# PROSIDING
# SEMINAR NASIONAL JURUSAN MATEMATIKA 2023

**"Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju"**

**Kamis, 9 November 2023**
**Aula lantai 3 Gedung FMIPA**

**Penyelenggara :**

**Jurusan Matematika**
**Fakultas Matematika dan Ilmu Pengetahuan Alam**
**Universitas Negeri Medan**



UNIMED Publisher

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Universitas Negeri Medan.

Layout :
*Team*
Desain Cover:
*Team*

**Redaksi :**

Lembaga Penerbitan dan Publikasi UNIMED PUBLISHER
Universitas Negeri Medan.
Jalan Willem Iskandar Pasar V – Kotak Pos Nomor 1589 – Medan 20221
Telepon/WA 0822 – 6760 – 0400, Email : publisher@unimed.ac.id
Website : https://publisher.unimed.ac.id



ISBN : 978-623-5951-32-4
978-623-5951-33-1 (EPUB)

**TIM REDAKSI PROSIDING**
**SEMINAR NASIONAL JURUSAN MATEMATIKA**
**FMIPA UNIVERSITAS NEGERI MEDAN**

**"Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju"**

**Universitas Negeri Medan, 09 November 2023**

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## KATA PENGANTAR
## KETUA PANITIA

Segala puji dan syukur kepada Allah SWT atas terbitnya Prosiding Seminar Nasional Jurusan Matematika (SEMNASTIKA) FMIPA Universitas Negeri Medan. Prosiding ini merupakan kumpulan artikel ilmiah yang telah dipresentasikan pada kegiatan SEMNASTIKA 09 November 2023 di Aula Gedung Prof. Syawal Gultom, Universitas Negeri Medan. Adapun cakupan bidang kajian yang disajikan dalam prosiding ini meliputi Matematika, Statistika, Ilmu Komputer, dan Pendidikan Matematika.

Dengan mengangkat tema seminar, "Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju", kami mengharapkan SEMNASTIKA dapat turut serta berkontribusi bagi perkembangan ilmu pengetahuan jurusan matematika sebagai wadah bagi para peneliti, praktisi, penggiat pendidikan matematika dan pengguna untuk terjalinnya komunikasi dan diseminasi hasil-hasil penelitian.

Kegiatan SEMNASTIKA dan prosiding ini dapat diselesaikan dengan baik tidak terlepas dari bantuan berbagai pihak, oleh sebab itu kami mengucapkan banyak terimakasih kepada:

1. Pimpinan Universitas Negeri Medan
2. Dekan FMIPA dan para Wakil Dekan FMIPA Universitas Negeri Medan
3. Para Narasumber yaitu Bapak Prof. Dr. Janson Naiborhu, M.Si., Bapak Mangara Marianus Simanjorang, M.Pd., Ph.D dan Bapak Ahmad Isnaini, M.Pd.
4. Ketua Jurusan Matematika FMIPA Universitas Negeri Medan
5. Para Ketua Program Studi di Jurusan Matematika Universitas Negeri Medan
6. Panitia SEMNASTIKA
7. Pemakalah dan Peserta SEMNASTIKA
8. Semua pihak yang terlibat dalam pelaksanaan SEMNASTIKA

Kami menyadari bahwa buku prosiding ini masih jauh dari kata sempurna, karena itu kami mengharapkan kritik dan saran yang membangun dari para pembaca untuk perbaikan selanjutnya. Akhirnya, kami menghaturkan maaf jikalau ada hal-hal yang kurang berkenan bagi para pembaca serta ucapan terimakasih kepada semua pihak yang telah berkontribusi bagi terbitnya buku prosiding ini. Semoga buku prosiding ini dapat memberikan manfaat sesuai dengan yang diharapkan.

Medan, November 2023
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Susiana, S.Si., M.Si.
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## KATA PENGANTAR
## DEKAN FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
## UNIVERSITAS NEGERI MEDAN

Puji dan Syukur kepada Allah SWT atas segala rahmat dan anugerah-Nya sehingga Prosiding Seminar Nasional Jurusan Matematika dengan tema "Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju" yang diselenggarakan oleh Jurusan Matematika FMIPA Universitas Negeri Medan pada hari Kamis, 09 November 2023 di Medan dapat diselesaikan.

Publikasi prosiding ini bertujuan untuk memperluas wawasan pengetahuan yang berasal dari para akademisi baik dari Universitas Negeri Medan maupun yang berasal dari luar Universitas Negeri Medan. Selain itu, prosiding ini juga sebagai sarana untuk mengkomunikasikan hasil penelitian dengan menyajikan topik-topik terbaru yang meliputi bidang Pendidikan Matematika, Statistika, Ilmu Komputer dan Matematika.

Kami mengucapkan terimakasih dan apresiasi yang setinggi-tingginya kepada semua pihak yang telah berkontribusi dalam Seminar Nasional Jurusan Matematika, baik sebagai keynote speakers yaitu Prof. Dr. Janson Naiborhu, M.Si., Mangara Marianus Simanjorang, M.Pd., Ph.D dan Ahmad Isnaini, M.Pd., reviewer makalah, peserta dam panitia yang terlibat. Akhir kata, semoga Prosiding Seminar Nasional Jurusan Matematika ini bermanfaat bagi kita semua sehingga dapat memberikan kontribusi maksimal bagi negara dan bangsa.

