J. Pijar MIPA, Vol. 18 No. 5, September 2023: 670-675 ISSN 1907-1744 (Print)
DOI: 10.29303/jpm.v18i5.5428 ISSN 2460-1500 (Online)

PROBLEM-BASED LEARNING INTEGRATED WITH FLIPPED CLASSROOMS ASSISTED BY GOOGLE SITES TO IMPROVE STUDENT MATHEMATICS LEARNING ACHIEVEMENT

Adam Arya Nugraha[1*], Heni Purwati[1], Lilik Ariyanto[1], and Sumarti[2]
[1]Postgraduate Teacher Professional Education, Universitas PGRI Semarang, Semarang, Indonesia
[2]SMK Negeri 6 Semarang, Semarang, Indonesia
*Email: adamarya150@gmail.com

Received: July 22, 2023. Accepted: August 16, 2023. Published: September 20, 2023

Abstract: Mathematics is a subject taught at every level of education and has a vital role in everyday life. However, in reality, student mathematics learning achievement tends to be low. One of the reasons is the monotonous learning model or strategy and uninteresting learning media. The learning process is only one-way, making students imitate and record how to answer the questions given by the teacher without understanding the concept correctly. In addition, the learning media used is monotonous and tends to be traditional. Namely, only the whiteboard and several times using an LCD projector, making students bored and passive. So, innovative learning strategies and media are needed to overcome these problems. This study aims to determine the improvement of student mathematics learning achievement in statistics material in grade 10 through implementing Problem-based Learning integrated with Flipped Classroom assisted by Google Sites. The research method used is Classroom Action Research with the Kemmis and McTaggart model, which consists of four stages: Planning, Action, Observation, and Reflection. The results showed increased student mathematics learning achievement in statistics material in grade 10 through implementing Problem-based Learning integrated with Flipped Classroom, assisted by Google Sites. The percentage of classical learning completeness in each cycle is Pre-Cycle 56% with an average of 69.3, Cycle I 72% with an average of 75.7, and Cycle II 89% with an average of 84.7. So, Problem-based Learning integrated with Flipped Classroom, assisted by Google Sites, successfully improves student learning achievement and is recommended to be implemented in the classroom.

Keywords: *PBL, Flipped Classroom, Google Sites, Learning Media, Learning Strategy*

INTRODUCTION

Mathematics is one of the subjects taught at every level of education and has a vital role in everyday life [1]. Mathematics is a subject that can train students to develop critical, logical, and creative ways of thinking [2]. Therefore, math skills are often the basis for other subjects, and student progress in other issues depends on their ability in basic mathematics [3]. So that through learning mathematics, students can develop their potential in the classroom and everyday life. However, the reality in the field shows that student learning achievement in mathematics is low [4]. It can occur because of inappropriate learning models or strategies and less attractive learning media.

Students are said to be successful in learning mathematics if they have good learning achievements; this can be used as a measure of the completeness of students in mastering the material presented during learning [5]. The test results at the pre-cycle stage show that many students still need to complete or below the KKM (Minimum Completion Criteria). It is also corroborated by the discussions where students feel they do not understand the material being taught. In addition, from the results of observations made by researchers during PPL (Field Experience Practices) at the school where the internship was found that, in general, the mathematics learning process in the classroom was dominantly teacher-centered. Most teachers who teach math still use conventional methods. The teacher writes the material on the blackboard, then students take notes and work on problems according to the example. In addition, the learning media used is very monotonous and tends to be traditional, namely, the blackboard and several times using an LCD projector. It is considered boring by students. The learning process is one-way, making students imitate and record how to solve problems the teacher has taught without understanding the concept properly [6]. Therefore, learning models and strategies are needed to facilitate students to be more active in learning and construct their own understanding to improve their mathematics learning achievement.

One of the student-centered learning models is Problem-based Learning (PBL). PBL can be defined as a learning model that focuses on real-world problems, whose main purpose is to solve these problems to help students clearly understand what they have learned [7]. There are five steps in implementing the PBL model, namely: (1) orienting students to the problem; (2) organizing students to learn; (3) guiding individual and group investigations; (4) developing and presenting work; and (5) analyzing and evaluating the problem-solving process [8]. PBL is one of the learning models that applies the constructivism approach, where students actively construct their understanding. Implementing PBL can improve students' learning achievement and learning activities [9]. However, in its application, PBL will be difficult to implement if students do not have an adequate initial understanding of the problems faced, so they have difficulty solving the problems and require a longer time in the learning process [10]. To overcome this, a learning strategy is

needed to encourage students to learn independently before class starts so that students are ready to learn in class.

