

Problem Solving Approach Based on Blended Learning on Trigonometric Comparison of Right Triangles on Mathematical Concept Understanding Ability

Yosafat Ardian Kristiarta^{1*}, Wahyu Setyaningrum², Marsigit³ 

^{1,2,3} Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

ARTICLE INFO

Article history:

Received June 26, 2023

Accepted October 06, 2023

Available online October 25, 2023

Kata Kunci:

Blended Learning, Flipped Classroom, Sistem Manajemen Pembelajaran, Pemahaman Konsep Matematis

Keywords:

Blended Learning, Flipped Classroom, Learning Management System, Mathematical Concept Understanding



This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.

Copyright © 2023 by Author.
Published by Universitas Pendidikan Ganesha.

ABSTRAK

Matematika merupakan mata pelajaran wajib bagi siswa tingkat dasar hingga menengah. Namun bagi sebagian siswa, matematika merupakan mata pelajaran yang sulit dan menakutkan. Penelitian ini bertujuan untuk menganalisis pengaruh pilihan strategi pembelajaran matematika siswa SMA, khususnya dengan mengetahui keefektifan pemilihan pendekatan pemecahan masalah melalui blended learning, khususnya model flipped class, yang didukung dengan sistem manajemen pembelajaran. Penelitian ini menggunakan jenis penelitian kuantitatif dengan menggunakan metode eksperimen tunggal atau metode eksperimen dengan satu kelompok (single-group pretest-post-test design). Teknik pengumpulan data dalam penelitian ini terdiri dari 3 cara yaitu observasi, dokumentasi, dan tes. Instrumen pengumpulan data menggunakan lembar kuesioner. Teknik analisis data metode uji-t yang dikenal dengan uji-t berpasangan. Proses analisis data ini menggunakan bantuan software RStudio®. Hasil dari uji statistik dan observasi kelas menunjukkan hasil yang positif, mengindikasikan bahwa pendekatan ini merupakan pilihan tepat untuk membantu siswa belajar matematika. Hal ini berarti terdapat peningkatan pemahaman konsep matematika dengan menggunakan pendekatan problem solving berbasis blended learning tipe flipped classroom berbantuan LMS (Google Classroom) pada pembelajaran matematika kelas X MIA materi perbandingan trigonometri pada segitiga siku-siku. Hasil dari penelitian ini adalah pembelajaran campuran (daring dan luring) tipe flipped classroom memberikan dampak positif yang signifikan terhadap peningkatan pemahaman konsep matematis siswa khususnya pada materi ajar perbandingan trigonometri pada segitiga siku-siku.

ABSTRACT

Mathematics is a mandatory subject for elementary to middle-level students. However, for some students, mathematics is a complex and scary subject. This research aims to analyze the influence of high school students' choice of mathematics learning strategies, mainly by determining the effectiveness of choosing a problem-solving approach through blended learning, especially the flipped class model, supported by a learning management system. This research uses quantitative research using a single experimental method or an experimental method with one group (single-group pretest-post-test design). The data collection technique in this research consists of 3 methods: observation, documentation, and tests. The data collection instrument uses a questionnaire sheet. The t-test method data analysis technique is known as the paired t-test. This data analysis process uses the help of RStudio® software version RStudio. Statistical tests and classroom observations show positive results, indicating that this approach is the right choice to help students learn mathematics. This means that there is an increased understanding of mathematical concepts by using a problem-solving approach based on a blended learning type flipped classroom assisted by LMS (Google Classroom) in class X MIA mathematics learning material on trigonometry comparisons in right triangles. The results of this research are that mixed learning (online and offline) in the flipped classroom type has a significant positive impact on increasing students' understanding of mathematical concepts, especially in teaching material on trigonometry comparisons in right triangles.

1. INTRODUCTION

Mathematics is a compulsory subject for students at the primary to secondary level. However, for some students, mathematics is a difficult and scary subject (Ekowati et al., 2021; Huzaimah & Amelia, 2021). The image of difficult mathematics has a negative impact on students' development in learning mathematics. Such conditions have an impact on students can have anxiety about mathematics and result in students becoming less interested in mathematics subjects (Sahaya Ami & Yuniantaq, 2020; Fahma & Purwaningrum, 2021; Mamolo, 2022). Such conditions are very dangerous if left by teachers as mathematics educators. Because if such conditions are not handled properly, it may interfere with students' ability to comprehend mathematical ideas (Diana et al., 2020b; Juniati & Budayasa, 2020). For students to be able to comprehend the content of the mathematics material that teachers teach in class, they must first understand basic mathematical principles (Abdulah et al., 2023; Öztürk et al., 2020; Yang et al., 2021). Through a good and correct understanding of concepts, students can understand and be able to implement the concepts they receive in the process of solving mathematical problems (Ahmad et al., 2021; Komariyah et al., 2018). This is what should receive attention for teachers who work in schools whose students still find it difficult to understand mathematics. Students who go to school in remote areas usually experience this. Moreover, these students rely on the teacher as the only companion in learning math (Gabriel et al., 2020; Hadar & Tirosh, 2019; Sulastri & Kusmanto, 2016).

A learning needs to be well prepared, including mathematics. Learning mathematics at school begins with designing the learning process (Malikah et al., 2022; Ulusoy & Çakiroğlu, 2018). In the design process, the teacher must prepare a lesson plan (RPP). When preparing lesson plans, teachers must pay attention to the syllabus and school curriculum guidelines (Fitriyah & Wardani, 2022; Mulyadi et al., 2021). In addition, no less important is the selection of learning methods and models (Dewi & Lestari, 2021). Although the content or content of the material that the teacher will convey has been compiled completely and structured, but the learning methods and models are not suitable, it can result in students not optimally receiving and understanding the content of the mathematics material that the teacher conveys in class. Therefore, teachers need to understand various types of methods and models of learning mathematics as a whole and correctly (Hasim et al., 2022; Lau & Man, 2018). So that teachers are expected to design interactive math learning activities for their students.