Medan, November 2023
Dekan

Prof. Dr. Fauziyah Harahap, M.Si
NIP. 196607281991032002

**KATA PENGANTAR**
**KETUA JURUSAN MATEMATIKA**
**FMIPA UNIVERSITAS NEGERI MEDAN**

Dengan penuh rasa syukur kepada Allah SWT, prosiding Seminar Nasional Jurusan Matematika FMIPA Universitas Negeri Medan ini dapat diselesaikan. Kemajuan ilmu pengetahuan dan teknologi di era ini sangat berdampak bagi kehidupan manusia. Kajian penelitian terkait perkembangan ilmu pengetahuan dan teknologi serta terapannya perlu disosialisasikan kepada khalayak. Seminar Nasional Jurusan Matematika merupakan forum diskusi ilmiah yang sangat penting dalam pengembangan dan penyebaran pengetahuan di bidang matematika yang meliputi pendidikan matematika, statistika, ilmu komputer dan matematika (non pendidikan). Melalui buku prosiding ini, kami berupaya untuk menyajikan rangkuman makalah-makalah yang telah dipresentasikan, serta memberikan wadah bagi pembaca untuk menjelajahi gagasan-gagasan cemerlang yang ditawarkan dan penelitian-penelitian terkini yang dihasilkan oleh para akademisi, peneliti, dan praktisi matematika.

Tema seminar kali ini, "Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju", mencerminkan komitmen kami untuk terus menghadirkan diskusi yang relevan dan mendalam mengenai isu-isu terkini dalam dunia matematika. Melalui buku ini, kami berharap pembaca dapat m engeksplorasi berbagai sudut pandang, temuan, dan pemikiran-pemikiran baru yang dapat memperkaya wawasan serta menginspirasi penelitian dan pengembangan dan ilmu matematika.

Secara khusus, kami mengucapkan terimakasih kepada para narasumber, yaitu : Prof. Dr. Janson Naiborhu, M.Si., Mangara Marianus Simanjorang, M.Pd., Ph.D dan Ahmad Isnaini, M.Pd., yang telah membagikan ilmunya dalam kegiatan seminar. Terimakasih yang tulus juga kami sampaikan kepada semua pihak yang telah mendukung kegiatan ini, para pimpinan Universitas Negeri Medan dan para pimpinan FMIPA Universitas Negeri Medan. Apresiasi yang tinggi juga saya ucapkan teruntuk para penulis, reviewer, dan panitia yang telah berperan aktif dalam pembuatan buku prosiding ini. Kontribusi dari setiap individu adalah pondasi kesuksesan acara ini, dan semangat kolaboratif ini sangat berharga bagi perkembangan ilmu matematika.

Akhirnya, kami berharap buku prosiding ini dapat menjadi sumber pengetahuan yang bermanfaat dan memotivasi pembaca untuk terus menggali potensi dalam bidang matematika. Mari kita bersama-sama memperkuat dan memajukan ilmu matematika demi keberlanjutan pembaruan pengetahuan.

Medan, November 2023

Ketua Jurusan Matematika

Dr. Pardomuan Sitompul, M.Si
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## SUSUNAN ACARA

| Waktu | Kegiatan | PIC |
|---|---|---|
| 08.00 - 08.30 | Pendaftaran Ulang | Panitia |
| 08.30 - 09.00 | Acara Pembukaan<br>1. Salam Pembuka<br>2. Menyanyikan Lagu Indonesia Raya<br>3. Doa<br>4. Laporan Ketua Pelaksana<br>5. Sambutan dan Pembukaan acara seminar oleh Dekan Fakultas Matematika dan Ilmu Pengetahuan Alam<br>6. Foto Bersama | MC:<br>Putri Maulidina Fadilah, S.Si., M.Si<br>Nurul Ain Farhana, M.Si<br>Khairuddin, M.Pd.<br>Susiana, S,Si., M.Si.<br>Prof. Dr. Fauziyah Harahap,M.Si |
| 09.00 - 10.00 | Pembicara I<br>Prof. Dr. Janson Naiborhu, M.Si<br>(Guru Besar Matematika ITB) | Moderator:<br>Yulita Molliq Rangkuti, M.Sc., Ph.D |
| 10.00 - 11.00 | Pembicara II<br>Mangaratua Marianus Simanjorang, M.Pd. Ph.D (Dosen Jurusan Matematika UNIMED) | Moderator:<br>Andrea Arifsyah Nasution, S.Pd., M.Sc. |
| 11.00 - 11.45 | Pembicara III<br>Ahmad Isnaini, M.Pd (Guru berprestasi Nasional) | Moderator:<br>Dinda Kartika, S.Pd., M.Si. |
| 11.45 - 13.00 | ISOMA | |
| 13.00 - 14.30 | Sesi I : Seminar Paralel | Moderator<br>Pemakalah Pendamping |
| 14.30 - 16.00 | Sesi II: Seminar Paralel | Moderator<br>Pemakalah Pendamping |
| 16.00 | Penutupan acara oleh Dekan FMIPA | MC |

**KEYNOTE SPEAKER**

KEYNOTE SPEAKER 1

# Prof. Dr. Janson Naiborhu, S.Si., M.Si.

Prof. Janson Naiborhu memiliki dua gelar doktor yang ia peroleh dari Keio University (Jepang) dan Institut Teknologi Bandung. Kariernya sebagai dosen dimulai sejak tahun 1991, sejak ia bergabung sebagai Dosen FMIPA ITB, dengan Kelompok Keahlian Matematika Industri dan Keuangan. Ia menjadi Guru Besar sejak 1 Desember 2014 dan Pembina Utama Muda/Gol IV C sejak 1 April 2011.

Prof. Janson aktif dalam melakukan riset dan telah banyak menghasilkan jurnal ilmiah baik nasional maupun internasional. Namanyapun telah dikenal luas di dunia pendidikan dan industri, khususnya dalam bidang Matematika.

