Jurnal Cakrawala Pendas
Vol. 9 No. 1, January 2023
DOI: http://dx.doi.org/10.31949/jcp.v9i1.3719

p-ISSN: 2442-7470
e-ISSN: 2579-4442

DIGITAL SCIENCE TEACHING MATERIALS INTEGRATED WITH SCAFFOLDING PROBLEM-BASED LEARNING FOR PROBLEM-SOLVING AND SCIENTIFIC REASONING SKILLS OF PROSPECTIVE MADRASAH IBTIDAIYAH TEACHERS ON KINEMATICS MATERIAL

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Abstract
The ability to solve problems and reason scientifically is needed by prospective elementary schools or Madrasah Ibtidaiyah teachers to meet the demands of the 21st century. This study aimed to determine the effect of digital science teaching materials based on scaffolding problem-based learning on students' scientific thinking skills and problem-solving. This research is quasi-experimental quantitative research with a pre-test-post-control group design. The sample of this study was 24 PGMI students at UIN Maulana Malik Ibrahim Malang who chose the concentration of Natural Sciences. The research instrument used scientific reasoning tests and problem-solving, which consisted of five descriptive questions. Data analysis was performed using paired sample t-test. Data analysis showed that students who used scaffolding problem-based learning digital science teaching materials had higher scientific thinking and problem-solving skills than those who did not use these materials. Therefore, it can be concluded that digital science material influences students' scientific thinking skills and problem-solving.
Keywords: *Scaffolding; Problem-Based Learning; Scientific Explanation; Problem-Solving Skills*

Abstrak
Kemampuan memecahkan masalah dan bernalar secara ilmiah sangat dibutuhkan calon guru sekolah dasar atau Madrasah Ibtidaiyah untuk memenuhi tuntutan abad 21. Tujuan pelaksanaan riset berikut guna memberi pendeskripsian pengaruhnya bahan ajar sains digital berbasiskan scaffolding problem-based learning terhadap kemampuan berpikir ilmiah dan pemecahan permasalahan mahasiswa. Riset berikut ialah riset kuantitatif dengan desain kuasi eksperimen pre-post-control group design. Sampel penelitian ini adalah 24 mahasiswa PGMI UIN Maulana Malik Ibrahim Malang yang memilih konsentrasi Ilmu Pengetahuan Alam. Instrumen penelitian ini menggunakan tes penalaran ilmiah dan pemecahan masalah yang terdiri dari lima pertanyaan deskriptif. Analisis data dilakukan dengan menggunakan uji-t sampel berpasangan. Analisis data menandakan yakni murid yang mempergunakan bahan ajar digital sains berbasis scaffolding PBL memiliki tingkat berpikir ilmiah dan keterampilan pemecahan masalah yang lebih tinggi daripada siswa yang tidak menggunakan bahan tersebut. maka begitu, berkeismpulan yakni bahan ajar sains digital berbasiskan scaffolding PBL membawa pengaruh kepada keterampilan berpikir ilmiah dan pemecahan masalah siswa.
Kata Kunci: *Scaffolding*; *Problem Based Learning*; Kemampuan Penalaran Ilmiah; Kemampuan Pemecahan Masalah

Received	: 2022-11-17	Approved	: 2023-01-24
Reviesed	: 2023-01-20	Published	: 2023-01-31

Introduction

Problem-solving ability is one of the most needed skills, especially in science learning. The ability to solve quantitative and qualitative problems is a key learning outcome in all science learning. To solve problems appropriately, students must identify the science concepts and principles relevant to the question and apply their knowledge appropriately to achieve the

expected goal (Milbourne & Wiebe, 2018). Problem-solving ability is defined as designing, evaluating, and applying strategies to solve a question (Rubric, 2010) and involves scientific reasoning (Alshamali & Daher, 2016), which will impact changes and improvements in emotional, cognitive, and psychomotor development. Students can solve problems in an evidence-based manner to meet high-level problem-solving standards by using scientific knowledge while engaging in scientific reasoning processes (Csanadi et al., 2016).

Reasoning in everyday life and scientific explanation are two very different things. Data and related ideas describe a problem; a scientific explanation is the cornerstone of scientific reasoning in the natural sciences (McNeill, 2011). When an academic narrates an event, the first step is to make a claim and then present facts and reasons to support the claim (McNeill, 2011).