One learning strategy that can be combined with PBL and positively impacts student learning outcomes is the Flipped classroom [11]. The flipped classroom is a learning process where students study subject matter at home before class starts and teaching and learning activities in class in the form of doing assignments and discussing material or problems that have yet to be understood [12]. In Flipped Classroom, learners prepare for learning before entering class by reading e-books, watching videos, understanding PowerPoint slides, listening to podcasts, or accessing other learning resources provided by educators both through offline and online media. Based on previous research results, the Flipped Classroom model has a good effect on learning outcomes and student motivation [13]. In line with PBL, Flipped Classroom uses a learner-centered approach so that the responsibility for learning is more on learners; teachers only encourage them to experiment and facilitate learners with interesting learning resources [14]. Therefore, an interesting learning media is needed to convey material to support this teaching and learning process.

Technology development is very important in teaching and learning and delivering mathematics learning materials, which can increase students' understanding [15]. The utilization of technology as a learning media has a good influence on student learning outcomes. Learning mathematics using digital media can improve student learning outcomes and make learning more interesting [16]. One of the platforms that can be used to develop learning media is Google Sites. Google Sites is one of Google's products as a tool for creating websites. Google Sites is free and connected to other Google products such as Google Forms and Google Drive. In addition, we can also enter various content in the form of text, images, and videos, and we can even embed other sites into the learning website we have created [17]. Therefore, using Google Sites as a learning media is very helpful for a teacher in the learning process, especially in the Flipped Classroom.

Based on the description above, the researcher is interested in examining whether there is an increase in students' mathematics learning achievement if the Problem-based Learning model combined with Flipped Classroom is applied to Google Sites learning media. The limitation of this research is statistics material for grade 10. It is hoped that this research can provide solutions to the problems encountered.

RESEARCH METHODS

This research uses the type of Classroom Action Research. Classroom action research is the efforts made by teachers in the form of research to improve student learning and teaching in classes [18]. The research method used is the Kemmis and Mc Taggart model, which consists of four stages, namely the stages of Planning, Action, Observation, and Reflection [19]. Planning is carried out by analyzing and identifying problems, determining ways to solve problems, and compiling an action plan that will be carried out by designing learning devices. After the planning stage, we continued with the action and observation stages. Researchers implemented the Problem-based Learning model combined with Flipped Classroom with the help of Google Sites learning media in the classroom and were observed by peer teachers or peers. In the last stage, namely the reflection stage, researchers review and evaluate all actions that have been taken and the results of observations based on the data that has been collected [20].

This research was conducted in 3 cycles: pre-cycle, cycle I, and cycle II. Pre-cycle was conducted in 1 meeting where the teacher taught as usual, namely with conventional methods assisted by PowerPoint media. The results of this pre-cycle were used to compare the success of learning using the Problem-based Learning model combined with Flipped Classroom assisted by Google Sites learning media in cycle I and cycle II. Cycle I and cycle II consist of classroom action research steps that refer to the Kemmis and McTaggart model, which consists of four stages, namely the stages of Planning, Action, Observation, and Reflection. The subjects of this research were 36 10th-grade students in one of the high schools in Semarang City.

The data collection techniques in this research are tests, observation, and documentation. Tests measure student learning achievement at the end of each cycle. Observation of the learning process to discover the shortcomings that need to be improved from each cycle. While documentation in the form of field notes, pictures, videos, and student work related to learning.

Data from observations and documentation were analyzed qualitatively. Qualitative analysis was carried out by reflecting on the results of observations of the learning process by researchers and students in the classroom supported by data from documentation. The data in this form was processed into meaningful sentences and analyzed qualitatively. The data from the test was analyzed using the percentage of classical learning completeness to determine the study's success. The formula for calculating the percentage of classical learning completeness is as follows.

$$\% = \frac{\Sigma \text{ Students who reached KKM}}{\Sigma \text{ All of the students}} \%$$

Students are said to have completed learning mathematics if they have reached the KKM (Minimum Completeness Criteria) [21]. In this study, the KKM score was 70, and the cycle in this study will be stopped if students who have reached KKM reach 75% or more.

RESULTS AND DISCUSSION

This research was carried out in 3 cycles: pre-cycle, cycle I, and cycle II. In the pre-cycle activity, the

teacher carries out conventional learning and then conducts a student learning achievement test on statistical material. Descriptive statistics of pre-cycle test results are as follows.