KEYNOTE SPEAKER 2

# Mangaratua M Simanjorang, M.Pd., Ph.D

Mangaratua M Simanjorang, M.Pd., Ph.D adalah dosen Pendidikan Matematika di Universitas Negeri Medan. Beliau meraih gelar sarjana di Universitas HKBP Nomensen tahun 2003, dan di tahun 2007 beliau mendapat gelar magister dari Universitas Negeri Surabaya. Beliau melanjutkan program doktor di Murdoch University, Australia dan memperoleh gelar Ph.D tahun 2016. Fokus pada pendidikan matematika, beliau melaksanakan tridarma universitas, beliau mendapatkan penghargaan sebagai dosen muda terbaik tahun 2009.

Dengan menjadi reviewer dan narasumber dibanyak kegiatan seminar, beliau berbagi ilmu dalam bidang pendidikan matematika, pendidikan karakter dan media pembelajaran seperti *augmented reality*.

KEYNOTE SPEAKER 3

# Ahmad Isnaini M.Pd.

Ahmad Isnaini, M.Pd adalah seorang pendidik yang memiliki dedikasi tinggi terhadap dunia pendidikan. Ia meraih gelar Sarjana Pendidikan Matematika dari Universitas Negeri Medan pada tahun 2010, kemudian melanjutkan studi pascasarjana dan meraih gelar Magister Pendidikan Matematika pada tahun 2019 dari universitas yang sama. Saat ini, Ahmad sedang mengejar gelar Doktor dalam bidang yang sama di Universitas Negeri Medan.

Ahmad Isnaini juga telah mengukir prestasi gemilang dalam berbagai kompetisi dan olimpiade. Sebagai Finalis Apresiasi GTK 2023 BBGP Sumatera Utara Tingkat Provinsi dan penerima berbagai medali emas, perak, dan perunggu dalam Olimpiade Guru tingkat Nasional dan Provinsi, Ahmad Isnaini memperlihatkan dedikasinya dalam pengembangan kemampuan diri dan juga siswanya.

Tidak hanya aktif di dunia akademis, Ahmad Isnaini juga telah berkontribusi dalam literatur pendidikan. Karya-karyanya yang terpublikasi dalam jurnal nasional dan internasional, serta buku-buku seperti "Guru Merdeka" (2020) dan "Inovasi Pembelajaran" (2018), mencerminkan pemikiran dan wawasan yang mendalam dalam bidang Pendidikan.

# DAFTAR ISI

# THE IMPLEMENTATION OF PROBLEM BASED LEARNING MODEL ASSISTED BY GEOGEBRA SOFTWARE TO IMPROVE STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY IN GRADE X AT SMA NEGERI 8 MEDAN

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## Abstract

*This research aims to describe the increase in the problem solving skills of SMA Negeri 8 Medan students with the implementation of the Problem-Based Learning model assisted by Geogebra. This research is a classroom action research which consists of 2 cycles with each cycle consisting of 2 meetings. The subjects of this study were students of class X IPA 2 of SMA Negeri 8 Medan with a total of 36 students. Data collection techniques used tests of students' problem solving abilities and teacher observation sheets. The results of this study indicate an increase in students' problem-solving skills in class X IPA 2 after the implementation of the problem-based learning model assisted by Geogebra. Based on the research results it is known that the average problem-solving abilities of students in the first cycle of 57.87 and in the second cycle 76.39 and the observation result was the very good category. By increasing the average test results of each cycle and achieving the classical completeness criteria, it can be concluded that learning with the Problem-Based Learning model assisted by Geogebra can improve the problem solving abilities of students of SMA Negeri 8 Medan.*

**Keywords:** *Geogebra, Problem Based Learning Model, Problem Solving Ability*

## 1. INTRODUCTION

The dynamics of education issues in Indonesia are always interesting to discuss. The quality of education is required to always be integrated with the progress of the times. Education is the source of all sources of national progress of a nation because the quality of a nation's human resources can be improved by education. In UU RI No.20 Pasal 1 Tahun 2003 about Nasional Education Systems states that with education, students can actively develop their potential and skills which will later be needed to carry out life in society, nation and state. Education can also be interpreted as a conscious and systematic effort in developing all the potential that exists within humans to achieve a better standard of living or progress where in education there is a learning process to be able to understand and make humans more critical in thinking. One of the sciences that has a significant influence in developing the ability to think, solve problems and challenges of science and technology progress. Therefore, from basic to higher education, mathematics is a subject that is taught at all levels. The skills resulting from studying mathematics develop the skills to think logically, systematically, innovatively, creatively (Vernia, 2019) and others which are the basis for creating innovations in the development of science and technology. As stated by Hasratuddin (2015) that mathematics is very important for everyone to learn because mathematics can develop logical, systematic, objective, critical and rational thinking tools and is very competent in shaping one's personality so that human resources can also develop forward.

One of the goals of mathematics in the 2013 curriculum as contained in the attachment to Permen No. 58 Tahun 2014 section of the Mathematics Subject Guidelines is must be able to Use concepts and techniques in a precise, flexible, accurate, and efficient way while addressing issues, which requires an understanding of mathematical concepts that are fundamental in describing how concepts relate to one another (Permendikbud, 2014). Based on these objectives, it can be said that mathematics is a discipline that can improve thinking and argumentation skills, contributing to solving problems in everyday life. To be able to understand a subject in mathematics, students are expected to have mathematical abilities that are useful for facing global challenges. The ability needed is the ability to solve students' mathematical problems which is the ability needed to solve life's problems and face today's global (Suraji, et al, 2018). The ability to solve problems in learning mathematics is one of the results to be achieved, so it must be considered by teachers and given special attention, given its role in developing students' intellectual potential. It is expected of students who study mathematics in school to be able to answer mathematical issues. This objective makes problem-solving a crucial component of the mathematics curriculum. Furthermore, Purwaningrum & Ahyani (2016) explain that the ability to solve mathematical problems is an example of high-level mathematical thinking skills because when students use these abilities to solve non-routine math problems, they indirectly also use other mathematical abilities such as mathematical connection skills, mathematical communication skills, creative thinking skills and others in an effort to solve the problem. One of the main goals of mathematics education is to develop mathematical problem solving abilities so that knowing each student's mathematical problem solving abilities in solving various mathematical problems in depth is an important part for teachers. A student is said to have the ability to solve problems in learning mathematics when students achieve certain criteria or commonly known as indicators. There are four indicators of solving mathematical problems according to Polya, namely understanding the problem, devising a plan, carrying out the plan, and looking back.