The ability to reason scientifically and problem-solving skills are very important to be mastered by prospective teachers of Madrasah Ibtidaiyah. However, based on the results of Maulana Malik Ibrahim Malang's observation of the UIN PGMI tutorial, it was concluded that the scientific reasoning and problem-solving skills of prospective MI / SD educators had not yet developed. Students still do not fully understand various science concepts. Most students explain the facts of the problem correctly but are often confused when asked why they answered the question (Kusumah, 2019; Nugraheni, 2017). In general, prospective teachers can explain arguments and proofs, but have difficulty arguing (Nurhayati, 2016).

Based on the results of observations and questionnaires to PGMI PTKIN students in East Java, it was found that learning in the last year has been running online. Several teaching materials have been used in online learning; 45% use printed Teaching Modules, 37.5% use printed books, and 41.3% use Student Worksheets (LKM). Among the East Java PGMI PTKIN study programs, only 25% use problem-based learning models, and the rest use lectures and practicums. Therefore, science learning in the East Java PGMI PTKIN study program has not facilitated students' scientific reasoning and problem-solving skills.

In online learning in the era of the Covid-19 pandemic, students have demands to learn independently, so media is needed to facilitate the student's independent learning process. One of them is a digital textbook that will make it easier for students to access material wherever and whenever they student is. Previous studies have stated that digital textbooks can improve problem-solving skills (Wu et al., 2021). Scientific reasoning ability (Cheng et al., 2021), self-efficacy(Hung et al., 2014a), motivation, and student achievement (Zwart et al., 2017).

One of the teaching strategies that can support the scientific reasoning skills and problem-solving ability of prospective Madrasah Ibtidaiyah teachers is scaffolding integrated into Problem-Based Learning. Students will be stimulated, guided, and provided with relevant resources during problem-based learning activities. Such assistance to students is called scaffolding. Scaffolding refers to assistance offered to students in the form of support to help them achieve their tasks. As such, the tasks are those that the students themselves cannot accomplish. Once the student has more ability to perform those tasks, the help and support will decrease; this is no longer necessary when the student can perform those tasks independently. Recent research found that integrating problem-based learning activities and scaffolding will increase students' scientific reasoning and problem-solving skills (Gita & Apsari, 2018a; Hung et al., 2014a).

Some researchers have previously investigated the use of problem-based learning scaffolding in learning. Research Kim et al. (2018) stated that using computer-based scaffolding in PBL can affect students' thinking skills. Gita & Hung's research revealed that using scaffolding in problem-based learning can improve students' problem-solving ability, scientific

reasoning, and learning achievement (Gita & Apsari, 2018a; Hung et al., 2014a). Some previous studies on problem-based learning scaffolding focused more on the development of the most appropriate learning design and its effect on students' thinking skills (Gita & Apsari, 2018a; Hung et al., 2014a; Kim et al., 2018; Saleh et al., 2018; Wu et al., 2021). Meanwhile, this study examines the effect of science teaching materials integrated with problem-based learning scaffolding on students' scientific reasoning skills and problem-solving, especially on kinematics material. Thus, the following research aims to test the effect of science teaching materials integrated with scaffolding problem-based learning on students' scientific reasoning skills and problem-solving, especially in kinematics material.

Research Methods

The following research is quantitative research with the quasi-experimental method. This research design applies a pretest-posttest control group design. This research design uses one treatment class as the research subject. Before being given the treatment of science teaching materials integrated with scaffolding problem-based learning, students were given a pretest to identify the scientific reasoning ability and problem-solving ability of prospective Madrasah Ibtidaiyah teachers before being given treatment by using digital science teaching materials based on scaffolding problem-based learning. After being given the treatment of science teaching materials integrated with scaffolding problem-based learning on kinematics material, students are given a posttest of scientific reasoning and problem-solving skills, as shown in Figure 1. The population of this study consisted of prospective Madrasah Ibtidaiyah teacher students of UIN Maulana Malik Ibrahim Malang.

In comparison, the sample of this study involved 24 PGMI students of UIN Maulana Malik Ibrahim Malang who took courses with a concentration in science specialization. Research instruments include measurement and treatment instruments. The treatment instrument includes a learning implementation sheet and science teaching materials integrated with scaffolding problem-based learning. At the same time, the measurement instrument includes scientific reasoning skills test questions, and problem-solving skills, including description questions. Before use, the test instrument was validated by two science material experts. The data analysis of this study consisted of prerequisite tests and hypothesis testing. The prerequisite test used a data normality test using Kolmogorov-Smirnov, while hypothesis testing used paired sample t-test.

