

The Role of Mathematics Education in Improving Problem-Solving Abilities in the Era of Revolution Industry 4.0

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ABSTRACT

Industrial Revolution 4.0 brings many aspects of change that must be addressed as a challenge, especially in mathematics education. According to the OECD, in the field of mathematics, around 71% of students do not reach the minimum competency level in mathematics. This means that many Indonesian students still struggle with situations requiring problem-solving skills using mathematics. This study uses a library approach with data sources derived from several articles, and to support this research, searches were also conducted via the internet and books. After the data is collected, data processing is carried out. The data analysis is carried out using descriptive analysis. Data collection techniques used are primary data and secondary data. The data source comes from several articles, namely the work of Maifit Hendriani, Silfi Melindawati and Afri Mardicko with the title "Mathematical Problem solving ability in the Industrial Revolution Era 4.0 Elementary School Students", the work of Fitrie Andayani and Adiska Nadiyah Lathifah with the title "Analysis of Problem-Solving Capabilities of Middle School Students in Solving Questions on Social Arithmetic Material," by Ayu Yarmayani with the title "Analysis of Mathematical Problem Solving Abilities of Class XI Mipa SMA Negeri 1 Jambi City" as well as other journal articles that support this writing. The role of mathematics in the era of the Industrial Revolution 4.0 as a foundation of knowledge for the development of modern technology and knowledge is significant to study. Someone with mathematical ability can study their natural surroundings to develop technology that will benefit humankind. One of these mathematical abilities is problem-solving, which allows students to solve a mathematical problem related to everyday life. The role of mathematics education in improving problem-solving abilities in the era of the Industrial Revolution 4.0 is vital in this development. We must be able to keep up with technological and scientific developments, which are growing, while the ability to solve mathematical problems in the era of the Industrial Revolution 4.0 is said to be inadequate. Providing good mathematics education and problem-solving training to each student can help students develop problem-solving abilities.

Keywords: Mathematics Education, Problem-Solving Ability, Revolution Industry 4.0.

INTRODUCTION

The role of mathematics in the era of Industrial Revolution 4.0 is as a science that underlies the development of modern technology and knowledge. Furthermore, mathematics can advance logical, analytical, systematic, critical, and creative thinking

skills, so it is important to learn it. Someone with mathematical abilities can study the natural environment to develop technology for the welfare of humanity. Students have mathematical literacy skills if they can estimate, interpret information, and even solve realistic problems in order to be able to provide reasons in numeracy, graphic and geometric situations and communicate using mathematics. The results of several surveys and research show that mathematical literacy skills are running well because they are supported by the use of appropriate technology in the era of the Industrial Revolution 4.0.

Released from the Ministry of Education and Culture's website on December 5, 2022, entitled "Revisiting PISA Results as a Learning Innovation Approach for Improving Literacy and Numeracy Competencies "written by Hadi Wuryanto, S.Kom., MA and Moch. Abduh, Ph.D. It is said that in May-June 2022, Indonesia will repeatedly participate in the Program for International Students Assessment (PISA). A test was designed by the Cooperative Organization Economy and Development (Organization for Economic Co-operation and Development, OECD) to evaluate the reading, mathematics, and science abilities of students in Indonesia who have almost completed their primary education period. This test is not directly related to the school curriculum in Indonesia but is a competency test whose results can be compared internationally. In addition, the PISA test aims to determine the extent to which 15-year-old students who have almost completed their primary education have mastered the skills and knowledge that are important for them to participate fully in modern society. The PISA assessment focuses on the core learning substances in schools: reading, mathematics and science.

The trend in Indonesia's PISA scores has been increasing from 2000 to 2018, with small increases in reading and science and more significant increases in mathematics.

In mathematics, the average PISA test score of Indonesian students fluctuates. The lowest average score was obtained in PISA 2003, amounting to 360. The highest average score was achieved in PISA 2006, 391 points. In PISA 2018, Indonesian students obtained an average score of 379.