The efficient learning of mathematics is also impacted by the usage of proper learning resources. Learning resources are delivered to students by teachers with the use of learning media (Hobri et al., 2021; Purba & Harahap, 2022; Wardani & Setyadi, 2020). Through learning media, students can more effectively understand the content of the mathematics teaching material that the teacher provides (Hendra Saputra & Pasha, 2021; Nugraheni, 2017). Learning mathematics material on fractional number calculation operations for grade IV of elementary school can take place more optimally with the help of learning video prototype media with Camtasia Studio 9 (Suwardi, et al., 2021). Comparable to the results of this study, other research found that the use of Prezi software can foster the interest of grade VIII students in learning mathematics on function material (Rohiman & Anggoro, 2019). In addition to using modern learning media, the delivery of mathematics material can also be through traditional learning media and contains cultural elements. Therefore, through the determination of appropriate learning media, students will be helped in understanding the mathematical concepts that teachers teach (Apriyani, 2017; Solichah & Mariana, 2018).

Teachers need to understand the combination of elements in the learning activities they design. Appropriate collaboration in the use of learning media, determining appropriate learning methods and models, and packaging learning content that is concise and clear can help students better understand the content of the subject matter that teachers convey in class (Muhaimin & Juandi, 2023; Wahyuningsih et al., 2020). In this case, teachers must have the skills to process good packaging and learning content. Teachers must also have a paradigm that is open to the times. Learning mathematics can now be done in a variety of ways, including online, offline, and mixed learning. Mathematics teachers must be able to maintain the substance of their teaching materials even though learning is carried out online (Giantara & Astuti, 2020; Suprianto et al., 2019). Therefore, a mathematics teacher has the responsibility to package his learning activities to be more interesting but still on the substance. In order to increase students' motivation to learn mathematics and, subsequently, their capacity to comprehend a wider range of mathematical ideas (Muslihatun et al., 2019; Schukajlow et al., 2023). Through a correct understanding of mathematical concepts, students can obtain optimal mathematics learning outcomes.

There are 3 other studies that inspired this research. In order to increase high school students' interest in learning, the first study examines the effectiveness of using brainly as an e-learning platform (Murtiyasa et al., 2021). The second research discusses the development of problem-based learning worksheets (LKPD) on the topic of angles for class VII junior high school (Abdillah & Astuti, 2021). The

third study examines how well the CORE learning model and cognitive conflict methods perform when used in teaching and learning activities, particularly in the areas of learning achievement, critical thinking, and self-efficacy (Ningsih et al., 2020). The four steps that make up the problem-solving process (Kusaeri, 2019). The first is understanding the problem. In this stage it is necessary to first understand the context and purpose of the problem at hand. Second, developing a problem-solving plan. In this stage it is necessary to make a clear flow related to the steps that will be carried out to solve the problem. The third is to carry out the plan that has been prepared. In this stage, what must be considered is the adherence to implementing the problem solving plan that has been previously compiled. The fourth is to recheck the results or answers found on the problem at hand. In this stage, accuracy is needed in checking the answers that have been found. Therefore, it can be concluded that the problem solving approach in learning mathematics is an approach in learning mathematics that specifically fosters in students the skills to solve mathematical problems.

Blended learning is a learning activity that combines several appropriate learning media and has an impact on improving the quality of learning and student behavior (Dewi et al., 2019; Wulandari et al., 2020). There are 4 aspects in blended learning namely delivery mode, technology, pedagogy, and chronology (Borba et al., 2016; K. C. Dewi et al., 2019; Suryani et al., 2021). Furthermore, Blended learning type flipped classroom is a synchronous/real time learning activity with asynchronous that combines learning activities in class and at each student's home according to the instructions the teacher gives to students (Clarisa et al., 2020; Dewi et al., 2019; Long et al., 2017). In this type, students are asked to periodically and continuously access the materials and practice questions that the teacher provides through online learning media (e.g., Google Classroom). The purpose of this type of blended learning is for students to intensively learn the material taught by the teacher and have a great spirit of independence to learn mathematics (Lee & Martin, 2020; Suhartati, 2021). Therefore, it can be understood that blended learning in mathematics learning is a mathematics learning process that combines synchronous/real time and asynchronous approaches to deliver mathematics material to students through supporting media or technology.

Blended learning requires a tool that can facilitate learning activities that are carried out remotely. These facilities are found in the learning management system (LMS). A learning management system (LMS) is a piece of software used for administration, documentation, material search, activity reports, and the distribution of training materials for online teaching and learning activities (Muchlis & Muharika, 2019; Namaziandost & Çakmak, 2020). LMS has characteristics that are easy to use and can connect all who use it flexibly (Ekayana et al., 2021; Muchlis & Muharika, 2019). The basic thing that needs to be considered when using an LMS is the availability of an internet network as a connection between LMS users. One LMS that is often used by teachers is Google Classroom. Through this application teachers, students, and even parents can connect in real time and can monitor each other in blended learning activities. Some of the features of Google Classroom that are very helpful in the blended learning process are comments, access to learning links (videos, questions, materials, etc.), setting deadlines for submitting assignments, and online assignment collection points (Lee & Martin, 2020; Ríos-Lozada et al., 2022).

Understanding is a level of ability that students are expected to understand concepts, situations, or circumstances, as well as facts that they previously knew (Moll-Khosrawi et al., 2021; Purwaningsih et al., 2017). Discovery learning is a process of active search for knowledge by humans and produces the best results (Aryantini et al., 2021; Masitoh & Prabawanto, 2016). Concept understanding has 3 important components, namely translation, interpretation, and extrapolation (Diana et al., 2020). Translation is a person's ability to change a symbol to another symbol without changing its meaning. Interpretation is a person's ability to describe a concept in detail so that it can be used to compare, contrast, and or contrast it with others. Meanwhile, extrapolation is a person's ability to complete the continued process of a finding. So, it can be understood that concept understanding in learning mathematics is an important element that must be developed by teachers.

In addition, this research aims to examine the influence of high school students' choice of mathematics learning strategies, mainly by finding out the effectiveness of choosing a problem-solving approach through blended learning, especially the flipped class model, supported by a learning management system.

2. METHOD

This research uses a type of quantitative research using a single experimental method or experimental method with one group (single-group pretest-post-test design). In quantitative research, researchers must explain the relationship between the variables they choose. So that it can be understood

that there is an influence between the independent variable and the dependent variable. Based on these observations, researchers are expected to draw conclusions more objectively based on existing data (Creswell, 2012). This research was conducted at SMA Negeri 1 Samigaluh, Tanjung, Ngargosari, Samigaluh District, Kulon Progo Regency, Yogyakarta Special Region Province.