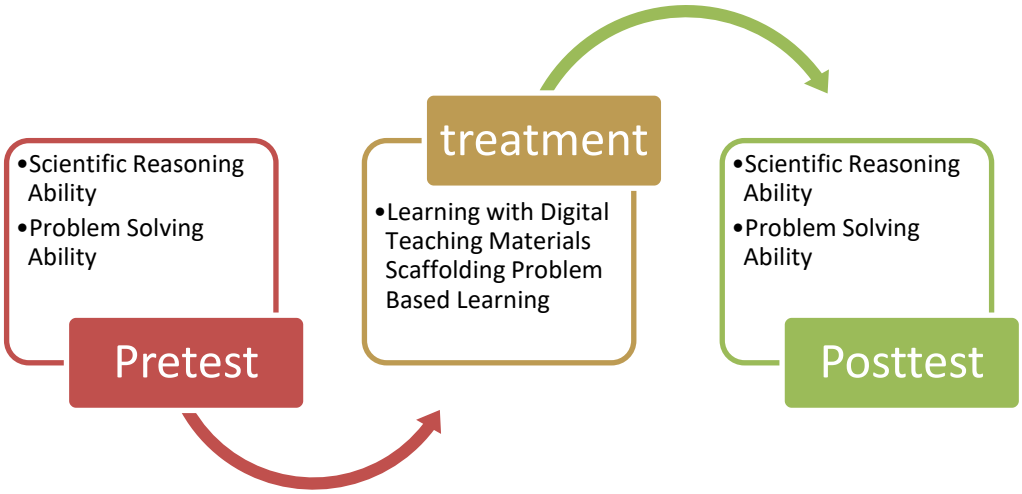

Figure 1. Research Design Flow

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Results and Discussion

Data on scientific reasoning ability and problem-solving skills were obtained based on the results of scientific reasoning ability tests and problem solving skills consisting of ten essay questions related to kinematics material, including motion, force, and newton's law. Based on analyzing the data that has been held and displayed through Table 1, it is found that the average scientific reasoning skills of students on the pretest are 19.8 and 42.07 on the posttest. At the same time, the average student's problem-solving ability was 12.8 on the pretest and 57.58 on the posttest. The data description of students' scientific reasoning and problem-solving skills is shown in Table 1.

Table 1. Data Description of Scientific Reasoning and Problem-Solving Skills

Aspect	Scientific Reasoning Ability	Problem-Solving Ability
Pretest	19,8	12,8
Posttest	42,07	57,58

Furthermore, prerequisite testing and hypothesis testing were carried out to test the effect of problem-based learning scaffolding teaching materials. The prerequisite test uses normality testing with the Kolmogorov-Smirnov test. The prerequisite test consists of normality and homogeneity tests. Because the following research only uses one class, the prerequisite test needed is the normality test. The normality test was analyzed using Kolmogorov-Smirnov analysis using SPSS. A summary of the results of the Kolmogorov-Smirnov normality test using SPSS is shown in Table 2.

Table 2. Normality Test Results

N	Kolmogorov-Smirnov	Sig
24	0,939	0,341

Based on Table 2, the normality test results using the Kolmogorov-Smirnov method with the help of SPSS show a sig value of 0.341> 0.05, resulting in the conclusion that the data is normally distributed. Since the data is normally distributed, parametric statistics, paired sample t-test, can be used in hypothesis testing.

Hypothesis testing was analyzed using paired sample t-test. This study used the same class for the pretest and posttest. A summary of the paired sample t-test results is shown in Table 3. Based on Table 3, the significant result of 0.00 < 0.05 was recognized. Therefore, it is concluded that SIPBL digital science teaching materials can influence students' scientific thinking and problem-solving skills, especially those related to motion, force, and Newton's law.

Table 3. Paired Sample T-Test Results

	Mean Difference	t	Sig
Scientific Reasoning Ability	22,27	8,28	0,000
Problem-Solving Ability	44,78	12,34	0,000

Based on the results of data analysis, it was found that the posttest score of students' scientific reasoning ability was higher than the pretest score. This shows that the scientific reasoning ability after using science teaching materials integrated with problem-based learning is higher than when students learn without using teaching materials integrated with scaffolding problem-based learning. The following matter is in line with previous research, which reveals

that the scientific reasoning ability of students who learn using scaffolding is better than conventional methods (Amelia et al., 2016, 2020; Oktavianti et al., 2018). The existence of scaffolding helps students build their knowledge and helps students to focus more on the problem. Therefore, students can build reasoning by connecting existing phenomena with the problems that must be solved (Amelia, 2021b, 2021). (Amelia, 2021b, 2021a; Sarah, 2022).