Based on facts in the field, students' problem solving ability is still weak. As stated by Astuti (2016) in their research, namely the performance of students in solving mathematical problems is still in the low criteria. Many students do not like mathematics because most of the problems given can only be solved with higher-order thinking skills. As stated by Purbaningrum (2017) which states that students still find it difficult when asked to solve non-routine math problems. This is partly because they are more accustomed to working on routine questions in textbooks so they are not used to working on everyday problems with certain topics. Ifut Riati (2015) in his research stated that many students had difficulty solving questions, students tended not to understand the problems in the questions in advance, so they only answered briefly. Whereas before students solve a problem, they must understand the existing problem, be able to identify and determine the right way to solve it. In other words, students are not able to understand the problem, formulate what is known from the problem, the student's settlement plan is not directed and the calculation process or settlement strategy from the answers made by students is not correct. In addition, the teacher only explains the material through examples, not giving concepts so that students tend not to understand concepts in learning mathematics, students only understand examples and similar questions. As stated by Dwi, et al (2018) in their research that students tend to memorize formulas without understanding concepts and work on math problems carelessly. Students prefer to use short methods without paying attention to the correct completion process. Teachers still use the lecture method where learning is still centered on the teacher, so that the teacher dominates the process of learning activities in class compared to students. The exercises given are Lower Order Thinking Skills (LOTS), the lack of opportunity for students to ask questions to the teacher so that they do not train students' reasoning power in problem-solving. Low learning outcomes and passive teaching and learning processes are the results of several of these

factors. In fact, the achievements of Indonesian students at the international level are also low. According to the Trends in International Mathematics and Science Study (TIMMS) scores from 1999, 2003, 2007, 2011 and 2015, Indonesia is still below the international level. The results of the latest research by TIMSS in 2015 showed that Indonesia was ranked 46th out of 51 countries with an average score of 397 (Retnowati, P. & Ekayanti, A., 2020). Comparable results were also obtained from the 2018 PISA study report, placing Indonesia ranked 73 out of 79 countries for mathematics ability with a score of 379 while the average international score was 489. Weak problem solving ability that are not routine or high level are factors that cause the low performance of Indonesian students in the PISA test. Routine questions at low levels have become a habit for students in Indonesia. According to the results of the PISA survey, it can be said that the achievements of Indonesian students at the international level are still lagging behind compared to other countries.

In addition, the researcher also conducted an interview with Mr. Zulkifli, a mathematics teacher at SMA Negeri 8 Medan on February 25th, 2023 where he explained that the problem-solving abilities of students at SMA Negeri 8 Medan were still low. Many students struggle to answer the questions that are presented. Only problems that are almost identical to the examples given can be solved by students. From the results of the interviews, the process of learning mathematics is still carried out by direct learning using the lecture and question and answer method. The media used is also limited, namely textbooks provided from schools. So, it can be said that the learning process is still teacher-centered, while students are not yet active in the process of solving problems. In addition to conducting interviews with teachers, the researchers also conducted diagnostic tests on Saturday, February 25th, 2023 for grade X SMA Negeri 8 Medan with the material they had studied. This diagnostic test was conducted to determine students' initial mathematical problem-solving abilities. The three problem-solving ability questions in the form of essays given are diagnostic tests that will be used as a tool to measure students' problem-solving abilities. The following are the diagnostic tests given.

1. Mr. Ucok's parking lot at that time accommodated 70 vehicles consisting of 2-wheeled motorbikes and 4-wheeled cars. The total number of motorcycle and car wheels was 176. If the parking fee for a motorbike is Rp. 5,000.00 and a car is Rp. 10,000.00, how much did Mr. Ucok's income at that time?
   a. Write down what information you got and what was asked.
   b. Let's say a motorcycle is x and a car is y. Set up a system of linear equations according to the problem above.
   c. Solve the problem. Is the information provided sufficient to calculate Pak Ucok's income?
   d. Check whether the number of motorcycles and cars respectively 44 and 26 is the solution to the problem? Explain!
2. A company has built minimarket A at the 30th kilometer of a road and minimarket B at the 60th kilometer of the same road. The company wants to build another minimarket on that road. If the company wants the new minimarket to be more than 15 km from minimarket B, at what kilometer will the new minimarket be built?
   a. Write down what information you got and what was asked.
   b. What is the solution plan that you will use to solve the problem? What concept will you use?
   c. Solve the problem.
   d. Can a new minimarket be built at the 45th kilometer or the 75th kilometer? Give your reasons.
3. A number consists of three digits that add up to 9. The units are three more than tens. If the hundreds and tens are swapped, the same number is obtained. Determine the number.
   a. Write down what information you got and what was asked.
   b. Create a mathematical model..
   c. Solve the problem.
   d. What if the units digit of the number is 1? What results were obtained? Give your reasons.