The population of this study were students that studied the material of trigonometric ratio/comparison in right triangles with learning treatment using problem solving approach based on blended learning type flipped classroom. The sample in this study is a single sample. The single sample of this research is class X MIA SMA Negeri 1 Samigaluh. Class X MIA SMA Negeri 1 Samigaluh administratively there are 12 students who are still recorded. However, in reality, only 10 students actively participate in learning. There was one student who had moved to another school in the middle of the semester and there was one student who never came to class without clarity or permission. In this class, the author conducted a pretest, learning treatment, and post-test.

The research variables used in this single-sample study consisted of independent variables and dependent variables. The independent variable of this research is learning mathematics material on trigonometric ratio/comparison in right triangles using problem solving approach based on blended learning type flipped classroom. Meanwhile, the dependent variable is students' understanding of mathematical concepts. Data collection techniques in this study consisted of 3 ways, namely observation, documentation, and tests. The validity of the research data was carried out through triangulation. Triangulation was carried out based on 4 things, namely sources, methods, researchers, and theories (Cohen et al., 2007). Through triangulation, objective data will be obtained from the research conducted.

In the data analysis technique section, pretest and post-test data were analysed using a t-test method known as paired t-test. The process of analysing this data uses the help of RStudio® software version RStudio 2022.07.1+554. The use of paired t-test was chosen because the data obtained is paired data, which measures the ability to understand mathematical concepts before (pretest) and after (post-test) the application of learning trigonometric ratio/comparison material in right triangles using a problem solving approach based on blended learning type flipped classroom. Through this t-test, it can be assessed whether there is a significant increase in the understanding of mathematical concepts after the application of the approach or is no significant increase after the application of the approach. Furthermore, the significance value (p-value) generated from the t-test will be used to determine whether the difference between the pretest and post-test scores is statistically significant. If the p-value is smaller than the predetermined significance level (usually 0.05), then the difference is considered statistically significant. Meanwhile, if the p-value is greater, it indicates that there is no significant difference between the two scores.

3. RESULT AND DISCUSSION

Result

The results of the pretest and post-test that have been carried out to 10 students of class X MIA SMA Negeri 1 Samigaluh can be seen in Table 1.

Table 1. Pretest And Post-Test Scores Of Class X Mia

No.	Student ID	Pretest	Post-test
1	Student 1	25	85
2	Student 2	15	80
3	Student 3	20	85
4	Student 4	45	90
5	Student 5	60	90
6	Student 6	5	80
7	Student 7	20	80
8	Student 8	65	95
9	Student 9	55	90
10	Student 10	15	80

Based on Table 1, the scores of the pretest and post-test results of class X MIA related to trigonometric comparison material in right triangles vary. The lowest score on the pretest was 5. While the highest score was 65. As for the post-test, the lowest score is 80. While the highest score is 95. Based on Table 1, data visualisation can be made in the form of boxplots processed with the help of RStudio® software version RStudio 2022.07.1+554. Boxplot of Pre-test and Post-Test Score of Class X MIA showed in Figure 1.

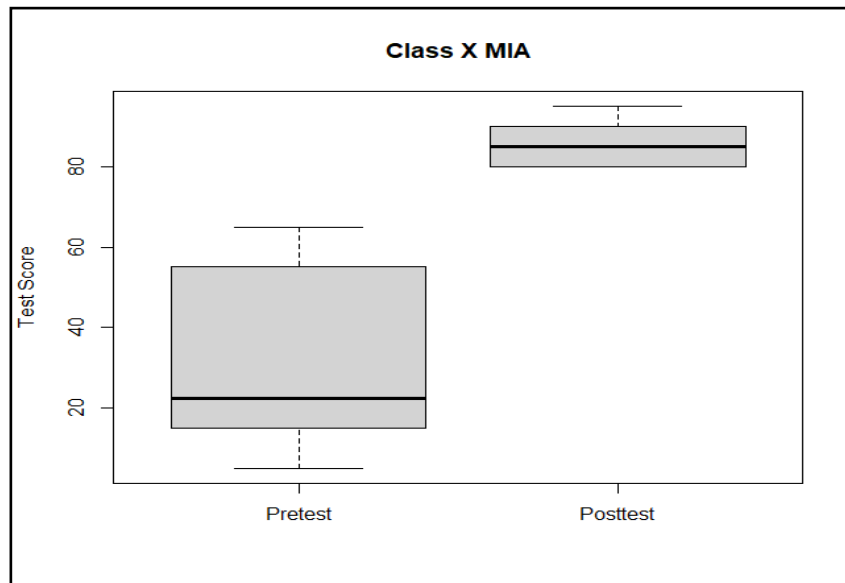


Figure 1. Boxplot of Pre-test and Post-Test Score of Class X MIA

Based on the data visualization in [Figure 1](#), the test scores of students in class X MIA before receiving the learning treatment with problem solving approach based on blended learning type flipped classroom are lower than the test scores after receiving the treatment. Meanwhile, the difference value of the pretest and post-test results showed varying results. The difference value is useful for initial identification of the increase in the ability to understand the concept of trigonometric ratio/comparison material in right triangles in the research sample. Based on the results of the pretest and post-test scores of X MIA class students, the difference value can be obtained as presented in [Table 2](#).

Table 2. Difference Score of Pre-test and Post-Test of Class X Mia

No.	Student ID	Pretest	Post-test	Difference Score
1	Student 1	25	85	60
2	Student 2	15	80	65
3	Student 3	20	85	65
4	Student 4	45	90	45
5	Student 5	60	90	30
6	Student 6	5	80	75
7	Student 7	20	80	60
8	Student 8	65	95	30
9	Student 9	55	90	35
10	Student 10	15	80	65

Based on [Table 2](#), the lowest difference value is 30 and the highest difference value is 75. The distribution of the difference value follows the characteristics of each student in class X MIA. In general, there is an increase in the score of each grade X MIA student in understanding the concept of trigonometric ratio/comparison material in right triangles. The next step is to check the normality of the data on the difference in pretest and post-test results. In testing the normality of the pre-test and post-test difference data, the author uses the Shapiro - Wilk test statistics contained in the RStudio® software version RStudio 2022.07.1+554. From the RStudio® output, the Shapiro-Wilk test statistics were obtained, $W = 0.86831$ and $p\text{-value} = 0.09553 > 0.05$, so H_0 is not rejected. So, at a significance level of 0.05 it can be concluded that the distribution of the difference (d) follows a normal distribution. Thus, the normality assumption of the difference score of pretest and post-test data of X MIA class students is fulfilled. Because the difference data is normally distributed, it can be continued with the two dependent samples t-test (paired t-test).

