second session. The subject explained that the situation that caused the subject to think that mathematical formulas were difficult to memorize was due to lack of time to study. Subjects are students who are in the cottage and can only study after dusk. Often the subject is tired before having time to study mathematics. Associated with the advantages and disadvantages of having poor thinking about mathematics, the subject explained that he thought that difficult mathematical formulas would not help her score to be good. Instead, she builds the idea that he should study more regularly so that he no longer sees mathematical formulas as difficult, and can get better grades

After cognitive restructuring was carried out on the subject, it was found that the anxiety score for mathematics was 128 in the post-test. So it can be seen that there is a decrease of 29 points.

Subject SER

Subject SER is a 17-year-old female. At the time of the experiment, the subject is a final year senior high school student. Subjects have a fairly regular schedule for learning mathematics, namely after dusk to completion. The subject said that she could study mathematics for more than two hours, but often less than two hours. If there is no math exam, the subject usually studies 1-2 times per week and even then because there is an assignment. So far, the learning method used is memorizing formulas.

Based on the pretest data, the subject had a score of 153 on mathematics anxiety. This score was included in the very high classification. The implementation of cognitive restructuring on SER was carried out for 3 sessions.

The first session was held on March 28, 2021. The first session was the introduction stage, approval of informed consent, development of rapport, delivery of research objectives, and explanation of anxiety about mathematics. The subject pays attention to the researcher's explanation and is willing to follow series of experiments that will be given.

The second session was held on April 1, 2021. In this session, the subject explained that he did not understand mathematics. This makes the subject feel restless and anxious to get unsatisfactory scores. The subject explained that the anxiety she experienced was caused by a mathematical formula that was difficult to understand. At the time of the exam the subject often cannot think because the mind is full of worries when dealing with mathematics.

The third session will be held on April 8, 2021. This session is an extension of the second session. The subject explained that the situation that caused him to feel anxious was because he was worried about getting unsatisfactory grades. Besides, she can't see formulas when doing math. These thoughts have a positive impact on the subject. The subject explained that the worries he felt made her provoked to study. On the other hand, excessive anxiety interferes with her understanding mathematical formulas. The subject said that she would change his thinking and habits in dealing with mathematics. He will study harder and be braver in facing mathematics because he thinks that mathematics is important.

After cognitive restructuring was done on the subject, it was found that the anxiety score for mathematics was 125 in the post-test. So, it can be seen that there is a decrease of 28 points.

Subject NAS

Subject NAS is a 19-year-old male. At the time of the experiment, the subject is a final year senior high school student. Subjects have a schedule for learning mathematics, which is to go home from school with a duration of about 1 hour. In one week, the subject can carry out the schedule about 3 times. However, the subject still has difficulty understanding mathematics, so he often chooses to study with his friends.Based on the pretest data, the subject had a score of 153 on mathematics anxiety. This score was included in the very high classification. The implementation of cognitive restructuring on NAS subjects was carried out in 3 sessions.

The first session was held on March 28, 2021. The first session was the introduction stage, approval of informed consent, development of rapport, delivery of research objectives, and explanation of anxiety about mathematics. The subject pays attention to the researcher's explanation and is willing to follow a series of experiments that will be given.

The second session was held on March 29, 2021. In this session, the subject explained that he did not feel integrated with the lessons taught by the teacher. The subject admitted that he did have anxiety about mathematics, but more in the form of being less comfortable.

The third session will be held on April 5, 2021. This session is an extension of the second session. The subject explained that the situation that prompted him to feel uncomfortable about mathematics was that the learning provided by the teacher in class was not in accordance with the ideal learning expectations he had in mind. The subject thought that after studying in class, he would understand a lot of mathematics. But apparently, he did not get a good understanding. The subject said that thinking too much about expectations and discomfort in learning in class made him less focused. After discussing with the researcher, the subject said that he would change his mind. The subject believes that he must study harder and take mathematics more seriously.

After cognitive restructuring was done on the subject, it was obtained a score of 116 on mathematics anxiety in the post-test. So it can be seen that there is a decrease of 37 points.

Subject SFA

Subject SFA is an 18 year old female. At the time of the experiment, the subject was a final year senior high school student. Subjects have a schedule for learning mathematics after dusk with a duration of about 2 hours. Sometimes the subject wakes up at 3 am and studies after the sunnah prayer until dawn. This study schedule is usually carried out about 3 times a week. Based on the pretest data, the subject has a score of 152 on mathematics anxiety. The score is included in the very high classification. The implementation of cognitive restructuring on SFA was carried out for 3 sessions.

The first session was held on March 28, 2021. The first session was the introduction stage, approval of informed consent, development of rapport, delivery of research objectives, and explanation of anxiety about mathematics. The subject pays attention to the researcher's explanation and is willing to follow a series of experiments that will be given.

The second session was held on March 30, 2021. In this session, the subject explained that she was afraid of mathematical formulas. Subjects also feel afraid of math exams because there are too many formulas. However, she said that so far, it's not too bad. The subject explained that there were many formulas that had to be memorized, so when she saw mathematics, he immediately felt anxious about getting a bad score.