Based on the results of the diagnostic test given to 36 class X students who took the test at SMA Negeri 8 Medan, it was obtained a score of achievement of mathematical problem solving based on the level of students' abilities in several criteria, namely as many as 4 students were in high criteria, 6 students were in medium criteria, 11 students are in the criteria, and 15 other students are in very low criteria or as many as 91.66% of students do not complete. According to the diagnostic test results, the percentage of students who can understand the problem reached 56.17% and fell into the "moderate" category, meaning that they were unable to do so as evidenced by their failure to record what they knew and the questions they were asked, the percentage of students who can plan problem solving strategies reached 36.57% and belonged to the "very low" category where students were not yet able to plan problem solving or write mathematical models, the percentage of students who can solve problems reached 37.04% and belonged to the "very low" category where students were not able to solve problems based on the plan that has been made, and the percentage of students' ability to interpret solutions/check back reaches 23.15% and belongs to the "very low" category where students do not re-check answers and provide conclusions or reasons for the answers given. The class average score obtained from 36 students on the diagnostic test was 39.91 on a scale of 0-100 with a completeness level of 8.33% (3 people) and 91.66% (33 people) who did not complete, KKM value ≥70. So,

it may be argued that the mathematical problem-solving ability of grade X students of SMA Negeri 8 Medan is low. The researcher identified several student weaknesses, namely students often had difficulty understanding questions, determining concepts and solving plans, and students were also not careful in doing calculations.

To anticipate this problem, a teacher is expected to be able to provide a solution in the form of an appropriate learning model that train students' mathematical problem-solving ability and able to create a pleasant atmosphere and make students more active and more courageous in expressing their opinions, namely by using a problem-based learning model. According to Ngalimun (2017), problem-based learning is an innovative teaching strategy that can give students the opportunity for active learning. Students' abilities in solving mathematical problems can be improved with a problem-based learning model. The research results of Panjaitan & Rajagukguk (2017) suggest that problem-based learning models can improve students' mathematical problem-solving ability. The first step of this model is for the students or teacher to present the problem to be solved. Then, students will collect some information to deepen their knowledge in solving the problem such as what is known, what needs to be known, and what it being asked. This information is obtained from the results of investigations using a problem-based learning model. Students' mathematical problem solving abilities are expected to improve after implementing the problem-based learning model.

In addition to using the right learning model, mathematical problem-solving ability can be overcome by using effective learning media. In accordance with the times, learning mathematics in high schools has also experienced changes with the integration of technology and computers (ICT) in learning. The use of ICT media can help teachers in terms of conveying material that is abstract to be concrete. One of the software that can be developed as a media for learning mathematics is Geogebra. Markus Hohenwarter developed geogebra in 2001 from Australia and released as open source software so it can be used for free and is free to develop. Nur'aini, et al (2017) stated that: "With Geogebra students can improve the experimental process, be problem oriented, and find mathematical concepts. Geogebra can solve problems such as drawing geometric objects easily and precisely. Geogebra can be used on computer or mobile media. Geogebra can be used to discover concepts in geometry, algebra, trigonometry, calculus or other concepts. Geogebra can help construct students' knowledge independently. This is because the tools in Geogebra are easy to use as a visualization and computing tool (Fatimah, et al, 2017).

Based on the background of the problems above, the author is interested in conducting research entitled "The Implementation of Problem Based Learning Model Assisted by Geogebra Software to Improve Students' Mathematical Problem-Solving Ability in Grade X of SMA Negeri 8 Medan".

## 2. RESEARCH METHOD

This research was conducted at SMA Negeri 8 Medan which is a classroom action research with the aim of describing the increase in students' mathematical problem solving ability by implementing the problem based learning model assisted by Geogebra software in class X SMA Negeri 8 Medan. This research was done in two cycles, each consisting of two meetings from May 24$^{th}$ to June 03$^{rd}$ 2023. The subjects of this research were students of class X IPA 2 of SMA Negeri 8 Medan with a total of 36 students. The material taught by researcher is trigonometry material to determine students' problem-solving ability so they are given problem solving ability tests I and II which consist of 3 questions in the form of essay. Data collection techniques used tests of students' problem solving abilities and teacher observation sheets. The research instruments used in this study, namely: problem solving ability test, observation guide, and documentation.

## 3. RESULT AND DISCUSSION

The increase in students' mathematical problem solving abilities was seen from the results of the initial tests and the tests given at the end of the learning cycle, namely in cycle I and cycle II. From the results of data processing carried out, it was seen an increase in the average value and classical completeness for each of the initial tests, cycle I and cycle II.

Based on the problem-solving ability test on the diagnostic test that was given to 36 students, along with details of indicators of achievement of students' problem-solving abilities, there were 4 students out of 36 students or 11.11% who had a high level of ability, 6 students out of 36 students or 16.67 % who had a moderate level of ability, 11 students out of 36 students or 30.55% who had a low level of ability, and 15 students out of 36 students or 41.67% who had a very low level of ability. Overall the level of students' ability to solve problems on the diagnostic test was 39.91 with an average score of 11.97. The number of students who have achieved learning mastery (score ≥70) is 3 of 36 students or 8.33%, while the number of students who had not achieved completeness was 33 out of 36 students or 91.66%. This score has not yet reached classical completeness because the number of students who have completed (score ≥70) has not reached (score ≥85) of the total number of students.

From the results of the diagnostic tests, several things have been found that become difficult in solving problems which result in very low problem-solving abilities of students, namely:

1. The inability of students to understand the meaning of the questions in determining what is known and what is asked from the questions given.

2. The inability of students to plan problem solving and apply appropriate strategies and procedures to solve problems.
3. Students are not careful in working on problems so that they are wrong in doing calculations.
4. Students have difficulty analyzing the results of their answers and only focus on the final results without concluding the results of the work so that they are less able to re-examine the results of their answers.