Table 1. Descriptive Statistics of Test Results at Pre-Cycle

Description	Value
Subject	36
Highest Score	85
Lowest Score	50
Average Score	69.3

And here is the data on the classical learning completeness of students in the pre-cycle.

Table 2. Classical Learning Completeness at Pre-Cycle

Score	Category	Frequency	Percentage (%)
≥70	Completed	20	56
<70	Not Completed	16	44
Total		36	100

Based on the data from the test results, Table 1 shows that the average score of students is 69.3, while Table 2 shows that the percentage of classical learning completeness of students is 56%. The data will be the basis for comparing the improvement of student learning achievement seen from the average test score and classical learning completeness. Furthermore, the cycle of classroom action research is carried out, each of which consists of four stages: the planning stage, the action stage, the observation stage, and the reflection stage.

Planning Stage

The planning stage is carried out to determine the actions that will be taken based on the problem. The main problem in this study is the low learning achievement of students in mathematics learning, where the classical learning completeness of students is 56% based on the test results in the pre-cycle. Based on the analysis of observation results, the cause of the problem is that the mathematics learning process in the classroom is still dominated by the teacher with conventional methods, so students tend to be passive. The teacher writes the material on the whiteboard, then the students take notes and do the problems according to the example. In addition, the learning media used is monotonous and tends to be traditional, namely only the whiteboard and several times using an LCD projector. The one-way learning process makes students passive and less able to understand concepts well. So, innovative learning strategies and media are needed to overcome these problems.

Cycle 1 planning was preceded by a literature study and discussions with student teachers and peers, so the researchers decided to implement the Problem-based Learning model combined with Flipped Classroom assisted by Google Sites learning media. PBL combined with Flipped Classroom can increase students' activeness in the learning process [22]. This planning stage results in a draft lesson plan using teaching tools, including teaching modules, learning media, and test questions. At the same time, Cycle 2 learning planning is based on the results of the reflection in Cycle 1.

The planned learning model combines PBL syntax with Flipped Classroom techniques. Before learning in class, students are given material through learning media assisted by Google Sites to study independently at home. The learning media is in the form of a website that contains subject matter in various formats, including text, visual, video, manipulative media, and others, to accommodate the different learning styles of students.

Action Stage

The action stage activities in this study were carried out by implementing the Problem-based Learning model combined with a Flipped Classroom assisted by Google Sites learning media in the classroom. The learning procedures carried out include: (1) Students are given material through Google Sites learning media and study it at home; (2) During the learning process in the classroom, students are guided by the teacher to carry out learning activities with PBL syntax, (3) students and teachers reflect on the learning process and are given reinforcement, (4) students take a learning achievement test at the end of the cycle. The descriptive statistics of the test results in cycle I are as follows.

Table 3. Descriptive Statistics of Test Results at Cycle I

Description	Value
Subject	36
Highest Score	90
Lowest Score	55
Average Score	75.7

And here is the data on the classical learning completeness of students in cycle I.

Table 4. Classical Learning Completeness at Cycle I

Score	Category	Frequency	Percentage (%)
≥70	Completed	26	72
<70	Not Completed	10	28
Total		36	100

Based on data from the test results in Table 3, the average score of students is 75.7. The average is above the KKM (Minimum Completeness Criteria). Still, Table 4 shows that the percentage of classical learning completeness of students is 72%, where 26 students are in the completed category, and 10 are still in the uncompleted category. From these data, the student learning achievement in cycle I has not met the success indicators. So, cycle II action was carried out by making some necessary corrections. The descriptive statistics of the test results in cycle II are as follows.

Table 5. Descriptive Statistics of Test Results in Cycle II

Description	Value
Subject	36
Highest Score	95
Lowest Score	70
Average Score	84.7

And here is the data on the classical learning completeness of students in cycle II.

Table 6. Classical Learning Completeness in Cycle II

Score	Category	Frequency	Percentage (%)
≥70	Completed	32	89
<70	Not Completed	4	11
	Total	36	100

Based on data from the test results in Table 5, the average score of students is 84.7. The average is above the KKM (Minimum Completeness Criteria) and has increased from the average score in cycle I. Meanwhile, Table 6 shows that the percentage of classical learning completeness of students is 89%, where 32 students are in the completed category, and four students are in the uncompleted category. From these data, the student learning achievement in cycle II has met the target. So, the research cycle is stopped, and those students who still need to complete will be given remedial.