The third session will be held on April 6, 2021. This session is an extension of the second session. The subject explained that the situation that caused her to feel anxious was a formula that had to be memorized too much and was too complicated. The subject explained that the presence of anxiety about mathematics can be a driving force for learning mathematics. But on the other hand, he also feels that if he is too anxious, it will interfere with the process of understanding mathematics. After discussing with the researcher, the subject explained that he should not be too worried about mathematics. It is better if he learns to deal with mathematics more because he already has the right way and tempo of learning.

Table 4. Changes in Mathematics Anxiety

No.	Initial	*Pre-test*	*Post-test*	Changes	Changes (%)
1.	MAT	173	137	-36	20,81
2.	NFA	162	129	-33	20,37
3.	DFI	157	128	-29	18,47
4.	SER	153	125	-28	18,30
5.	NAS	153	116	-37	24,18
6.	SFA	152	107	-45	29,61

After cognitive restructuring was done on the subject, it was obtained a score of 107 on mathematics anxiety in the post-test. So, it can be seen that there is a decrease of 45 points.

Based on these results, it is obvious there are changes in anxiety towards mathematics in each research subject. Further analysis is conducted to make sure the effectivity of cognitive restructuring technique to reduce mathematics anxiety. Therefore, the following is a table that presents the data for the analysis.

Table 5. Wilcoxon Ranks Results

		Ranks		
		N	**Mean Rank**	**Sum of Ranks**
Posttest - Pretest	Negative Ranks	6[a]	3.50	21.00
	Positive Ranks	0[b]	.00	.00
	Ties	0[c]		
	Total	6		

Based on these data, the Wilcoxon test was performed and obtained p value (0.028) <0.05. Then H0 is rejected, and H1 is accepted. So, it can be concluded that the cognitive restructuring technique is effective in reducing math anxiety. In addition, based on tables above, it can be seen that there is a change in anxiety scores towards mathematics with a percentage change between 18.47% to 29.61%.

Table 6. Wilcoxon Signification Test Results

	Posttest - Pretest
Z	-2.201[a]
Asymp. Sig. (2-tailed)	.028

Discussion and Conclusion

Cognitive restructuring is a technique that can be done to help someone in dealing with anxiety through the process of changing irrational thoughts into rational ones (Beck, 2011). Cognitive restructuring techniques change thoughts that says such as "I can't" to "I can", with consequences for follower actions that need to be done afterwards. The subject's cognitive restructuring procedure was carried out on March 28 - April 8, 2021 with each subject getting 3 sessions. The implementation date of each research subject is different, and not all subjects have the same interval between sessions. To overcome unwanted things due to the difference in intervals, during the second and third sessions the researchers conducted a review of the implementation of cognitive restructuring in the previous session and ensured that the subject was ready to move on to the next session.

According to Alexander and Matray (in Hunt, 2011) there are three types of anxiety towards mathematics, namely: 1) mathematical test anxiety, 2) numerical task anxiety, 3) math course anxiety. Based on the results of the pre-test of this study, students with very high mathematics anxiety were mostly grade XII students. According to this research, the students of final year senior high school student indeed tend to have high anxiety compared to first and second year senior high school student. This is in accordance with what was expressed by Saputra (2014) which also stated that final year student has higher anxiety rather than other. Many students view math exams as a problem in their lives because they think they will not get good grades and are not prepared to face them.

Based on the process of the first stage of the cognitive restructuring technique, namely self-monitoring, it is known that the research subjects know that they have anxiety about mathematics. They feel afraid and anxious about math formulas and exams. The cause of anxiety about mathematical formulas (numerical task anxiety) is because the subject assumes that mathematical formulas are difficult to memorize and complicated. For example, subject SFA explained that there were too many mathematical formulas for high school students. The same thing was also expressed by subject MAT. The subject said that he had great anxiety towards mathematics because the formulas were not easy to understand.

Another opinion is also given by subject NAS. He explained that the anxiety about mathematics was triggered by the feeling of not being integrated in the lessons taught by the teacher. A similar opinion was also conveyed by subject NFA who felt that the process of delivering material by the teacher was not comfortable. This is in accordance with the explanation of Alexander and Matray about one type of anxiety towards mathematics, namely maths course anxiety.

The second stage of the cognitive restructuring technique is evaluating assumptions. The research subjects explained that they were anxious about mathematics because they thought that mathematics was difficult to understand. One of the subjects, SER, explained that when he thinks mathematics is difficult, she will feel more anxious. Subject MAT explained that the anxiety was stronger when facing math formulas and exams.

Researchers explore these problems and help research subjects to realize that these thoughts interfere with the subject's productivity. The study subjects agreed that it interfered with their productivity when dealing with mathematics. Furthermore, for example, subject NAS explained that negative thinking about mathematics made him not focus during math class. Subject NFA explained that the anxiety they experienced prevented her from being able to understand mathematics.