The next step is to conduct a t-test. The paired t-test method was used in this study because the research subjects subjected to the pretest and post-test were the same subjects. The t-test used RStudio® software version RStudio 2022.07.1+554. The significance level (α) used is 0.05. Meanwhile, the critical value ($t_{0.05(9)}$) is 1.833113. The average for the difference value is 53, while the standard deviation value

is 16.5328. Based on processing using RStudio® software version RStudio 2022.07.1+554, the test statistic (t) value is 10.13796. Because $t = 10.13796 > 1.833113$, H_0 is rejected. (p-value < 0.001) So, that at a significance level of 0.05 it can be concluded that there is an increase in understanding of mathematical concepts by using a problem solving approach based on a blended learning type flipped classroom assisted by a learning management system (Google Classroom) in learning mathematics class X MIA trigonometric comparison material on right triangles.

Then with the help of RStudio® software version RStudio 2022.07.1+554, the t-test for the dependent sample and the value of the confidence interval for μ_D were calculated. From the RStudio® output, the 95% confidence interval for μ_D is $41.17315 \leq \mu_D \leq 64.82685$. For the problem solving approach based on blended learning type flipped classroom assisted by learning management system (Google Classroom) in learning mathematics class X MIA trigonometric comparison material on right triangles, 95% confidence that the average difference between the post-test score of understanding of mathematical concepts and the pre-test score of understanding of mathematical concepts is between 41.17315 and 64.82685. Since this interval is positive, it can be concluded that the mean of the post-test understanding of mathematical concepts is higher than the mean of the pre-test understanding of mathematical concepts. In other words, there is an increase in understanding of mathematical concepts by using a problem solving approach based on a blended learning type flipped classroom assisted by a learning management system (Google Classroom) in learning mathematics class X MIA trigonometric comparison material on right triangles.

The class observation results showed that the problem solving approach based on blended learning with flipped classroom type was effective in improving students' mathematical concept understanding ability. Students are actively involved in the learning process, they participate in group discussions, apply problem solving strategies, and communicate well in explaining the steps of problem solving. In addition, the use of technology through the learning management system platform (Google Classroom) provides easy access to students to study the material before the class meeting. This provides flexibility in learning, allowing students to learn at their own pace (Marian et al., 2023). Thus, students can gain a better understanding of the concepts and apply them in problem solving.

Based on the results of class observations, it can be understood that the problem solving approach based on blended learning with a flipped classroom type assisted by a learning management system (Google Classroom) is effective in improving students' ability to understand mathematical concepts on the material of trigonometric comparison of right triangles. This approach gives students the opportunity to be actively involved in the learning process, apply mathematical concepts in problem solving, and utilize technology as an effective learning tool (Topping et al., 2022). Using online learning platforms, students also learn to be skillful in using technology by doing quizzes and submitting assignments online in their respective online accounts. It certainly provides a more interesting and interactive learning experience for students in learning mathematics. Through such mathematics learning experiences, students become more enthusiastic about learning and more easily accept explanations from the teacher. Students also learn to coexist with technological advances, especially in learning mathematics.

Discussion

Based on the results of statistical tests and class observations, positive results were obtained regarding the use of a blended learning-based problem solving approach with a flipped classroom type assisted by a learning management system (Google Classroom) in improving the level of understanding of mathematical concepts that exist in students in their understanding of trigonometric comparisons of right triangles in class X MIA. This indicates that the use of problem solving approach based on blended learning with flipped classroom type assisted by learning management system (Google Classroom) is the right choice to help students in learning mathematics, especially trigonometric ratio/comparison material in right triangles. Meanwhile, based on the calculation of statistical tests using RStudio® software version RStudio 2022.07.1+554 shows that the application of mathematics learning using a problem solving approach based on blended learning with the type of flipped classroom assisted by a learning management system (Google Classroom) on the material of trigonometric comparison in right triangles in class X MIA is effective for improving students' understanding of mathematical concepts.

The positive results of this research show that the combination of online and offline learning conditions students to have independence in learning and the habit of practising maths problems. In blended learning (offline and online learning) the teacher must maintain the truth and the point of the discussion to be delivered to the students (Dewi et al., 2019; Dewi & Lestari, 2021; Giantara & Astuti, 2020). Teachers are expected not only to focus on making media that attracts learning interest, but also to think about how the learning structure is coherent and the completeness of teaching materials (Fitriyah & Wardani, 2022; Mulyadi et al., 2021; Rohiman & Anggoro, 2019). In addition, this learning also provides

an interesting experience for students in using technology in learning. Students become more skilled in using technology, especially in optimising the functions of various features in the learning management system (Google Classroom) (K. C. Dewi et al., 2019; Ihsan et al., 2019). This approach also enabled the students of class X MIA to achieve a final post-test score above the KKM for mathematics (KKM for mathematics is 70). These results show that the use of this learning approach provides positive results on students' understanding of mathematical concepts.

The concept formation that occurs in students must receive intensive assistance from the teacher. Although through blended learning students are given freedom in learning certain teaching materials, the process of students' understanding of concepts, situations, circumstances, and facts needs assistance from the teacher (Borba et al., 2016; Surjono et al., 2017; Suryani et al., 2021). This is a form of responsibility and professional attitude of teachers in teaching materials to students. Through mixed learning, students are expected to have new experiences in forming mathematical concepts in themselves. Thus, the formation of important components in students' concept understanding in the form of translation, interpretation, and extrapolation in students can be more optimal and the truth can be accounted for (Diana et al., 2020).