According to the findings of the diagnostic tesr, it can be said that students are unable to resolve the offered mathematical problem-solving issues. Providing actions and designing learning scenarios by applying the Geogebra-assisted problem-based learning model based on diagnostic test results with the aim of improving students' problem-solving abilities. The action plan I is designed as follows :

1. Using the Problem Based Learning model and Geometry, the teacher develops instructional scenarios.
2. The teacher develops a learning implementation plan (RPP), which includes stages in learning activities using the problem-based learning model.
3. The teacher prepares learning support facilities that support the implementation of actions, namely: (1) Student Worksheets (LKPD) with trigonometry material, (2) Subject books for researchers, and (3) GeoGebra software learning media.
4. The teacher prepares research instruments, namely: (1) a problem-solving test used to measure the level of students' problem-solving abilities and (2) observation sheets of the teacher's ability to apply Problem Based Learning.
5. The teacher arranges study groups randomly consisting of 4-5 people.

Cycle I was the first stage of research on how to use the Problem Based Learning and the GeoGebra program to enhance students' mathematical problem-solving skills in trigonometric material. The data obtained from the implementation of trigonometry learning material cycle I consisted of tests and non-tests. The test results in cycle I consist of mathematical problem-solving abilities and non-test results in form observations test. The results of the two data are described in detail as follows. Based on the outcomes of the students' responses to the mathematical problem-solving ability test cycle I, the level of problem-solving ability can be described as follows:

1. Understanding the problem

   Based on students' answers in the problem-solving ability test I, the total score of students' ability to understand problems on the problem-solving ability test is 224 out of a maximum score of 324 with a percentage of 69.14%. According to the data, class X IPA 2 SMAN 8 Medan have high levels of mathematical problem-solving abilities.

2. Devising plan the problem

   Based on students' answers in the problem-solving ability test I, the student's ability score in planning problem-solving was 147 out of a maximum score of 216 with a percentage of 68.06%. According to the data, class X IPA 2 SMAN 8 Medan have high levels of mathematical problem-solving abilities..

3. Carrying out the problem

   Based on students' answers in the problem-solving ability test I, the student's ability score in carrying out problem-solving was 164 out of a maximum score of 324 with a percentage of 50.62%. According to the data, class X IPA 2 SMAN 8 Medan have low levels of mathematical problem-solving abilities.

4. Looking Back

   Based on the students' answers in the problem-solving ability test I, the student's score in checking again was 90 out of a maximum score of 216 with a percentage of 41.67%. According to the data, class X IPA 2 SMAN 8 Medan have low levels of mathematical problem-solving abilities..

Based on the data collected, Table 1 below shows the average score of students' performance on each indicator of students' mathematical problem-solving abilities :

**Table 1.** Achievement Score of Students' Mathematical Problem-Solving Indicators in Cycle I

| Indicator | Problem-Solving Ability Test I | |
|---|---|---|
| | Average Score | Category |
| Understanding problem | 69.14 | High |
| Devising a plan | 68.06 | High |
| Carrying out the plan | 50.62 | Low |
| Looking back | 41.67 | Low |
| Average score of problem-solving ability test I | 57.87 | Moderate |

Based on the analysis of scores for each indicator of mathematical problem solving above, the highest indicator achieved by students was understanding the problem, namely 69.14% in the high category, while the lowest indicator achieved by students was the ability of students to check again, namely 41.67% in the low category.

Based on the outcomes of cycle I's test of mathematical problem-solving aptitude, it was obtained detailed indicators of achievement of students' problem-solving abilities, namely that there were 2 students or 5.55% who have a very high level of ability, 8 students or 22.2% who have a high level of ability, 13 students or 36.11% who have medium ability level, 10 students or 27.77% who have low ability level, and 3 students or 8.33% who have very low ability level. The class average score obtained from 36 students in the first cycle ability test was 57.87. The results of tests of students' mathematical problem solving abilities in cycle I can be seen in Table 2 below:

**Table 2.** Level of Students' Mathematical Problem Solving Ability in Cycle I

| Interval Score | Category | Many Students | Average | Average Ability of Students |
|---|---|---|---|---|
| 80.00 – 100,00 | Very High | 2 | 5.55% | 57.87 (Moderate) |
| 66.00 – 79.99 | High | 8 | 22.2% | |
| 56.00 – 65.99 | Moderate | 13 | 36.11% | |
| 40.00 – 55.99 | Low | 10 | 27.77% | |
| < 40.00 | Very Low | 3 | 8.33% | |
| ∑ | | 36 | 100% | |

Based on the criteria for the completeness of students' problem solving abilities, the results of the problem solving ability test showed that only 9 students or 25% of the 34 students had achieved a learning completeness score greater than or equal to 70 and 27 other students (75%) did not complete. This shows that class X IPA 2 students are not yet thorough in solving students' mathematical problems. Based on the outcomes of assesments of students' capacity for solving mathematical problems, it was obtained an increase in classical mastery of problem solving abilities of 16.67%, from 8.33% to 25%. Even though there has been an increase, the classical mastery level obtained in cycle I has not met the minimum classical mastery requirement, which is 85%. Therefore, this research has not been successful. For this reason, several improvements are needed in cycle II. Besides that, the observation results obtained in cycle I were that the final score of the teacher's (researcher) ability to carry out learning at the first meeting was 2.54 in the good category and at the second meeting was 3.08 with the very good category. As for the results of the overall observation of the teacher's (researcher) ability to carry out learning cycle I was 2.81 in the good category. However, it still needs improvement in the management of learning so that learning can be maximized.