The researcher then facilitated the subject to enter the fourth stage of cognitive restructuring, which was analysing usefulness. At this stage the researcher helps the subject to consider whether or not a change is needed in looking at mathematics. This stage is an important stage in the successful process of cognitive restructuring and will later lead to a new perspective in looking at mathematics.

Subject NFA explained that no longer wanting to maintain old thoughts about mathematics was difficult because it prevented her from understanding mathematics. In line with this, subject DFI explained that if she always thought that mathematical formulas were difficult, it would not help her math grades to be good. Subject NAS also realized that negative thinking about math made them less focused when studying.

Subject SFA explained that excessive anxiety when dealing with mathematics made her unable to understand mathematics, but mild anxiety also had a positive impact. She explained that feeling a little anxious about mathematics could encourage her to study mathematics. The same thing was conveyed by subject MAT. He explained that excessive anxiety sometimes made him run away from math class, but that anxiety sometimes made him study harder. The same thing was conveyed by subject SER. This explains that having a little anxiety about mathematics, makes the subjects worry about their grades and makes them motivated to study.

The research subjects explained that they no longer wanted to be too anxious and thought that mathematics was a very difficult subject. Instead, they want to change that thought. The subjects explained that they wanted to feel capable and better prepared for mathematics. The researcher then helped the subject to come up with a new perspective on mathematics by providing motivation. Furthermore, the researcher also helped the subject to realize that with new thinking there would be consequences that needed to be done. The consequence is for example in the form of learning to be more disciplined. Some research subjects also understand the consequences that must be done without the need for help from researchers. For example, on the subject SER which explains that she will be more diligent in studying. Then on subject SFA who explained that she no longer needed to worry too much about mathematics because she only needed to discipline her schedule for studying. After giving cognitive restructuring technique, the subjects have the view that mathematics is important and useful, so it must be faced and mastered.

Based on the process that has been carried out, it is known that this research succeeded in growing a new perspective on mathematics in the six research subjects. At first the research subjects viewed mathematics as complicated, difficult to memorize, and would not get good grades in mathematics, causing them to be anxious. Then after implementing cognitive restructuring, they agreed to change their thinking towards mathematics. The research subjects showed optimistic and positive thoughts towards mathematics and some stated that mathematics was important and they should not be too anxious about mathematics. This indicates that cognitive restructuring has succeeded in influencing the research subjects.

From this study also obtained the results of the Wilcoxon test where the p value (0.028) <0.05. So it can be proven that cognitive restructuring techniques are effective in reducing math anxiety. This is in accordance with the research of Anyamene & Ogugua (2019) and research by Adetola & Oladunmoye (2017) which also found that cognitive restructuring was effective in reducing math anxiety.

This study has proven that cognitive restructuring techniques can help to reduce anxiety towards mathematics. However, researchers have not been able to find out their performance from the new point of view that each research subject has. Therefore, it is not known for certain whether there is a change in the academic performance of research subjects in the field of mathematics. According to Beck (2011), the cognitive restructuring technique will get more optimal results if it is continued by giving behavioural interventions. This can be the input for further research.

Recommendations

Based on the research that has been done, the researcher provides several suggestions that can be improved and improved for further research. (1) Improving the design of the implementation of cognitive restructuring techniques and increasing the number of meeting sessions. (2) It is recommended that the practice of implementing cognitive restructuring techniques be carried out by professionals such as psychologists. (3) Involving more research subjects so that the results obtained are more representative and giving more statistical significancy.

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Research Article

Investigation of the effect of Go (Baduk) education on problem solving processes and thinking styles*

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Abstract

According to the report published by the World Economic Forum in 2020, the top five skills that will be needed most in 2025 are analytical thinking and innovation, active learning and learning strategies, complex problem solving, critical thinking and analysis, creativity, originality, and initiative. Problem-solving has always been among the essential skill areas an individual needs to develop. On the other hand, mathematics is important in developing this skill by providing logical thinking and reasoning ability. For this reason, the research's primary purpose is to examine the effect of the Go game instructional design, which was prepared by taking into account the problem-solving steps of Polya, on the students' problem-solving processes and thinking styles. A quantitative research method, a single group pre-test-post-test design, was used to achieve this aim. When the literature is examined, it has been seen that the Go (Baduk) education program and curricula, which are widely played in Asian countries, are included in their curricula. Still, although various tools are used in teaching mathematics with games in Turkey, the Go strategy game was used for the first time in this study. 18 volunteer elementary mathematics teacher candidates participated in the research in the summer term of 2021. The study used Cable Reel and Airplane Boarding Activities, Thinking Styles Scale, and opinion form as data collection tools. The data obtained as a result of the study were analyzed statistically. When the findings that emerged as a result of the analysis are interpreted, it can be stated that the GO education process has a positive effect on the problem-solving skills of teacher candidates

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Introduction

The game of Go, considered one of the oldest intelligence games, dates back to 4 thousand years ago. According to one rumor, King Yao's purpose was to teach his son Tan Chu discipline and concentration (Barsbey, 2012), while another rumor was to teach astronomy. Recent studies have shown a significant difference between the brain waves of students who play and do not play Go (Ahn, 2010), that it can be used in the treatment of diseases such as Alzheimer's and depression (Lin, 2015). Teaching Go improves students' cognitive functions with attention deficit and hyperactivity disorder (Kim, 2014). However, the fact that it contains more moves than chess and is a game with simple rules but a complex structure could not affect the regions far from the starting point for a long time.