Observation Stage

The observation was carried out during the action stage. The cooperating teacher and peers assisted the researcher as observers to observe learning management during the implementation. Meanwhile, the researcher observes students' activeness and documents it through field notes, photos, and videos. From the observations made by the observer and the researcher, several shortcomings were found, such as poor time management, inadequate attention to all students, students still having difficulty in working on student worksheets, less varied media in Google Sites, and no feedback from students when studying at home so that it cannot be monitored. The findings in the observation stage of the cycle I will be used by researchers as material for reflection and determining the follow-up plan. The follow-up plan is in the form of learning improvements in process and media used in cycle II.

Reflection Stage

In the reflection stage, the researcher reviews the actions taken, analyzes the data collected at the observation stage, and then evaluates the successes and shortcomings of the learning in the previous cycle. Based on discussions between researchers and observers related to learning in cycle I have been carried out by implementing the Problem-based Learning model combined with Flipped Classroom assisted by Google Sites learning media, improvements will be made in cycle II, including (1) student worksheets which were previously only in the form of questions, will then be accompanied by guiding questions so that students have less difficulty and more efficient learning time, (2) include more varied media in Google Sites to accommodate differences in students' learning styles, (3) provide feedback in the form of questions and reflections in Google Sites to ensure students have learned the material at home, and (4) improve classroom management in time management and attention to students.

The increase in the average score of students' test results in each cycle starting from pre-cycle, cycle I, and cycle II is accumulated in the following diagram.

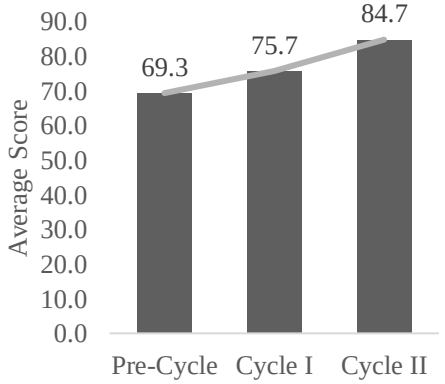

Figure 1. Average Score of Student Test Results

While the increase in the percentage of classical learning completeness of students is accumulated in the following diagram.

Figure 1 shows that the average score of students' test results has increased every cycle, from pre-cycle 69.3 to 75.7 in cycle I and 84.7 in cycle II. In addition, from Diagram 2, it can also be seen that the percentage of classical learning completeness of students has increased every cycle, from pre-cycle where 56% of students reached KKM (Minimum Completeness Criteria), then to 72% in cycle I, and 89% in cycle II. So, the cycle in this study was stopped because it had met the success indicator. Namely, learning has been said to be successful if 75% or more

of the students have reached the KKM (Minimum Completeness Criteria) or scored above or equal to 70.

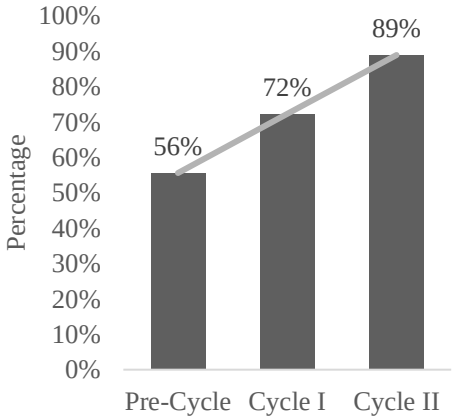

Figure 2. Percentage of Classical Learning Completeness

Based on the data in Figure 1 and Figure 2, there is an improvement in student learning achievement in statistics material through implementing the Problem-based Learning model combined with Flipped Classroom assisted by Google Sites learning media. The observation results show that students are more active in the learning process in class through the PBL model compared to the conventional model. It is in line with previous research, which shows that through the PBL model, there was an increase in student activity in the learning process [23]. PBL can increase interaction between students [24]. The cooperative learning model positively affects student mathematics learning achievement [25]. It is in line with previous studies, which show that the level of learning achievement of students who take PBL is higher than students who take teacher-centered learning [26].

However, teachers and students still experience difficulties in implementation, so other learning strategies are needed to support PBL [27]. Therefore, this study combines the PBL model with Flipped Classroom. The Flipped Classroom learning model helps students to learn independently at home through materials provided by the teacher so that students are ready when facing problems to be solved in the learning process. It is in line with the results of previous research, which shows that Flipped Classroom can help students' understanding [28].