The formation of mathematical concepts in students in learning mathematics is an important part of learning mathematics. The formation of correct mathematical concepts in students will help students to be able to achieve predetermined learning targets (Abdulah et al., 2023; Nitko, A. & Brookhart, S., 2011). Besides that, students can comprehend and be able to apply the concepts they are taught when solving mathematical problems by having a solid conceptual knowledge (Ahmad et al., 2021; Komariyah et al., 2018). Usually, students get poor results in the final assessment because their concept formation is not optimal (Diana et al., 2020b). One way to make students' concept formation optimal is to choose the right learning media. Especially in mixed learning, teachers are expected to be creative in determining the learning media that will be used to convey material to students (Hendra Saputra & Pasha, 2021; Murtiyasa et al., 2021). Through blended learning, teachers are expected to optimize the learning methods and media they choose so that students achieve the target of cultivating mathematical concepts.

In this research, the learning media used is a Learning Management System (LMS). The form of LMS chosen is Google Classroom. The LMS is easy to use by teachers and students. Google Classroom provides a flexible space for students and teachers to interact in blended learning activities (Ali & Maksum, 2020; Nainggolan & Manalu, 2021). In the Google Classroom account, the teacher also provides learner worksheets (LKPD) that can be accessed by students in real time. Through appropriate learning media, the delivery of teaching material will be more effective and have a good impact on the process of students understanding the teaching material that the teacher provides (Dantes et al., 2022; Ramadhani et al., 2019). In addition, another positive impact in the selection of appropriate learning media is that students' motivation in learning mathematics will increase. This research also refers to research on the CORE learning model and cognitive conflict method when used in teaching and learning activities, especially in the areas of learning achievement, critical thinking, and self-efficacy (Ningsih et al., 2020). Specifically, this research raised the problem solving approach to improve students' mathematical concept understanding ability. Through the problem solving approach, students are invited to be able to improve their mathematical understanding skills.

The concept formation experience that students have during blended learning influences the formation of mathematics learning independence (Masitoh & Prabawanto, 2016). Students are directly given the freedom to access mathematics learning content from Google Classroom. This freedom gives students the opportunity to explore various things that support and are related to the process of forming their understanding of mathematical concepts in accordance with the concepts that the teacher teaches (Kusaeri, 2019). This independent learning experience includes forming good mathematical problem solving skills in students. In addition, through various exercises that students do on the LMS and confirmation from the teacher, students' mathematical problem solving skills are well supported (Muchlis & Muharika, 2019). So, it can be stated that the hypothesis in this study is proven correct. That there is an increase in the understanding of mathematical concepts in students after experiencing mathematics learning using a problem solving approach based on blended learning type flipped classroom on the material of trigonometric ratio/comparison in right triangles for class X MIA. This is based on the results of statistical tests using the help of RStudio® software version RStudio 2022.07.1+554 and supported by observation results which also show positive results. Thus, it is proven that the use of problem solving approach based on blended learning type flipped classroom assisted by learning management system (Google Classroom) in learning mathematics class X MIA trigonometric comparison material on right triangle is effective to enhance one's capacity for comprehending mathematical ideas.

4. CONCLUSION

First, the use of problem solving approach in mathematics learning effectively improves students' mathematical concept understanding ability. Secondly, the use of blended learning method by applying the flipped classroom type brings benefits in learning mathematics. Third, the utilisation of learning management system (Google Classroom) as a learning platform has a positive impact in terms of accessibility and flexibility. Fourthly, this research contributes to the development of mathematics education by introducing an innovative approach to learning mathematics. The results of this research provide a better understanding of how to integrate problem solving, blended learning and technology approaches in teaching mathematics materials to students. Through this innovation, students are expected to have flexibility in learning mathematics and be more motivated to learn mathematics.

5. ACKNOWLEDGE

Thank you to the principal, teachers, and staff of SMA Negeri 1 Samigaluh for giving the researchers the opportunity to conduct this research. The researcher is very grateful and happy to be able to work together with SMA Negeri 1 Samigaluh in this research. Thank you also to Universitas Negeri Yogyakarta for facilitating this research. We hope that the results of this study can make a useful contribution to the development of mathematics learning, especially at the senior high school level.

6. REFERENCES

- Abdillah, D. M., & Astuti, D. (2021). Sudut. *Pythagoras: Jurnal Pendidikan Matematika*, 15(2), 190–200. <https://doi.org/10.21831/pg.v15i2.36444>.
- Abdulah, S., Hulukati, E. P., Ismail, Y., & Zakiyah, S. (2023). Meningkatkan Pemahaman Konsep Pada Materi Statistika Dengan Media Pembelajaran Video Interaktif Pada Siswa Kelas Viii Smpn 4 Limboto. *Jes-Mat*, 9(1), 15–28. <https://doi.org/10.25134/jes-mat.v9i1.6665>.
- Ahmad, M., Nasution, D. P., & Sabri, S. (2021). Implementasi pendekatan pendidikan matematika realistik ditinjau dari pemahaman konsep, aktivitas, dan respons siswa. *Journal of Didactic Mathematics*, 2(3), 122–133. <https://doi.org/10.34007/jdm.v2i3.1006>.
- Ali, M. K., & Maksun, H. (2020). Utilization of E-Learning-Based ICT Learning Using the Google Classroom Application During the COVID-19 Pandemic. *Journal of Education Research and Evaluation*, 4(4), 373. <https://doi.org/10.23887/jere.v4i4.29181>.
- Apriyani, D. D. (2017). Pengaruh Penggunaan Media Proyeksi Terhadap Hasil Belajar Matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 7(2). <https://doi.org/10.30998/FORMATIF.V7I2.1828>.
- Aryantini, N. K., Sujana, I. W., & Sri Darmawati, I. G. A. P. (2021). Model Discovery Learning Berbantuan Media Power Point Meningkatkan Hasil Belajar IPA Siswa SD. *Jurnal Pedagogi dan Pembelajaran*, 4(2), 251–259. <https://doi.org/10.23887/jp2.v4i2.36193>.
- Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *ZDM - Mathematics Education*, 48(5), 589–610. <https://doi.org/10.1007/s11858-016-0798-4>.
- Clarisa, G., Danawan, A., Muslim, & Wijaya, A. F. C. (2020). Penerapan Flipped Classroom dalam Konteks ESD untuk Meningkatkan Kemampuan Kognitif dan Membangun Sustainability Awareness Siswa. *Journal of Natural Science and Integration*, 3(1), 13–25. <https://doi.org/10.24014/jnsi.v3i1.8953>.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education*. Routledge.
- Creswell, J. W. (2012). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. University of Nebraska–Lincoln.
- Dantes, G. R., Rinawati, N. K. A., Suwastini, N. K. A., & Artini, N. N. (2022). Vocational school students' perceptions of Google Classroom in full online learning at the beginning of the Covid-19 pandemic. *Jurnal Pendidikan Teknologi dan Kejuruan*, 19(2), 86–94. <https://doi.org/10.23887/jptkuniksha.v19i2.47917>.
- Dewi, K. C., Ciptayani, P. I., Surjono, H. D., & Priyanto. (2019). BLENDED LEARNING - Konsep dan Implementasi pada Pendidikan Tinggi Vokasi. In *Jl. Tukad Batanghari VI.B No. 9 Denpasar-Bali* (Number 28). SWASTA NULUS.
- Dewi, S. L., & Lestari, T. (2021). Pengaruh Metode Mengajar Terhadap Minat Belajar Siswa Sekolah Dasar Pada Pelajaran Matematika. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 4(4), 755–764. <https://doi.org/10.22460/jpmi.v4i4.755-764>.
- Diana, P., Marethi, I., & Pamungkas, A. S. (2020). Kemampuan pemahaman konsep matematis siswa: ditinjau dari kategori kecemasan matematik. *SJME (Supremum Journal of Mathematics Education)*, 4(1), 24–32. <https://doi.org/10.22202/jl.2021.v7i2.4911>.