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Although there is information that chess was played in the 2000s BC., it is considered to have emerged in the 6th century AD, and the origin of the first computer to play chess dates back to 1951. However, even though the game of Go was released 4000 years ago, Alphago, artificial intelligence with the algorithm of the game of Go, came out in 2015 and beat the Go player at the Pro level for the first time. This can be explained by the fact that the game has a unique philosophy. The game of Go caught the attention of world chess champion Emmanuel Lasker who said, "If there are aliens, they are probably playing GO." he said. In our country, the game of Go started with the publication of two translations in TUBITAK science journals in 1970 and 1971, and then the METU Go Community was established in 1989 (TGOD, 2016). It has gradually spread to the present day with such a small community. There are 159 active players registered with the Turkish Go Players Association (Rating list of players from TR,2021).

Go, an important strategy and intelligence game are included in the elective courses in secondary schools within the scope of the Intelligence Games Course. The aims of intelligence games lesson are "to enable students to recognize and develop their intellectual potential, to be able to find original and new solutions to the problems they encounter, to make fast and correct decisions, to develop their study skills by creating a competitive environment within games, to create different perspectives, to gain self-confidence, to reason and think logically and to develop a positive attitude towards problem-solving" (TTKB, 2013).

The concepts of "problem-solving" and "reasoning" expressed in the program appear as skills students are expected to have in many different disciplines. Polya (1957) stated problem-solving as reaching the goal most shortly and beneficially, and on top of that, he put forward his studies expressing the steps of problem-solving. In addition, studies have revealed the relationship between problem-solving and reasoning (Chang, 2002, Chang, 2010). Studies showing that students learn to solve problems informally have also taken their place in the literature (Yazgan & Bintaş, 2005). Although there are different ways in the curriculum to help students gain problem-solving and reasoning skills, using the game in this sense makes the job enjoyable for both teachers and students (Anlıak, Dinçer, 2005). People discover playing games before learning to think and make cultural transfers through games before actions such as reading, writing, and speaking (Huizinga, 1938 as cited in Yılmaz 2017). Today's studies show that intelligence games positively affect problem-solving, critical thinking, and creativity (Bottino, Ott, & Benigno, 2009; Demirel, 2015).

Conceptual Framework

When the literature is examined, there are various studies in which intelligence games are used for teaching mathematics (Aydoğdu & Ayaz, 2007; Büyükaşık, 2017; McFeetors & Palfy, 2017; Kwoen, 2016; Şahin, 2019; Ün, 2010). These studies are presented in Baduk (Go) education, especially in the South Korean education system (Kwoen, 2016). In some studies conducted in our country, it has been observed that the effect of chess (Büyükaşık, 2017; Ün, 2010) on problem-solving has been examined. In this study, activities were prepared based on the game of Go, a strategy and intelligence game with much more possibilities than chess. Go, an ancient Chinese game that inspired artificial intelligence algorithms, is a cult game, especially in the Far East. This game inspired the AlphaGo artificial intelligence algorithm development and has been seen as a standard for comparing machine and human intelligence. In this sense, in this study, the effect of Go, a strategy and intelligence game, on problem-solving processes and thinking skills is emphasized. In this sense, it is thought that this study will contribute to the literature in light of the teaching design and the findings on the Go game's problem solving and reasoning skills.

Method

Research Design

In this study, one group pre-test-post-test design, one of the quantitative research designs, was used to examine the effect of Go training on problem-solving processes and thinking styles. Experimental designs are intended to test the cause-effect relationship between variables (Cohen, Manion & Morrison, 2007; Fraenkel & Wallen, 1996). In experimental studies, researchers observe the effects of at least one independent variable on one or more dependent variables. Although there are different experimental designs, a single-group pretest-posttest experimental design was used in this study. Here, an independent variable was applied to a single group, and measurements were made before and after the experiment. The difference between the pre-test and post-test means shows the effect of the independent variable on the dependent variable (Cohen, Manion & Morrison, 2007; Gay & Airasian, 2000). Although the single-group pretest-posttest experimental design is one of the weakest designs among the experimental designs, as Creswell (2012) stated, it is the nature of the research to prefer the single-group experimental design in studies where a new training module is developed and applied.

Study Group

The research study group was chosen as the appropriate case study group from the purposeful study groups by the purpose of the study and the quantitative methodology taken as the basis. The research focuses on the strategic intelligence game (Go) - problem-solving relationship. Thus, it aims to determine the people and groups that are suitable for the research and easily researched (Creswell, 2012; Sönmez & Alacapınar, 2016). For this reason, the research study group was composed of pre-service mathematics teachers, who will be the most important human factor in delivering mathematics to society. The study group consists of 18 teacher candidates studying in the primary school mathematics teaching language program of 5 different education faculties in Turkey. All of the pre-service teachers in question participated in the research voluntarily.