Based on the data described above there are still students who have not achieved mastery of classical learning so that the learning process continues into cycle II. The results of the first problem solving ability test are used as a reference in giving action and compiling learning procedures by applying the Problem Based Learning model in cycle II to improve students' problem solving abilities. Based on the results of reflection I, namely that the objectives of this learning have not been achieved and there are still a number of things that must be corrected in learning activities, cycle II is carried out to improve and overcome problems that occur in cycle I. With the hope that learning cycle II can improve mathematical problem solving abilities students according to the expected target. The problems obtained from learning in cycle I include:

1. The number of students who achieved completeness was 9 students (25%) and those who did not complete were 27 students (75%), thus classical mastery had not been achieved.
2. Students still struggle to solve problems. This is based on the results of the problem solving ability test I where the indicator of carrying out problem solving reaches a percentage of 50.62% in the low category.
3. The ability of students to re-examine the solutions they worked on is still low. This is based on the outcomes of the problem-solving test in which the re-checking indicator reaches a percentage of 41.67% in the low category.
4. The management of learning by the teacher must be maximized, especially in an effort to motivate students to be more active in interacting both with friends in groups and with the teacher.
5. The teacher was still not strict about the use of time so that there were several groups that could not complete the LKPD because time was running out.

At this stage, the researcher made an action plan II to overcome the deficiencies and failures of learning during cycle I. The action plans that will be carried out at this stage include:

1. Students' problem solving abilities are expected to increase after implementing the problem based learning model assisted by Geogebra with several improvements.
2. The application of problem solving steps is emphasized and explained to students. The teacher accustoms students to working on practice questions so that students can practice how to solve problem solving, are more careful in calculations, and are able to re-check the solutions that have been worked out.
3. Researchers motivate students more so that students are more interested and enthusiastic in finding solutions to the problems given.
4. Researchers are expected to be more in control of the class so that the time arrangements provided are timely and strictly limit the time for discussing and presenting the results of the discussion to have sufficient time.
5. A learning implementation plan (RPP) containing steps for learning activities using the Problem Based Learning model is prepared by the teacher.
6. The teacher prepares learning support facilities that support the implementation of actions, namely: (1) Student Worksheets (LKPD) with trigonometry material, (2) Subject books for researchers, and (3) Geogebra software learning media.
7. The teacher prepares research instruments, namely: (1) a problem-solving test used to measure the level of students' problem-solving abilities and (2) an observation sheet of the teacher's ability to apply Problem Based Learning.

8. Students are grouped heterogeneously (high, medium and low ability) by the teacher by looking at the results of the mathematical problem solving ability test I and activeness.

The data obtained from the implementation of trigonometry learning material cycle I consisted of tests and non-tests. The test results in cycle I consist of mathematical problem solving ability test results and non-test results in the form of observations. The results of the two data are described in detail as follows. According to the results of the students' responses on Cycle II of the mathematical problem-solving ability test, the level of problem-solving ability can be described as follows :

1. Understanding the problem

   Based on students' answers to the problem solving ability test II, students obtained a total score of 261 out of a maximum score of 324 with a percentage of 80.56% for the ability to understand problems. According to the data, class X IPA 2 SMAN 8 Medan have very high levels of mathematical problem-solving abilities.
2. Devising plan the problem

   Based on the students' answers in the problem-solving ability test II, the student's ability score in planning problem-solving was 185 out of a maximum score of 216 with a percentage of 83.01%. According to the data, class X IPA 2 SMAN 8 Medan have very high levels of mathematical problem-solving abilities.
3. Carrying out the problem

   Based on students' answers in the problem-solving ability test II, the student's ability score in carrying out problem-solving was 235 out of a maximum score of 324 with a percentage of 72.53%. According to the data, class X IPA 2 SMAN 8 Medan have high levels of mathematical problem-solving abilities.
4. Looking Back

   Based on students' answers to the problem solving ability test II, students obtained a total score of 144 out of a maximum score of 216 with a percentage of 66.67% for the ability to understand problems.. According to the data, class X IPA 2 SMAN 8 Medan have high levels of mathematical problem-solving abilities.

The average score of students' abilities on each indicator of their capacity for solving mathematical problems can be found in Table 3 below, which is based on the data that has been obtained :

**Table 3.** Achievement Score of Students' Mathematical Problem-Solving Indicators in Cycle II

| Indicator | Problem-Solving Ability Test II | |
|---|---|---|
| | Average Score | Category |
| Understanding problem | 80.56 | Very High |
| Devising a plan | 83.01 | Very High |
| Carrying out the plan | 72.53 | High |
| Looking back | 66.67 | High |
| Average score of problem-solving ability test II | 76.39 | High |

Considering the outcomes of the second cycle of mathematical problem-solving tests, detailed indicators of achievement of students' problem-solving abilities were obtained, namely that there were 14 students or 38.88% who had a very high level of ability, 21 students or 58.33% who had a high level of ability and 1 student or 2.77% who have a moderate ability level. The class average score obtained from 36 students on cycle II was 76.39. The results of tests of students' mathematical problem solving abilities in cycle II can be seen in the table 4 below:

**Table 4.** Level of Students' Mathematical Problem Solving Ability in Cycle II

| Interval Score | Category | Many Students | Average | Average Ability of Students |
|---|---|---|---|---|
| 80.00 – 100,00 | Very High | 14 | 38.88% | 76.39 (High) |
| 66.00 – 79.99 | High | 21 | 58.33% | |
| 56.00 – 65.99 | Moderate | 1 | 2.77% | |
| 40.00 – 55.99 | Low | 0 | 0% | |
| < 40.00 | Very Low | 0 | 0% | |
| ∑ | | 36 | 100% | |

Based on the criteria for the completeness of students' problem solving abilities, the results of the problem solving ability test showed that there were 33 students or 91.66% of the 36 students who had achieved a learning completeness score greater than or equal to 70 and 3 other students (8.33%) did not complete . This shows that class X IPA 2 students have been thorough in solving students' mathematical problems. Besides that, the observation results obtained in cycle II were that the final score of the teacher's (researcher) ability to carry out learning at the first meeting of cycle II was 3.5 with a very good category and at the second meeting was 3.8 with a very good category. As for the results of the overall observation of the teacher's (researcher) ability to carry out learning in cycle II was 3.65 with a very good category.