According to the OECD, around 71% of students do not reach the minimum level of competence. This means that many Indonesian students still have difficulty dealing with situations requiring problem-solving ability using mathematics. Usually, they cannot do arithmetic calculation problems that do not use whole numbers or problems whose instructions are not clear and well-detailed.

(1) One of the competencies in mathematics content contained in the Minister of Education and Culture Regulation Number 21 of 2016 shows a logical, critical, analytical, creative, careful and thorough attitude, responsible, responsive, and not giving up easily in solving problems. This statement implies that problem-solving is one of the mathematical skills that students must master. [National Council of Teachers of Mathematics \(NCTM\) \(2010\)](#) states that problem-solving plays a vital role in mathematics and should have a significant role in mathematics education. This mathematical problem-solving ability allows students to solve mathematical problems and those related to everyday life.

Research related to analyzing mathematical problem-solving ability has been carried out, including the results of research entitled Mathematical Problem solving Ability in the Era of Industrial Revolution 4.0 for Elementary School Students ([Hendriani et al., 2021](#)), shows that the problem-solving ability of fifth-grade elementary school children in IV Nagari sub-district, Sijunjung Regency experience obstacles in the third indicator, namely solving problems as many as 31 students (34%). The cause is students' weak ability to carry out number operations and weak ability to link known elements in the problem.

Middle School students' problem-solving abilities ([Andayani & Lathifah, 2019](#)), research results found that students had difficulty understanding social arithmetic questions, and only some students met the indicators in mathematical modelling, choosing a solution strategy, solving problems, and rechecking answer results. The researcher further suggests getting students used to solving non-routine problems so that students' ability to solve problems increases.

The third research, namely Analysis of the Mathematical Problem Solving Ability of Class XI MIPA Students Jambi City 1 Public High School ([Yarmayani, 2016](#)), the results of this research shows that the subjects can solve problem-solving questions even though there are still many students who are not precise and systematic. However, the subject has used the ability to think quickly, clearly, and accurately to calculate and solve problems well. This indicator is inaccurate because most subjects do not systematically write problem-solving.

This study focuses more on analyzing problem-solving ability in the Industrial Revolution 4.0 era. In this article, we will explore the role of mathematics education in improving problem-solving abilities in the era of the Industrial Revolution 4.0 because with problem-solving abilities, students will be trained to understand a problem well, reason well, analyze, choose the right strategy in solving problems, perform calculations to evaluate what has been done.

RESEARCH METHOD

In this article, we use the library approach method research). The method used in this article is a library method or approach research). In ([Zed, 2008](#)), Literature or literature study can be interpreted as a series of activities relating to collecting library data, reading and taking notes and processing research materials. In library research, there are at least four main characteristics that writers need to pay attention to. First, the writer or researcher deals directly with text (nash) or numerical data, not with direct knowledge from the field. Second, library data is "ready to use," meaning that researchers do not go directly into the field because they deal directly with data sources in the library. Third, library data is generally a secondary source, in the sense that researchers obtain material or data second-hand and not original data from first-hand data in the field. Fourth, the condition of library data is not limited by space and time. The data collection techniques used are primary data and secondary data. The data source comes from several articles, namely the work of Maifit Hendriani, Silfi Melindawati and Afri Mardicko with the title "Mathematical problem-solving ability in

the Era of the Industrial Revolution 4.0 for Elementary School Students", the work of Fitrie Andayani and Adiska Nadiyah Lathifah with the title "Analysis of Middle School Students' Problem-Solving Abilities in Solving Questions on Social Arithmetic Material," by Ayu Yarmayani with the title "Analysis of Class XI MIPA Students' Mathematical Problem Solving Ability Sma Negeri 1 Jambi City" as well as other journal articles that support this writing. Then, to support this research, searches were also carried out via the internet and books. After the data is collected, data processing is carried out; then, descriptive analysis is carried out.