- Diana, Putri, Marethi, I., & Pamungkas, A. S. (2020). Kemampuan Pemahaman Konsep Matematis Siswa: Ditinjau Dari Kategori Kecemasan Matematik. *SJME (Supremum Journal of Mathematics Education)*, 4(1), 24–32. <https://doi.org/10.22202/jl.2021.v7i2.4911>.
- Ekayana, A. A. G., Muku, I. D. M. K., & Hartawan, I. N. B. (2021). Implementasi Model Pembelajaran Flipped Classroom Pada Mata Kuliah Sensor Transduser Dalam Pembelajaran Daring. *Jurnal Teknologi Pembelajaran Indonesia*, 11(2), 106–119. https://doi.org/10.23887/jurnal_tp.v11i2.636.
- Ekowati, D. W., Azzahra, F. Z., Saputra, S. Y., & Suwandayani, B. I. (2021). Realistic mathematics education (RME) approach for primary school students' reasoning ability. *Premiere Educandum : Jurnal Pendidikan Dasar dan Pembelajaran*, 11(2), 269. <https://doi.org/10.25273/pe.v11i2.8397>.
- Fahma, M. A., & Purwaningrum, J. P. (2021). Teori Piaget dalam Pembelajaran Matematika. *MUST: Journal of Mathematics Education, Science and Technology*, 6(1), 31. <https://doi.org/10.30651/must.v6i1.6966>.
- Fitriyah, C. Z., & Wardani, R. P. (2022). Paradigma Kurikulum Merdeka Bagi Guru Sekolah Dasar. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, 12(3), 236–243. <https://doi.org/10.24246/j.js.2022.v12.i3.p236-243>.
- Gabriel, F., Buckley, S., & Barthakur, A. (2020). The impact of mathematics anxiety on self-regulated learning and mathematicKusmaryono, I., Suyitno, H., Dwijanto, D., & Dwidayati, N. (2019). The Effect of Mathematical Disposition on Mathematical Power Formation: Review of Dispositional Mental Functions. *Australian Journal of Education*, 64(3), 227–242. <https://doi.org/10.1177/0004944120947881>.
- Giantara, F., & Astuti, A. (2020). Kemampuan Guru Matematika Mempertahankan Substansi Materi Melalui Proses Pembelajaran Online. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(2), 787–796. <https://doi.org/10.31004/cendekia.v4i2.301>.
- Hadar, L. L., & Tirosh, M. (2019). Creative Thinking in Mathematics Curriculum: An Analytic Framework. *Thinking Skills and Creativity*, 33(September 2018), 100585. <https://doi.org/10.1016/j.tsc.2019.100585>.
- Hasim, S. M., Rosli, R., Halim, L., Capraro, M. M., & Capraro, R. M. (2022). STEM Professional Development Activities and Their Impact on Teacher Knowledge and Instructional Practices. *Mathematics*, 10(7), 1109. <https://doi.org/10.3390/math10071109>.
- Hendra Saputra, V., & Pasha, D. (2021). Komik Berbasis Scientific Sebagai Media Pembelajaran di Masa Pandemi Covid-19. *SJME (Supremum Journal of Mathematics Education)*, 5(1), 85–96. <https://doi.org/10.35706/sjme.v5i1.4514>.
- Hobri, Adeliyanti, S., Fatekurrahman, M., Wijaya, H. T., Oktavianingtyas, E., Putri, I. W. S., & Ridlo, Z. R. (2021). E-Comic Mathematics Based on STEAM-CC and its Effect on Students Creative Thinking Ability. *Journal of Physics: Conference Series*, 1839(1). <https://doi.org/10.1088/1742-6596/1839/1/012036>.
- Huzaimah, P. Z., & Amelia, R. (2021). Hambatan yang Dialami Siswa Dalam Pembelajaran Daring Matematika Pada Masa Pandemi COVID-19. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(1), 533–541.
- Ihsan, M. S., Ramdani, A., & Hadisaputra, S. (2019). Efektivitas Model Blended Learning dalam Pembelajaran Kimia untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Pijar Mipa*, 14(2), 84–87. <https://doi.org/10.29303/jpm.v14i2.1238>.
- Juniati, D., & Budayasa, I. K. (2020). Working memory capacity and mathematics anxiety of mathematics undergraduate students and its effect on mathematics achievement. *Journal for the Education of Gifted Young Scientists*, 8(1), 271–290. <https://doi.org/10.17478/jegys.653518>.
- Komariyah, S., Afifah, D. S. N., & Resbiantoro, G. (2018). Analisis Pemahaman Konsep Dalam Memecahkan Masalah Matematika Ditinjau Dari Minat Belajar Siswa. *SOSIOHUMANIORA: Jurnal Ilmiah Ilmu Sosial Dan Humaniora*, 4(1), 1–8. <https://doi.org/10.30738/sosio.v4i1.1477>.
- Kusaeri, A. (2019). *Pengembangan Program Pembelajaran Matematika*. Fakultas Tarbiyah dan Keguruan UIN Mataram.
- Lau, W. W. F., & Man, Y. K. (2018). Teacher Noticing: Advancing Understanding of Teaching, Learning, Policy, and Practice in Mathematics Education. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(11), 1–4. <https://doi.org/10.29333/ejmste/99810>.
- Lee, Y., & Martin, K. I. (2020). The flipped classroom in ESL teacher education: An example from CALL. *Education and Information Technologies*, 25(4), 2605–2633. <https://doi.org/10.1007/s10639-019-10082-6>.
- Long, T., Cummins, J., & Waugh, M. (2017). Use of the flipped classroom instructional model in higher education: instructors' perspectives. *Journal of computing in higher education*, 29(2), 179–200. <https://doi.org/10.1007/s12528-016-9119-8>.