Regarding problem-solving skills, the posttest score of students' problem-solving skills is also higher than the pretest score. This shows that science teaching materials integrated with problem-based learning scaffolding can affect students' problem-solving skills. This is in line with previous research, which states that the problem-solving skills of students who are given e-scaffolding are higher than students who learn with conventional methods (Koes-H et al., 2019; Saputri & Wilujeng, 2017). This is because scaffolding can help students' problem-solving process be more systematically structured, making it easier for students to develop solutions to problem-solving (Koes-H et al., 2019).

Science teaching materials integrated with scaffolding problem-based learning are also equipped with virtual practicum so that students can learn concepts and carry out practicum wherever and whenever the student wants to learn. The virtual practicum feature-oriented to scaffolding problem-based learning can encourage students to build their knowledge and help solve problems (van Riesen et al., 2018). Research Ersoy, (2014) (2014) also stated that the knowledge gained by students through problem-based learning-oriented learning could encourage students to have problem-solving skills using higher-order thinking skills. This is also in line with previous research revealing that a problem context in problem-based learning can direct students to solve problems, think creatively, and think critically (Kadir et al., 2016; Sani & Malau, 2017).

Some previous researchers have examined the use of problem-based scaffolding in learning. Research Kim et al. (2018) stated that using computer scaffolding in PBL can maximize students' thinking skills. This also follows Gita & Hung's research that using scaffolding in problem-based learning can improve problem-solving, scientific reasoning, and student learning achievement (Gita & Apsari, 2018b; Hung et al., 2014b).

Conclusion

The scientific reasoning and problem-solving skills of prospective teacher students are very important. Scientific reasoning and problem-solving skills can play a role in higher-order thinking in line with 21st-century skills. The scientific reasoning and problem-solving skills of students who learn using teaching materials integrated with scaffolding problem based learning are higher than those who learn without using these teaching materials. Thus, science teaching materials integrated with scaffolding problem-based learning can affect students' scientific reasoning and problem-solving skills. Therefore, educators can apply science teaching materials integrated with scaffolding problem-based learning in the learning process to facilitate students' 21st-century skills.

Bibliography

Alshamali, M. A., & Daher, W. M. (2016). Scientific reasoning and its relationship with problem-solving: The case of upper primary science teachers. International Journal of Science and Mathematics Education, 14(6), 1003–1019.

Amelia, R. (2021a). Development of web e-scaffolding based on scientific explanation as teaching materials for primary school pre-service teachers. Al Ibtida: Jurnal Pendidikan Guru MI, 8(2), 144–160.

Amelia, R. (2021b). The influence of e-scaffolding in blended learning on prospective teacher's scientific explanation. Journal of Physics: Conference Series, 1796(1), 012039.

Amelia, R., Handayanto, S. K., & Muhardjito, M. (2016). The Influence of V Diagram Procedural Scaffolding in Group Investigation Towards Students with High and Low Prior Knowledge. Jurnal Pendidikan IPA Indonesia, 5(1), 108–115.

Amelia, R., Rofiki, I., Tortop, H. S., & Abah, J. A. (2020). Pre-service teachers' scientific explanation with e-scaffolding in blended learning. Jurnal Ilmiah Pendidikan Fisika Al Biruni, 9(1), 33–40.

Cheng, P.-J., Liao, Y.-H., & Yu, P.-T. (2021). Micro: Bit Robotics Course: Infusing Logical Reasoning and Problem-Solving Ability in Fifth Grade Students Through an Online Group Study System. International Review of Research in Open and Distributed Learning, 22(1), 21–40.

Csanadi, A., Kollar, I., & Fischer, F. (2016). Scientific reasoning and problem solving in a practical domain: Are two heads better than one? Singapore: International Society of the Learning Sciences.

Ersoy, E. (2014). The effects of problem-based learning method in higher education on creative thinking. Procedia-Social and Behavioral Sciences, 116, 3494–3498.

Gita, I. N., & Apsari, R. A. (2018a). Scaffolding in problem-based learning to increase students' achievements in linear algebra. Journal of Physics: Conference Series, 1040(1), 012024.