Based on the outcomes of cycle II test for problem-solving skills and observations, it was found that there had been changes or improvements during learning in cycle II using the Problem Based Learning model designed in cycle II which was based on the problems in cycle I. Based on the results of the data analysis, it was found that :

1. The average ability of students in cycle I increased in cycle II, demonstrating an improvement inn students' mathematical problem-solving skills.
2. Cycle I results for the mathematical problem-solving ability exam showed an increase in the percentage of

classical completeness, which climbed by 25% in cycle II to reach 91.66%.

3. There was an increase in the teacher's ability to carry out mathematics learning which can be seen from the average score in cycle I, which was 2.81 in the good category, increasing in cycle II to 3.65 in the very good category.

Based on the test results of students' problem-solving abilities in the initial (diagnostic) ability test, the average test score of 39.91 increased to 57.87 in cycle I and increased to 76.39 in cycle II. Classical completeness was obtained by 3 students out of 36 students (8.33%) in the diagnostic test increasing to 9 students out of 36 students (25%) in cycle I and increasing to 33 students out of 36 students (91.66%) in cycle II. The increase that occurred from cycle I to cycle II already fulfilled the percentage of completeness of absorption capacity, namely the test results of students meeting the Minimum Completeness Criteria (KKM) ≥70 and the percentage of students' classical completeness was achieved if 85% of students scored with KKM ≥70. The tests used have been validated by Unimed lecturers and subject teachers and have undergone improvements. In the problem-based learning process to improve students' mathematical problem solving abilities it has been effective because it has achieved complete absorption, classical completeness, and the percentage of teacher activity in managing learning in class.

**Table 5.** Description of Student Problem Solving Ability Levels in Each Cycle

| Interval Score | Criteria | Diagnostic Test | TKPM Cycle I | TKPM Cycle II |
|---|---|---|---|---|
| 80.00 – 100,00 | Very High | 0 | 2 | 14 |
| 66.00 – 79.99 | High | 4 | 8 | 21 |
| 56.00 – 65.99 | Moderate | 6 | 13 | 1 |
| 40.00 – 55.99 | Low | 11 | 10 | 0 |
| < 40.00 | Very Low | 15 | 3 | 0 |
| ∑ | | 36 | 36 | 36 |
| Average of Class | | 39.91 | 57.87 | 76.39 |
| Classical completeness percentage | | 8.33% | 25% | 91.66% |
| Incomplete percentage | | 91.66% | 75% | 8.33% |

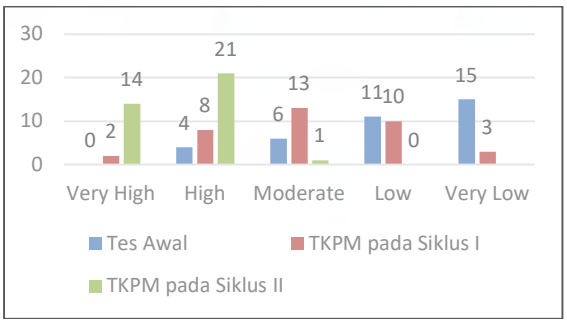


**Figure 1.** Description of the Initial Ability Test, Solving Ability Test Problems of Cycle I and Cycle II

From the collected data, it can be seen that each indicator of problem solving in cycle I is still low, but in cycle II each indicator is no longer low or can be said to be increasing. In working on the questions in cycle I students still do not understand the questions and it is difficult to solve problems and in cycle II students already understand the essence of the questions given and how to complete the correct answers because students have been trained in solving problems that have been given at each meeting and discussed with team members.

In addition to increasing students' mathematical problem-solving abilities, the use of GeoGebra was able to increase student motivation and help students better understand trigonometry material because the GeoGebra application helps students learn concretely.

Based on the description above, it can be concluded that students' mathematical problem solving abilities can be improved by implementing an effective alternative learning model, namely the geogebra-assisted problem-based learning model.

## 4. CONCLUSION

The following conclusions can be obtained from the research's findings and discussion : The improvement of students' ability in solving mathematical problems using the learning model of Problem Based Learning assisted by geogebra. Based on the research results it is known that the average problem-solving abilities of students in the first cycle of 57.87 and in the second cycle 76.39. This shows that the ability of students in solving mathematical problems increased after the Problem Based Learning model assisted by Geogebra software was applied. The classical completeness of class X SMA Negeri 8 Medan in learning trigonometry using the Problem Based Learning model assisted by Geogebra Software has increased. Based on the results of the study it was found that the students' classical completeness in cycle I was 25% and in cycle II was 91.66%. This shows that students' classical mastery increases after the Problem Based Learning model assisted by Geogebra is applied.


## ACKNOWLEDGEMENT

My deepest gratitude goes out to everyone who contributed to the preparation and publication of my scholarly research, especially to the SMA Negeri 8 Medan who have given permission to carry out this research and to the Mathematics Education Lecturers of Universitas Negeri Medan who have given me criticism and suggestions in making this scientific article. I hope that this article will be useful for readers and will be one of my contributions in developing science.


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