- Malikah, S., Winarti, W., Ayuningsih, F., Nugroho, M. R., Sumardi, S., & Murtiyasa, B. (2022). Manajemen Pembelajaran Matematika pada Kurikulum Merdeka. *Edukatif: Jurnal Ilmu Pendidikan*, 4(4), 5912–5918. <https://doi.org/10.31004/edukatif.v4i4.3549>.
- Mamolo, L. A. (2022). Online Learning and Students' Mathematics Motivation, Self-Efficacy, and Anxiety in the "new Normal". *Education Research International*, 2022. <https://doi.org/10.1155/2022/9439634>.
- Marian, A. L., Umasih, & Sarkadi. (2023). Google Meet and Google Classroom on Learning History: Review from Students Perspective. *Journal of Education Research and Evaluation*, 7(2), 285–293. <https://doi.org/10.23887/jere.v7i2.44337>.
- Masitoh, I., & Prabawanto, S. (2016). Peningkatan Pemahaman Konsep Matematika dan Kemampuan Berfikir Kritis Matematis Siswa Kelas V Sekolah Dasar Melalui Pembelajaran Eksploratif. *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, 7(2), 186. <https://doi.org/10.17509/eh.v7i2.2709>.
- Moll-Khosrawi, P., Cronje, J. S., Zöllner, C., Kubitz, J. C., & Schulte-Uentrop, L. (2021). Understanding How the Motivational Dimension of Learning is Influenced by Clinical Teaching in Medical Education: A Prospective Cohort Study. *Annals of Medicine and Surgery*, 65(February), 1–7. <https://doi.org/10.1016/j.amsu.2021.102366>.
- Muchlis, L. S., & Muharika. (2019). *Model Pembelajaran DIVA Learning Management System*. CV. Muharika Rumah Ilmiah.
- Muhaimin, L. H., & Juandi, D. (2023). The Role Of Learning Media In Learning Mathematics : A Systematic Literature Review. *Journal of Mathematics and Mathematics Education*, 13(01), 85–107. <https://doi.org/10.20961/jmme.v13i1.74425>.
- Mulyadi, D., Firmansyah, E., Barlian, U. C., & Sauri, S. (2021). Implementasi Kurikulum 2013 (Revisi) Di Sekolah Menengah Atas Pada Mata Pelajaran Peminatan. *Jurnal Pendidikan Glasser*, 5(1), 7–22. <https://doi.org/10.32529/glasser.v5i1.785>.
- Murtiyasa, B., Aulida, A. N., & Affendi bin Abdullah, M. A. (2021). Analisis efektivitas Brainly sebagai platform e-learning untuk meningkatkan minat belajar siswa SMA. *PYTHAGORAS Jurnal Pendidikan Matematika*, 16(2), 141–150. <https://doi.org/10.21831/pythagoras.v16i2.44875>.
- Muslihatun, A., Cahyaningtyas, L., Khaimudin, R. N. L. H., Fijatullah, R. N., Nisa', E. U., & Sari, C. K. (2019). Pemanfaatan Permainan Tradisional untuk Media Pembelajaran: Congklak Bilangan sebagai Inovasi Pembelajaran Matematika Sekolah Dasar. *Transformasi: Jurnal Pengabdian Masyarakat*, 15(1), 14–22. <https://doi.org/10.20414/transformasi.v15i1.915>.
- Naingolan, A. P., & Manalu, R. B. B. (2021). Pengaruh Penggunaan Google Classroom Terhadap Efektifitas Pembelajaran. *Journal Coaching Education Sports*, 2(1), 17–30. <https://doi.org/10.31599/jces.v2i1.515>.
- Namaziandost, E., & Çakmak, F. (2020). An account of EFL learners' self-efficacy and gender in the Flipped Classroom Model. *Education and Information Technologies*, 25(5), 4041–4055. <https://doi.org/10.1007/s10639-020-10167-7>.
- Ningsih, S. W., Sugiman, S., Merliza, P., & Ralmugiz, U. (2020). Keefektifan model pembelajaran CORE dengan strategi konflik kognitif ditinjau dari prestasi belajar, berpikir kritis, dan self-efficacy. *Pythagoras: Jurnal Pendidikan Matematika*, 15(1), 73–86. <https://doi.org/10.21831/pg.v15i1.34614>.
- Nitko, A. J., & Brookhart, S. M. (2011). *Educational assessment of students*. Pearson Education.
- Nugraheni, N. (2017). Penerapan Media Komik Pada Pembelajaran Matematika Di Sekolah Dasar. *Refleksi Edukatika : Jurnal Ilmiah Kependidikan*, 7(2), 111–117. <https://doi.org/10.24176/re.v7i2.1587>.
- Öztürk, M., Akkan, Y., & Kaplan, A. (2020). Reading comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey. *International Journal of Mathematical Education in Science and Technology*, 51(7), 1042–1058. <https://doi.org/10.1080/0020739X.2019.1648893>.
- Purba, Y. A., & Harahap, A. (2022). Pemanfaatan Aplikasi Canva Sebagai Media Pembelajaran Matematika Di SMPN 1 NA IX-X Aek Kota Batu. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 6(2), 1325–1334. <https://doi.org/10.31004/cendekia.v6i2.1335>.
- Purwaningsih, Zaenuri, & Hidayah. (2017). Analysis of Concept Understanding Ability in Contextual Teaching And Learning in Quadrilateral Materials Viewed from Students Personality Type. *Unnes Journal of Mathematics Education*, 6(1).
- Ramadhani, R., Umam, R., Abdurrahman, A., & Syazali, M. (2019). The effect of flipped-problem based learning model integrated with LMS-google classroom for senior high school students. *Journal for the Education of Gifted Young Scientists*, 7(2), 137–158. <https://doi.org/10.17478/jegys.548350>.
- Ríos-Lozada, R. N., Guevara-Fernández, J. A., Carranza-Dávila, R. G., Genaro Ramirez-Delgado, J., &