RESULTS AND DISCUSSION

Mathematics Education

Mathematics education is learning that is oriented towards mathematics subjects, which are taught at primary school and secondary school levels. Mathematics education is also called school mathematics, and it is about pupils or students. Through this mathematics education, they will go through a cognitive and emotional development process. As students' learning levels develop according to their mental and cognitive development, their abilities are likely to develop from low to high levels.

The Characteristics of Mathematics Education ([Agustianti et al., 2022](#)) include: Has concrete and abstract study objects, A thinking pattern that is inductive and deductive, Consistency and correlational truth, Relies on agreement, a symbol that is empty of meaning and also meaningful (meaning it has entered a specific universe), Obedient to the universe, it is even used to differentiate school levels.

The aim of learning school mathematics is that students are expected to be able to master skills and proficiency in mathematics. The fundamental goal of mathematics education is to learn the mathematics that is usually taught in schools. Apart from that, it also states the mathematical abilities or competencies that are expected when studying mathematics from SD/MI to SMA/MA.

Problem-Solving

In mathematics learning, problem-solving is a learning technique that encourages students to think and analyze a problem to find a solution. The National Council of Teachers of Mathematics (NCTM) ([Suryawan et al., 2021](#)) has recommended problem-solving as the focus of school learning. One of the backgrounds of the NCTM recommendation is problem-solving. Problem-solving is a big part of mathematics. They start by solving story problems, looking for patterns, interpreting a picture or illustration, proving a theorem, etc. The mathematics teaching and learning process should be designed so students experience mathematics as problem-solving.

Problem solving in mathematics is solving problems whose solution does not yet have certain principles (rules, formulas, postulates) that can be used to find answers to the problem. Problems in mathematics usually take the form of searches and proofs. Part of the problem that will be discovered is (a). what to look for, (b). how the information is known, (c). what are the conditions? The central part of the proof problem is (a) hypothesis. b) Conclusion.

Through problem-solving in mathematics, students should acquire ways of thinking, habits of perseverance, and the ability to foster curiosity and confidence in situations they are not familiar with so that they can use them outside the classroom. Problem-solving is integral to all mathematics learning and should not be isolated from mathematics programs.

Based on research conducted by Agung Nugraha and Luvy Sylviana Zanthi in 2018 entitled "Analysis of High School Students' Problem-Solving Abilities on Systems of Linear Equations," it is said that student's problem-solving abilities in learning mathematics are still low. So, in this research, there are several indicators for solving problems. These indicators are: 1.) Activities to understand the problem; 2.) Planning or designing strategy activities; 3.) Activities to complete mathematical models; and 4.) Activities to re-check the correctness of the results or solutions.

Students must solve problems based on the existing stages. Each stage must be done sequentially. If a student can work on the first stage or the stage of understanding the problem, then there is a possibility that the student will be able to work on the next stage.

Then, researchers carried out this test (Nugraha & Zanthi, 2019) on class X MIA students at Sumur Bandung High School. This test shows that out of 22 students, only six could answer the six problem-solving questions given, with a percentage of 26.52%. Meanwhile, students who answered correctly in the understanding the problem stage were given a percentage of 71.97%, and in the next stage, the percentage given decreased. In this condition, it can be seen that the stages for solving problems must be sequential and interrelated. Students who can solve the questions given can understand the problem, plan strategies, solve problems, and re-check the answers.

The tests results conducted by researchers showed that students' problem-solving abilities were still quite worrying. Most of the students were able to understand the problem given. However, students seemed to have difficulty completing the next stage, especially at the problem-solving stage, because there was a significant decrease from the previous stage.

Industrial Revolution 4.0

Industry 4.0 was first coined in Germany in 2011, marked by the digital revolution. This industry is a digitally connected industrial process that includes various types of technology, from 3D printing to robotics, which is believed to increase productivity.

Industrial Revolution 4.0 is a tendency for fundamental changes in the industrial world combining automation and cyber technology. Industry 4.0 technology is a manufacturing technology that has entered the automation and data exchange trend. This includes cyber-physical systems (CPS), the Internet of Things (IoT), cloud computing (cloud computing), and cognitive computing.