Practice Process of the Study

Due to the Covid-19 pandemic, the implementation process of the study was carried out using distance education tools. The path followed in this process is shown in Figure 1.

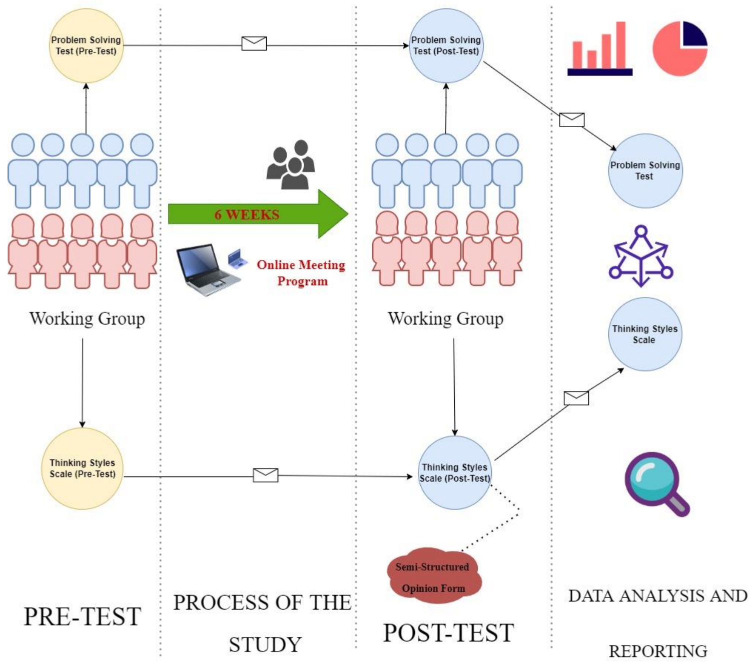

Figure 1. The Path Followed in the Study

The implementation process was carried out in July and August 2021, depending on the process shown in Figure 1. The researchers prepared all activities in the implementation phase. In this regard, the researchers gained experience in the "Teaching Mathematics with Games" course and developed content related to Go (scan the QR code to watch Video 1).

GO Wise Game

Video 1. GO Wise Game

The activities used in this project are the Go strategy game (Baduk) activities prepared by the researchers within the framework of Polya's problem-solving steps. Accordingly, before the implementation phase, the data were collected with pre-tests. The main application continued for six weeks, and in the end, the study was terminated by the post-test application.

In the implementation phase of the study, a remote online meeting program was used. The content was adapted to the digital environment with various web 2.0 tools during the lectures.

Data Collection Tools

Two different data collection tools were used to answer the questions in the research. The first is problem-solving activities, and the other is the thinking styles scale. Information on both data collection tools is given below.

Problem Solving Activities: At this stage, the researchers used the Cable Reel Activity (Föerster & Kaiser, 2010) and the Plane Boarding Activity (Pan, 2007) as data collection tools. These activities have been translated into Turkish by Taşkaya Alim (2018) (Appendix 1 and Appendix 2). An analytical rubric developed by Hollabaugh (1995) and adapted into Turkish by Ünsal and Ergin (2011) was used to score both problem-solving activities. In the rubric in which the four-stage process that Polya brought to the literature was taken into account, the inter-rater reliability coefficient was determined by the Kendall W coefficient. The analytical rubric used is given in Table 1.

Table 1. Rubric Used for Scoring Mathematics Activities

Answer Stages	Criteria to be Used in Evaluation	Score
1. The Process of Understanding the Problem	There is no evidence of an understanding of the problem.	0
	The problem is not understood correctly; the physical description is irrelevant or insufficient.	1
	Some deficiencies in understanding the problem (vector representation, relation, free body diagrams, etc. are missing).	2
	The problem was understood correctly with minor deficiencies (only axes were not named or data was not defined), and a solution plan was started.	3
	The problem was understood correctly (he/she re-expressed the problem in his/her own words with his/her figures and graphics), and the solution plan was started.	4
2. Solution Plan Preparation Process	The solution plan (physical+mathematical) is absent or irrelevant.	0
	The plan is unclear (Which relation to use is not specified or the wrong relation is used)	1
	Planning is ok but contains an error.	2
	Planning is complete. Physical definitions are presented by transforming them into appropriate mathematical forms (Granted and desired ones are determined; these are made available to develop solutions, and the relationships, formulas, and algorithms to be applied are determined)	3
3. Implementation Process of the Plan	There is no evidence that a solution plan or a solution has not been reached.	0
	There is an answer, but the wrong strategy was applied.	1
	The correct relationship has been established, the formula or algorithm has been tried, the necessary tables have been created, graphs have been drawn, and a solution has been tried.	2
4. Evaluation Process	The path and result are both wrong.	0
	The path is wrong, but the result is correct.	1
	The path to go is correct, but the result is wrong.	2
	The path to go is correct (even when an obstacle is encountered, mathematical bounds and other relations lead to the solution), but it contains an error (such as a unit error).	3
	Perfect complete answer.	4
Total	The highest score possible:13	