- Hernández-Fernández, B. (2022). Google Classroom in Educational Service: A systematic Review. *Journal of Positive School Psychology*, 6(2), 1634–1639.
- Rohiman, R., & Anggoro, B. S. (2019). Penggunaan Prezi untuk Media Pembelajaran Matematika Materi Fungsi. *Desimal: Jurnal Matematika*, 2(1), 23–32. <https://doi.org/10.24042/djm.v2i1.3312>.
- Sahaya Ami, D. E., & Yuniartaq, T. N. H. (2020). Profil Karakter Prokrastinasi Akademik Pada Siswa SMP Dalam Pembelajaran Matematika. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 4(1), 414–423. <https://doi.org/10.31004/cendekia.v4i1.241>.
- Schukajlow, S., Rakoczy, K., & Pekrun, R. (2023). Emotions and motivation in mathematics education: Where we are today and where we need to go. *ZDM - Mathematics Education*, 55(2), 249–267. <https://doi.org/10.1007/s11858-022-01463-2>.
- Solichah, L. A., & Mariana, N. (2018). Pengaruh Media Pop Up Book Terhadap Hasil Belajar Siswa Pada Mata Pelajaran Matematika Materi Bangun Datar Kelas Iv Sdn Wonoplintahan Ii Kecamatan Prambon. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, 6(9), 1537–1547.
- Suhartati, O. (2021). Flipped Classroom Learning Based on Android Smart Apps Creator (SAC) in Elementary Schools. *Journal of Physics: Conference Series*, 1823(1). <https://doi.org/10.1088/1742-6596/1823/1/012070>.
- Sulastri, S., & Kusmanto, B. (2016). Upaya Meningkatkan Motivasi Dan Prestasi Belajar Matematika Melalui Model Rme (Realistic Mathematics Education) Siswa Kelas Ix a Smp Negeri 04 Bumiayu Semester 1 Tahun Pelajaran 2013/2014. *UNION: Jurnal Ilmiah Pendidikan Matematika*, 4(3), 435–444. <https://doi.org/10.30738/v4i3.443>.
- Suprianto, A., Ahmadi, F., & Suminar, T. (2019). The Development of Mathematics Mobile Learning Media to Improve Students' Autonomous and Learning Outcomes. *Journal of Primary Education*, 8(1), 84–91. <https://doi.org/10.2991/assehr.k.200827.115>.
- Surjono, H. D., Muhtadi, A., & Wahyuningsih, D. (2017). The implementation of blended learning in multimedia courses for undergraduate students in Indonesia. *International Journal of Information and Education Technology*, 7(10), 783–786. <https://doi.org/10.18178/ijiet.2017.7.10.972>.
- Suryani, Y., Ningrum, A. R., Hidayah, N., & Dewi, N. R. (2021). The effectiveness of blended learning-based scaffolding strategy assisted by google classroom toward the learning outcomes and students' self-efficacy. *IOP Conference Series: Earth and Environmental Science*, 12031. <https://doi.org/10.1088/1742-6596/1796/1/012031>.
- Suwardi, S., Sutarna, S., Hidayati, Y., & Rahmawati, L. (2021). Pembelajaran pecahan melalui video: apakah dapat meningkatkan keaktifan dan prestasi siswa? *PYTHAGORAS Jurnal Pendidikan Matematika*, 16(2), 163–173. <https://doi.org/10.21831/pythagoras.v16i2.41864>.
- Topping, K. J., Douglas, W., Robertson, D., & Ferguson, N. (2022). Effectiveness of online and blended learning from schools: A systematic review. *Review of Education*, 10(2), 1–41. <https://doi.org/10.1002/rev3.3353>.
- Ulusoy, F., & Çakiroğlu, E. (2018). Using video cases and small-scale research projects to explore prospective mathematics teachers' noticing of student thinking. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(11). <https://doi.org/10.29333/ejmste/92020>.
- Wahyuningsih, S., Pudyaningtyas, A. R., Nurjanah, N. E., Dewi, N. K., Hafidah, R., Syamsuddin, M. M., & Sholeha, V. (2020). the Utilization of Loose Parts Media in Steam Learning for Early Childhood. *Early Childhood Education and Development Journal*, 2(2), 1. <https://doi.org/10.20961/ecedj.v2i2.46326>.
- Wardani, K. W., & Setyadi, D. (2020). Pengembangan Media Pembelajaran Matematika Berbasis Macromedia Flash Materi Luas dan Keliling untuk Meningkatkan Motivasi Belajar Siswa. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, 10(1), 73–84. <https://doi.org/10.24246/j.js.2020.v10.i1.p73-84>.
- Wulandari, Sudatha, & Simamora. (2020). Pengembangan Pembelajaran Blended Pada Mata Kuliah Ahara Yoga Semester II di IHDN Denpasar. *Jurnal Edutech Undiksha*, 8(1), 1–15. <https://doi.org/10.23887/jeu.v8i1.26459>.
- Yang, X., Kaiser, G., König, J., & Blömeke, S. (2021). Relationship Between Chinese Mathematics Teachers' Knowledge and Their Professional Noticing. *International Journal of Science and Mathematics Education*, 19(4), 815–837. <https://doi.org/10.1007/s10763-020-10089-3>.