The Flipped Classroom learning model requires multimedia that can support student learning activities [29]. This research uses Google Sites to create website-based learning media in which various multimedia useful for students are included. It is in line with previous research, which shows that the learning outcomes of students who use multimedia in learning are better than the learning outcomes of students who do not use multimedia [30]. So, Google Sites learning media is suitable for Flipped Classroom learning.

CONCLUSION

Based on the results of Classroom Action Research (PTK) and its discussion, it is concluded that implementing Problem-based Learning (PBL) integrated with Flipped Classroom assisted by Google Sites can improve student learning achievement. This conclusion is based on an increase in the average score of students' test results in each cycle, from pre-cycle 69.3 to 75.7 in cycle I and 84.7 in cycle II. In addition, there was an increase in the percentage of classical learning completeness of students in each cycle, from pre-cycle, where 56% of students reached the KKM (Minimum Completeness Criteria), then 72% in cycle I, and 89% in cycle II.

From these conclusions, teachers are recommended to use learning models and strategies that can facilitate and encourage students to be more active in learning and construct their own understanding so that it impacts on improving their mathematics learning achievement. In addition, learning media also plays an important role in the success of learning. This research is limited to grade 10 statistics material and math learning achievement, so further research is needed on other materials and other mathematical abilities.

REFERENCES

[1] Nugraha, A. A. (2022, April). Media Pembelajaran Interaktif Menggunakan GeoGebra Bernuansa Etnomatematika Untuk Meningkatkan Kemampuan Representasi Matematis Peserta Didik. In *Prosiding Seminar Pendidikan Matematika dan Matematika* (Vol. 5).

[2] Ariyanto, L., & Santoso, L. (2017). Pengaruh Pembelajaran Problem Based Learning Dan Discovery Learning Terhadap Mathematical Problem Posing Siswa Smk Kelas Xi. *JIPMat*, *2*(1).

[3] Purwati, H., Happy, N., & Endahwuri, D. (2021). Evaluation of Mathematics Lesson Planning In High School. *IndoMath: Indonesia Mathematics Education*, *4*(2), 119-128.

[4] Retnawati, H. (2022). Empirical Study of Factors Affecting the Students' Mathematics Learning Achievement. *International Journal of Instruction*, *15*(2), 417-434.

[5] Masitoh, S. I., Maharani, A., & Lubis, Y. (2021). Peningkatan Hasil Belajar Peserta Didik Pada Mata Pelajaran Turunan Fungsi Melalui Model Pembelajaran Flipped Classroom. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, *7*(1), 29-36.

[6] Inayah, Z., Buchori, A., & Pramasdyahsari, A. S. (2021). The Effectiveness of Problem Based Learning (Pbl) And Project Based Learning (Pjbl) Assisted Kahoot Learning Models on Student Learning Outcomes. *International Journal of Research in Education (IJRE)*, *1*(2), 129-137.

[7] Cevallos-Torres, L., & Botto-Tobar, M. (2019). *Problem-Based Learning: A Didactic Strategy in The Teaching of System Simulation*. Springer International Publishing.

[8] Sumayow, W. D., Buhungo, T. J., Uloli, R., & Supartin, S. (2022). Problem-Based Learning Model Assisted by Google Meet for Parabolic Motion Topic to Improve Student Learning Outcomes. *Jurnal Pijar Mipa*, *17*(3), 353-360.

[9] Nurlaelah, N. (2023). Problem-Based Learning Method for Improving the Learning Achievement of Students. *Edunesia: Jurnal Ilmiah Pendidikan*, *4*(2), 447-457.

[10] Tyas, R. (2017). Kesulitan Penerapan Problem Based Learning Dalam Pembelajaran Matematika. *Jurnal Tecnoscienza*, *2*(1), 43-52.

[11] Chang, Y. H., Yan, Y. C., & Lu, Y. T. (2022). Effects of Combining Different Collaborative Learning Strategies with Problem-Based Learning in A Flipped Classroom on Program Language Learning. *Sustainability*, *14*(9), 5282.

[12] Fani, V. G., & Mawardi, M. (2022). Flipped Classroom Learning System Based on Guided Inquiry Using Moodle on Acid-Base Solutions. *Jurnal Pijar Mipa*, *17*(3), 361-368.