Thinking Styles Scale: Thinking Styles Scale, Epstein et al. (1996; cited in Invention, 2003) to measure the individual differences that people show in the intuitive-experiential and analytical-rational ways of thinking they use in information processing. The scale consists of 31 items and two sub-dimensions (Appendix 3). The scale was adapted into Turkish by Invention (2003). As a result of the applications performed to determine the test-retest reliability of the scale with language equivalence (n=115), the internal consistency reliability of the scale was found to be .75 for Cognitive Need and .80 for Intuitive Belief. As a result of item-test correlations, two items that disrupted the additive feature of the scale were removed from the scale. As a result of factor analysis, it was seen that all items in the scale were collected in their respective subscales. As a result of these analyzes, the scale was made ready for use with 29 items. Thus, the number of items in the Need for Cognition subscale decreased to 18, and the score range to 17-85 (Buluş, 2003).

Opinion Form: It is aimed to support the quantitative data with the semi-structured opinion form prepared by the researchers. The opinion form was distributed to the participants along with the post-tests. It aimed to determine their thoughts about the process and support the study's quantitative data with qualitative data to analyze the findings in-depth.

Analysis of Data

Wilcoxon Sequential Signs test, one of the non-parametric analysis methods, was used to analyze the data in the first two problems of the study. This is because the number of students participating in the study was less than 30. In addition, before the analysis phase of the second problem, the Kendall W reliability coefficient between raters was calculated (TabachnickandFidell, 2014; Mertler & Vannatta, 2005; Thode, 2002).

Findings

In this section, the results of the analysis of the sub-problems are prepared to answer the research problem and comment on these results.

Problem: What is the effect of the learning process of the Go game on the thinking styles, problem-solving styles, and problem-solving skills of primary school pre-service mathematics teachers?

In order to seek an answer to this problem situation, the following sub-problems have been answered.

First Sub-Problem: How did the primary school mathematics teacher candidates' problem-solving styles scores change during the learning process of the Go game?

In order to find an answer to the first sub-problem, Wilcoxon signed-rank test was applied to the data collected from 18 pre-service teachers before and after the study. The data obtained are given in Table 2.

Table 2. Wilcoxon Signed-Rank Test of pre-and post-training problem-solving styles scores

Problem Solving Styles Scores	n	Rank Average	Rank Sum	z	p
Negative Rank	6	10.33	62	-0.310	0.756
Positive Rank	10	7.40	74		
Equal	2				

When Table 2 is examined, it is seen that the mean rank of negative (10.33) is higher than the mean positive rank (7.40). Analysis results show that this difference before and after the training is not statistically significant ($z=-0.310$, $p > 0.05$).

Second Sub-Problem: How did the primary school mathematics teacher candidates' thinking style scores change during the learning process of the Go game?

In order to find an answer to the second sub-problem, Wilcoxon signed-rank test was applied to the data collected from 18 pre-service teachers before and after the study. The data obtained are given in Table 3.

Table 3. Wilcoxon Signed-Rank Test Results of pre-and post-education thinking styles scores

Thinking Styles Scores	n	Rank Average	Rank Sum	z	p	d
NegativeRank	5	6	30	-2.421	0.015	1.39
Positive Rank	13	10.85	141			
Equal	0					

When Table 3 is examined, it is seen that the mean rank of positive (10.85) is higher than the mean negative rank (6). This finding indicates an increase in favor of post-experimental thinking style scores. Analysis results show that this difference before and after the training is statistically significant ($z=-2.421$, $p < 0.05$). In other words, after the pre-experimental measurement, the experimental procedure was meaningful, and the students' thinking styles increased their scores. The calculated effect size value indicates that the training process has a high effect ($d = 1.39$).

Third Sub-Problem: How did the primary school mathematics teacher candidates' scores on problem-solving skills change during the learning process of the Go game?

Here, two problems (cable reel and airplane riding) were used, and three experts evaluated the problems with a rubric. For this purpose, the findings related to the rater reliability of the problems used as pre-test and post-test, and then Wilcoxon sequential sign test results are given.

Findings Related to Airplane Riding Activity: Kendall's W coefficient, which shows the agreement between the pre-test and post-test scores given to 18 students by three raters separately for each criterion in the airplane riding activity, is given in Table 4.

Table 4. Pre-Post-Test Kendall's W agreement Coefficient for the Criteria

	Pre-Test			
	The Process of Understanding the Problem	Solution Plan Preparation Process	Implementation Process of the Plan	Assessment Process
Kendall's W Coefficient of Fit	0.942*	0.868*	0.807*	0.960*
	Post-Test			
	The Process of Understanding the Problem	Solution Plan Preparation Process	Implementation Process of the Plan	Assessment Process
	0.981*	0.908*	0.913*	0.965*

*p<0.01

When Table 4 was examined, it was found that the coefficients of agreement between the scorers' scores for each criterion were between 0.807 and 0.981 for the pre-test and post-tests, and all values were statistically significant. When the values are interpreted in general, it can be said that there is a high level of agreement between the raters according to the criteria of VonEye and Mun (2005).

