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Research Article

Improved Metacognition Reviewed Based on Mathematical Resilience through Flipped Classroom

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Wati Susilawati: <https://orcid.org/0000-0003-0346-9536>Herlinda Lulu Cahya Andari: <https://orcid.org/0009-0002-6407-8475>Hamdan Sugilar: <https://orcid.org/0000-0001-8588-3372>**Abstract.**

This study investigates students' interpretation of kinematics graphs. A total of 121 students taking a physics class were selected to solve problems involving the analysis of graphs depicting position, velocity, and acceleration versus time. Conducting interviews aimed to uncover students' difficulties while solving kinematics problems. The result emphasizes that students were able to determine velocity (if given position-time graph) and acceleration (if given velocity-time graph). However, students faced difficulty in selecting textual descriptions and choosing the corresponding graph when given a kinematics graph. These findings suggest that in learning physics, there should be an increased emphasis on deep analysis of kinematics graphs.

Keywords: flipped classroom, mathematical resilience, metacognition.

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1. INTRODUCTION

COVID-19 pandemic provides the world of education an opportunity to reform the learning system. Towards society 5.0 era, all learning activities based on technology, educators and students are required to adapt to technological development continually in the implementation of the interactive learning process that is able to attract interest, motivation, and resilience of students [1, 2]. To build students' prior knowledge, educators facilitates the design of learning materials in digital form in the form of videos to be studied by students at home, before the implementation of the learning process in class, so that students are ready for conflict, metacognitive, and resilience when implementing face-to-face learning in school or implementing flipped classroom [3–5]. Through flipped classroom assisted by Quipper School, resilience, habit of organizing

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metacognitive mindset, and creativity of students there is a significant increase [6–8]. So that professional educators are actually familiar with rapid development various variations of learning software.

Empirically, the demands of online learning have an impact on the resilience of educators and students, preparation for learning takes a long time to adapt to technological literacy [9]. Since the implementation of the distance learning policy, many parties feel the negative impact, including some teachers have difficulty choosing the right platform for distance learning activities.. The absence of face-to-face learning also results in teachers having to make greater efforts to prepare, inovate, and design online learning so that it can increase the concentration range of students [10]. Several research results reveal a decrease in student resilience in learning mathematics online, students have difficulty understanding abstract mathematical concepts, metacognitive thinking difficulties in solving non-routine math problems, have difficulty in modeling and planning mathematical problem solving strategies that are not yet known how to solve them, and complete a problem-solving ability test with high levels of stress and anxiety, limited technological facilities and infrastructure, power outages, time management, funding problems to buy quota [11–19]. Therefore, The complexity of the problem of learning mathematics requires creative educators to facilitate the implementation of the learning process, in accordance with trending technological developments.

Complex learning problems are very interesting to be followed up immediately. As an alternative, online learning that is able to increase interest, motivation and creativity and responsibility in solving metacognitive problems and student resilience is flipped classroom assisted by Quipper School. Several research results [20–23] reveal that flipped classroom assisted by Quipper School able to change the paradigm of traditional teaching into innovative learning, interactive through digital literacy according to 21st century learning expectations. Therefore, in addition to learning facilities through digital literacy there are aspects of students' mathematical metacognition and resilience which are used as learning objectives. Metacognition ability is closely related to the thinking processes of students who have varied potential in finding mathematical problem solving strategies. Every student has different abilities in dealing with problems. Metacognition skills play a very important role in solving a non-routine problem that requires a completion process with a single solution but with varied solutions, and many solutions but reasoning and algorithms clearly differentiate them. According to research results [24–26] revealed that metacognitive thinking skills affect the ability to solve mathematical problems, so that it effectively increases learning motivation, academic achievement, self efficacy, satisfaction with school and student resilience.

Thus students' metacognition and resilience skills are very important in the process of solving mathematical problems that require high thinking.