(Proceedings of the National Seminar on Mathematics Education II (SNPMAT II): Mathematics Learning in the Era of Industrial Revolution 4.0, 2019) be delivered that the principles of Revolution 4.0 include the following four aspects:

1. Interoperability (compatibility) is the ability of machines, devices, sensors and humans to connect and communicate with each other via the Internet for everything (IoT) or the Internet for the public (IoT).
2. Information transparency, namely the ability of an information system to create a virtual copy of the physical world by enriching digital factory models with sensor data.
3. Technical assistance, in the form of assistance systems to assist humans in collecting data and assisting visualization to make wise decisions, as well as the ability of cyber-physical systems to help humans carry out various final tasks that are difficult, unpleasant, or unsafe for humans.
4. Autonomous decisions are the ability of a cyber-physical system to make decisions and perform tasks as independently as possible.

Released from the website of the Ombudsman of the Republic of Indonesia on March 31 2020, entitled "Education in the Era of the Industrial Revolution 4.0 in the Middle of Covid-19" written by Shintya Gugah Asih Theffidy, it is said that educational theorists often refer to education in the Era of the Industrial Revolution 4.0 to describe various ways of integrating cyber technology. Both physical and non-physical in learning. Education in the Industrial Revolution Era 4.0 is a phenomenon that responds to the needs of the Industrial Revolution by adapting the new curriculum to the current situation.

Student Problem-Solving Ability in the Industrial Revolution Era 4.0

Wagner & Change in Nyoman 2019 (Nyoman, 2019) stated that students' competencies and skills to survive in the face of the Industrial Revolution and the world of work must have seven skills. One of them is problem-solving ability. In learning mathematics, students are expected to be able to solve problems or find solutions to existing problems.

Nyoman (2019) says that Problem problem-solving standards must enable all students to build mathematical knowledge through solving mathematical problems, solving problems that arise in mathematics and other fields, applying and choosing various strategies to solve problems, and observing and developing the solving process of math problems (Parwati, 2019).

The Role of Mathematics Education in Improving Problem-Solving Abilities in the Era of Industrial Revolution 4.0

The Industrial Revolution 4.0 brings many aspects of change that need to be addressed as challenges that must be faced, especially in mathematics education. Facing these conditions requires a solid mental character, a positive character that does not disappear over time. This character is a character in the form of morals and performance. Moral character is a mental attribute that a person must have in the form of universal good values such as honesty, commitment, responsibility, empathy or sincerity. Meanwhile, work character is an attribute needed in work or society, such as

discipline, leadership, tenacity, and initiative, and it becomes a habit (habituation) if a person has superior competence.

So, the role of mathematics in the era of Industrial Revolution 4.0 as a scientific basis for the development of technology and modern knowledge is vital to study. Someone with mathematical abilities can study the natural environment to develop technology for the welfare of humanity. One of these mathematical abilities is problem-solving, which allows students to solve mathematical problems related to everyday life.

Students can understand problems, make choices, and draw clear conclusions with the help of problem-solving ability. Learning in the Industrial Revolution 4.0 era requires teachers as educators to keep up with proliferating technological and scientific developments. If teachers can keep up with developments in technology and science quickly, students will be able to learn all the facts and concepts of science and apply them in everyday life. (Marini et al., 2021).

CONCLUSIONS

From the results obtained, it can be concluded that the ability to solve mathematical problems in the Industrial Revolution 4.0 era is inadequate. This is due to the lack of students' skills in solving problems. Solving mathematical problems in the Industrial Revolution 4.0 era can be said to be a skill that not all students have, especially in the 4.0 era, which is widely associated with the development of modern technology. This rapid development influences students to develop their skills, especially in solving problems in mathematics. Providing good mathematics education and problem-solving training to each student can help students develop problem-solving abilities.

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