The rater agreement between the pre-test and post-test total scores is given in Table 5.

Table 5. Inter-rater Kendall's W Coefficient Calculated for Total Scores

Total Scores	Kendall's W Coefficient of Fit
Pre-Test Total Score	0.919*
Post-Test Total Score	0.974*

*p<0.01

When Table 5 is examined, the coefficient of agreement between the three raters according to the total scores obtained from the pre-test and post-test was calculated as 0.919 for the pre-test and 0.974 for the post-test. This value was found to be significant. This value shows that the agreement between raters is high. Kendall's fit statistics was highly significant for three raters in both tables, a technique in which agreement is calculated by considering rank differences. This finding can be interpreted as the raters showing a high similarity in ranking the individuals.

The result of comparing the mean scores of the three raters for the airplane boarding activity in terms of pre-test and post-test scores with the Wilcoxon Sequential Sign test is presented in Table 6.

Table 6. Wilcoxon Signed Ranks Test Results of Pre-And Post-Training Flight Efficiency Scores

Airplane Riding Event Points	n	Rank Average	Rank Sum	z	p	d
Negative Rank	1	1.50	1.50	-3.565	0.000	3.1
Positive Rank	16	9.47	151.50			
Equal	1					

When Table 6 is examined, it is seen that the mean rank positive (9.47) is higher than the mean negative rank (1.50). This finding is an indication that there is an increase in favor of airplane riding activity scores after the experiment. Analysis results show that this difference before and after the training is statistically significant ($z=-3.565$, $p < 0.05$). In other words, the experimental procedure performed after the pre-training measurement effectively increased the students' airplane riding activity scores. The calculated effect size indicates that education has a high effect ($d = 3.1$).

When Table 6 is examined, it is seen that the mean rank positive (9.47) is higher than the mean negative rank (1.50). This finding is an indication that there is an increase in favor of airplane riding activity scores after the experiment. Analysis results show that this difference before and after the training is statistically significant ($z=-3.565$, $p < 0.05$). In other words, the experimental procedure performed after the pre-training measurement effectively increased the students' airplane riding activity scores. The calculated effect size indicates that education has a high effect ($d = 3.1$).

Findings on Cable Roller Activity: Kendall's W coefficient, which shows the agreement between the pre-test and post-test scores given to 18 students by three raters separately for each criterion in the scoring of the cable reel efficiency, is given in Table 7.

Table 7. Pre-Post-Test Kendall's W Agreement Coefficient for the Criteria

	Pre-Test			
Kendall's W Coefficient of Fit	The Process of Understanding the Problem	Solution Plan Preparation Process	Implementation Process of the Plan	Assessment Process
	0,792*	0,851*	0,883*	0,809*
	Post-Test			
	The Process of Understanding the Problem	Solution Plan Preparation Process	Implementation Process of the Plan	Assessment Process
	0,849*	0,903*	0,964*	0,890*

*p<0.01

When Table 7 was examined, it was found that the coefficients of agreement between the scorers' scores for each criterion were between 0.792 and 0.964 for the pre-test and post-tests, and all values were statistically significant. When the values are interpreted in general, it can be said that there is a high level of agreement between the raters according to the criteria of VonEye and Mun (2005).

The rater agreement between the pre-test and post-test total scores is given in Table 8.

Table 8. Kendall's W coefficient between Raters Calculated for Total Scores

Total Scores	Kendall's W Coefficient of Fit
Pre-Test Total Score	0,879*
Post-Test Total Score	0,917*

*p<0.01

When Table 8 is examined, the coefficient of agreement between the three raters according to the total scores obtained from the pre-test and post-test is 0.879 for the pre-test; for the post-test, it was calculated as 0.917, and this value was significant. This value shows that the agreement between raters is high.

Kendall's fit statistics, a technique in which agreement is calculated by considering rank differences, was highly significant for three raters in both tables. This finding can be interpreted as the raters showing a high similarity in ranking the individuals.

The result of comparing the mean scores given by the three raters for the cable reel efficiency in terms of pre-test and post-test scores with the Wilcoxon Sequential Sign test is presented in Table 9.

Table 9. Wilcoxon Signed Ranks Test Results of Pre-and Post-training Cable Reel Efficiency Scores

Cable Roller Activity Point	n	Rank Average	Rank Sum	z	p	d
NegativeRank	2	3	6	-3.219	0.001	2.33
PositiveRank	14	9.29	130			
Equal	2					

When Table 9 is examined, it is seen that the mean rank of positive (9.29) is higher than the mean negative rank (3). This finding indicates an increase in favor of the cable reel efficiency scores after the experiment. Analysis results show that this difference before and after the training is statistically significant ($z=-3.219$, $p<0.05$). In other words, the experimental procedure after the pre-training measurement was effective and increased the students' cable reel activity scores. The calculated effect size indicates that education has a high effect ($d = 2.33$).