Gita, I. N., & Apsari, R. A. (2018b). Scaffolding in problem-based learning to increase students' achievements in linear algebra. Journal of Physics: Conference Series, 1040(1), 012024.

Hung, C.-M., Huang, I., & Hwang, G.-J. (2014a). Effects of digital game-based learning on students' self-efficacy, motivation, anxiety, and achievements in learning mathematics. Journal of Computers in Education, 1(2), 151–166.

Hung, C.-M., Huang, I., & Hwang, G.-J. (2014b). Effects of digital game-based learning on students' self-efficacy, motivation, anxiety, and achievements in learning mathematics. Journal of Computers in Education, 1(2), 151–166.

Kadir, Z. A., Abdullah, N. H., Anthony, E., Salleh, B. M., & Kamarulzaman, R. (2016). Does Problem-Based Learning Improve Problem Solving Skills?—A Study among Business Undergraduates at Malaysian Premier Technical University. International Education Studies, 9(5), 166–172.

Kim, N. J., Belland, B. R., & Walker, A. E. (2018). Effectiveness of computer-based scaffolding in the context of problem-based learning for STEM education: Bayesian meta-analysis. Educational Psychology Review, 30(2), 397–429.

Koes-H, S., Suwasono, P., & Pramono, N. A. (2019). Efforts to improve problem solving abilities in physics through e-scaffolding in hybrid learning. AIP Conference Proceedings, 2081(1), 030006.

Kusumah, R. G. T. (2019). Peningkatan Kemampuan Berfikir Kritis Mahasiswa Tadris IPA Melalui Pendekatan Saintifik Pada Mata kuliah IPA Terpadu. IJIS Edu: Indonesian Journal of Integrated Science Education, 1(1), 71–84.

McNeill, K. L. (2011). Elementary students' views of explanation, argumentation, and evidence, and their abilities to construct arguments over the school year. Journal of Research in Science Teaching, 48(7), 793–823.

Milbourne, J., & Wiebe, E. (2018). The role of content knowledge in ill-structured problem solving for high school physics students. Research in Science Education, 48(1), 165–179.

Nugraheni, D. (2017). Analisis kesulitan belajar mahasiswa pada mata kuliah mekanika. Edu Sains: Jurnal Pendidikan Sains dan Matematika, 5(1), 23–32.

Nurhayati, N. (2016). Instrumen Pembelajaran Untuk Pola Penalaran Dan Kemampuan Penyelesaian Masalah Sintesis. JURNAL PEMBELAJARAN FISIKA, 4(5), 242–249.

Oktavianti, E., Handayanto, S. K., Wartono, W., & Saniso, E. (2018). Studentsâ€™ Scientific Explanation in Blended Physics Learning with E-Scaffolding. Jurnal Pendidikan IPA Indonesia, 7(2), 181–186.

Rubric, C. E. V. (2010). Association of American Colleges and Universities. Retrieved January 19.

Saleh, A., Silver, C. H., Chen, Y., Shanahan, K., Rowe, J., & Lester, J. (2018). Scaffolding peer facilitation in computer-supported problem-based learning environments. International Society of the Learning Sciences, Inc.[ISLS].

Sani, R. A., & Malau, T. (2017). The effect of problem based learning (PBL) model and self regulated learning (SRL) toward physics problem solving ability (PSA) of students at senior high school. American Journal of Educational Research, 5(3), 279–283.

Saputri, A. A., & Wilujeng, I. (2017). Developing Physics E-Scaffolding Teaching Media to Increase the Eleventh-Grade Students' Problem Solving Ability and Scientific Attitude. International Journal of Environmental and Science Education, 12(4), 729–745.

Sarah, L. L. (2022). The Implementation of Web Based E-Scaffolding Enhance Learning (ESEL) on Centre of Mass Concept Understanding. Jurnal Inovasi Pendidikan IPA, 8(1).

van Riesen, S. A., Gijlers, H., Anjewierden, A., & de Jong, T. (2018). The influence of prior knowledge on experiment design guidance in a science inquiry context. International journal of science education, 40(11), 1327–1344.

Wu, J., Guo, R., Wang, Z., & Zeng, R. (2021). Integrating spherical video-based virtual reality into elementary school students' scientific inquiry instruction: Effects on their problem-solving performance. Interactive Learning Environments, 29(3), 496–509.

Zwart, D. P., Van Luit, J. E., Noroozi, O., & Goei, S. L. (2017). The effects of digital learning material on students' mathematics learning in vocational education. Cogent Education, 4(1), 1313581.