[13] Zheng, L., Bhagat, K. K., Zhen, Y., & Zhang, X. (2020). The Effectiveness of The Flipped Classroom on Students' Learning Achievement and Learning Motivation. *Journal of Educational Technology & Society*, *23*(1), 1-15.

[14] Yanti, Y. A., Buchori, A., & Nugroho, A. A. (2019). Pengembangan Video Pembelajaran Matematika melalui Model Pembelajaran Flipped Classroom di Sekolah Menengah Kejuruan. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *1*(6), 381-392.

[15] Buchori, A. (2019). Pengembangan Multimedia Interaktif dengan Pendekatan Kontekstual untuk Meningkatkan Pemecahan Masalah Kemampuan Matematika. *Jurnal Inovasi Teknologi Pendidikan*, *6*(1), 104-115.

[16] Nugraha, A. A., Rizal, N., & Cahyono, A. N. (2023). Mathematical Modelling Ability in Outdoor Learning with Mobile Math Trails. *International Journal on Emerging Mathematics Education (IJEME)*, *7*(1).

[17] Khasanah, R., & Muflihah, S. M. (2021). Online Learning Management Using Google Sites on Relations and Functions in Pandemic Conditions. *Journal of Education and Learning Mathematics Research (JELMaR)*, *2*(1), 68-76.

[18] Meesuk, P., Sramoon, B., & Wongrugsa, A. (2020). Classroom Action Research-Based Instruction: The Sustainable Teacher Professional Development Strategy. *Journal of Teacher Education for Sustainability*, *22*(1), 98-110.

[19] Asrori, A., & Rusman, R. (2020). Classroom Action Research: Pengembangan Kompetensi Guru.

[20] Susanti, L., Muslimin, M., Hirza, B., & Atikah, D. (2023). Peningkatan Hasil Belajar Matematika Melalui Penerapan Model Problem Based Learning Siswa Kelas VIII SMP Negeri 4 Pendopo Barat. *Jurnal Penelitian Tindakan*, *1*(1), 1-12.

[21] Silvia, I., Oviana, W., & Lubis, A. H. (2023). Improving Learning Outcomes of Elementary School Students by Using Mind Mapping Models with Audio Visual Media: A Classroom Action Research. *Jurnal Pendidikan Profesi Guru*, *1*(2), 41-53.

[22] Sinmas, W. F., Sundaygara, C., & Pranata, K. B. (2019). Pengaruh PBL Berbasis Flipped Class terhadap Prestasi ditinjau dari Motivasi Belajar Siswa. *RAINSTEK: Jurnal Terapan Sains & Teknologi*, *1*(3), 14-20.

[23] Keiler, L. S. (2018). Teachers' Roles and Identities in Student-Centered Classrooms. *International journal of STEM education*, *5*, 1-20.

[24] Dawood, O., Rea, J., Decker, N., Kelley, T., & Cianciolo, A. T. (2021). Problem-Based Learning About Problem-Based Learning: Lessons Learned from A Student-Led Initiative to Improve Tutor Group Interaction. *Medical Science Educator*, *31*, 395-399.

[25] Arifuddin, M., Hayati, L., Amrullah, A., & Baidowi, B. (2021). The Effect of Cooperative Learning Model of Team Game Tournament (TGT) Type on Students Mathematical Learning Achievement of Junior High School. *Jurnal Pijar Mipa*, *16*(5), 583-588.

[26] Aslan, A. (2021). Problem-Based Learning in Live Online Classes: Learning Achievement, Problem-Solving Skill, Communication Skill, and Interaction. *Computers & Education*, *171*, 104237.

[27] Janah, M., & Dimas, A. (2021). Kesulitan Guru SMP Dalam Mengimplementasikan Model Pembelajaran Discovery Learning Dan Problem Based Learning. *Jurnal Tadris IPA Indonesia*, *1*(3), 420-426.

[28] Cevikbas, M., & Kaiser, G. (2020). Flipped Classroom as A Reform-Oriented Approach to Teaching Mathematics. *ZDM*, *52*(7), 1291-1305.

[29] Aprianto, E., & Purwati, O. (2020). Multimedia-Assisted Learning in A Flipped Classroom: A Case Study of Autonomous Learning on EFL University Students. *International Journal of Emerging Technologies in Learning (Online)*, *15*(24), 114.

[30] Chipangura, A., & Aldridge, J. (2019). Multimedia: A Means of Improving Students' Engagement in Mathematics Classrooms?. *International Journal for Mathematics Teaching & Learning*, *20*(2).