Fourth Sub-Problem: What are the opinions of primary school mathematics teacher candidates regarding the Go game learning process?

The opinions of the prospective teachers about the Go training given were as follows:

S1 (Student 1): It was an excellent opportunity to learn the game of Go. Playing with different people helped you gain experience.

S2: It was an instructive process, as we had the opportunity to play online, and the event was designed in stages. I also liked that the philosophy of GO was mentioned during the games.

S3: It was nice that it was fun, wanted competition, and made people think.

S4: If we had solved more GO problems suitable for understanding the game, we could have planned our moves more predictably during the game.

S5: Everyone entered the online meeting program simultaneously, getting very confusing. Longer-term planning could have been done. Instead, separate meeting rooms could be built by dividing them into two groups.

S6: It would be good if we put it into practice by just playing a little more.

When examined in general, there are positive effects of learning Go and evaluations that the process is beneficial. Pre-service teachers negatively stated that the education process is complicated due to the distance, which is short. It has been determined that an educational process that will be carried out by emphasizing the teaching and philosophy of the game will be beneficial for strategic development.

Discussion and Conclusion

Go, the intelligence game focused on strategy development; It is a game for improving decision-making, problem-solving, and empathy skills (TGOD,2002). Go is not different from solving a persistent problem methodologically (Aksüt,2018). This research sought the question, "What is the effect of learning the Go game on the thinking styles, problem-solving styles, and problem-solving skills of primary school mathematics teacher candidates?". For this purpose, within the scope of the research, at the end of a 6-week Go training process with primary school mathematics teacher candidates, how the problem-solving skills of the game and the thinking styles of the individual towards the problem change were examined the pre-test-post-test method. As a result of the analysis made for the first sub-problem, "How did the problem-solving styles scores of primary school mathematics teacher candidates change during the learning process of the Go game?", it shows the difference between pre-and post-training is not statistically significant.

The analysis results for the second sub-problem, "How did the thinking styles scores of primary school mathematics teacher candidates change during the learning process of the Go game?" show that this difference emerged before and after the education was statistically significant. The experimental procedure after the pre-experimental measurement was meaningful, and the students' thinking styles increased their scores. The calculated effect size value shows that the training process has a high effect.

The analysis results for the third sub-problem, "How did the primary school mathematics teacher candidates' scores on problem-solving skills change during the learning process of the Go game?" show that this difference emerged before and after the education was statistically significant. The experimental procedure after the pre-training measurement was effective and increased the students' cable reel activity scores. The calculated effect size value shows that education has a high effect.

In the fourth sub-problem, in the question "What are the opinions of primary school mathematics teacher candidates about the learning process of the Go game?", the first of the negative aspects is the short duration of the education. The candidates stated that the Go intelligence game is different and more complicated than other games. This difficulty and process transformation into a problem-solving activity shows that different results can be obtained based on these results.

As a result, Go training, combined with problem-solving using Polya's strategic steps, positively affected the candidates' problem-solving skills and thinking styles. However, it took as little as six weeks. However, it could not be effective in the concept of the problem-solving method called problem-solving style. The main reason for this is the short six weeks of training. Another reason is that it can be interpreted as a result of each candidate trying to use the steps of Polya given for the problem-solving style (the style in foreign literature and method in some Turkish literature). However, it is known that Go game players of different levels solve Go problems in different styles and make different decisions for each move. (Aksut, 2018). This is undoubted because there are endless options for a move in Go (Silver, Schrittwieser & Simonyan, 2017).

Recommendations

Considering that Go is seen as a critical artificial intelligence problem and is used as a method by which the human mind can be analyzed, creating the infrastructure in which this basic information can be used will benefit the development of intelligence games training and problem-solving activities. New results can be obtained by conducting more extensive research on this subject.

- With the support of the Ministry of National Education, Go courses, such as the courses opened for the game of chess, can be opened, and the students can observe their interest in the game by teaching Go to the willing students.
- Since there is no Go game-focused study in Turkey, studies can be conducted with students whose participants are at the secondary-high school level. Studies can be continued in problem-solving, innovative thinking, and strategic thinking skills. In this direction, it will be ensured that individuals gain competence in 2025 skills mentioned in the world economic forum.
- New results can be obtained by examining the philosophy and approaches of the game of Go in the fields of software and education by examining the studies of Far East countries on AlphaGo and artificial intelligence, inspired by the old game of the world, Go.
- There are no Pro level Go players in our country, but more extensive work can be done with professional Go players.

Ethics Committee Approval

Ethical permission was obtained from the Süleyman Demirel University Social and Human Sciences Ethics Committee for this research (Date of Decision: 28.06.2021; Number of Decisions: E-87432956-050.99-73704). All the rules in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed in this research. None of the actions in "Ethics Actions Against Scientific Research and Publication " were carried out.

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