Some of the results of previous researchers that became the basis for flipped classroom learning, metacognition and resilience including: [27, 28] that the blended learning flipped classroom assisted by the Quipper School application was an option during the COVID-19 pandemic as a solver of metacognition problems that provided many benefits for improving academic achievement, providing interactive, flexible, cost-effective, effective, efficient and resilient experiences for students. Finding result [29, 30] revealed that mathematical resilience has a significant effect on metacognitive skills in solving mathematical problems. So that educators and students actually have resilience and are skilled at metacognitive thinking in following the development of digital literacy in blended learning. There are differences with the results of previous researchers, an opportunity to complement the research results that metacognition and resilience abilities and blended learning flipped classrooms assisted by the Quipper School application need to be followed up immediately to become an alternative solution for students' problems in solving unstructured abstract mathematical problems. Thus, the purpose of this study is to improve students' metacognitive abilities in terms of mathematical resilience through flipped classroom learning.

2. RESEARCH METHOD

The research method used is Classroom Action Research with the Kemmis and McTaggart model which consists of four stages, namely: planning, implementation, observation, and reflection. At the planning stage: focus on determining the problem according to the characteristics of students, curriculum, subject matter, learning process, technological means, and making research instruments. Implementation stage: implementation of the plans that have been prepared, a two cycle learning process is carried out: each cycle consists of two meetings for the implementation of learning and observations regarding the activities of teachers and students during the Flipped Classroom learning process assisted by the Quipper School application. The last stage: reflection, the result of reflection becomes material for improvement for the next cycle. The research subjects involved 28 students of class XI MIPA 1 SMA Negeri in Bandung Indonesia. Research instruments include tests of metacognitive abilities, and non-tests in the form of questionnaires, interviews, observation formats that have been validated and are suitable for use. Data collection techniques include interviews, observations, documentation, tests,

questionnaires and field notes. ⁹ Data analysis through data reduction, data presentation, and data verification.

3. result and discussion

⁸ Based on the results of research on the Flipped Classroom learning process assisted by the Quipper School application with the subject of Trigonometry, for two cycles it can be carried out properly. Cycle I student activities during group discussions and enthusiasm in cycle II students are used to asking questions and completing their partner's ideas. ⁸ activities during the learning process can be seen in the image below in Figure 1.

The results of observing student activities in cycle one 67% are in the sufficient category, This shows that students are not used to carrying out Flipped Classroom learning with the help of the Quipper School application, in the second cycle, student activities increased by 20% with a score of 87%, in the good category. Students are already happy with the challenge of observing, investigating and analyzing material on video playback of learning materials at home, before being delivered by the teacher at school. The results of the acquisition of teacher activities in cycles one and two respectively with a score of 87% and 88% were in the very good category.



Figure 1: Student activities in cycles I and II of flipped classroom learning.

For students' metacognitive ability test results after obtaining ³ Flipped Classroom learning assisted by the Quipper School application, shows an increase in each cycle. In the first cycle, students are required to get used to learning the material through video shows of the material at home before learning at school. There are still some students who are not used to studying the material before the material is delivered by the teacher at school. For learning in the second cycle, students have shown the responsibility to study the subject matter before it is delivered by the teacher. More clearly the results of students' cognitive abilities can be seen in the Figure 2:

The average metacognitive ability test results of students in cycle one is 75%, namely 23 students who get a score more than the minimum school completeness criterion

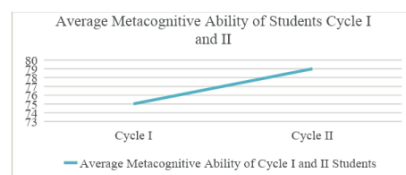


Figure 2: Metacognitive ability test results of students cycle I and II.

value, which is 75, and five students are under the value of 75. While the acquisition of the average value in the second cycle 79%, the number of students who scored above 75 were 28 students, indicating that they had completed the minimum school completeness criteria. The average value of students' metacognitive abilities at the end of the cycle as many as 26 people out of 28 students scored more than 75, while two students scored less than 75. More clearly can be seen in the Figure 3:

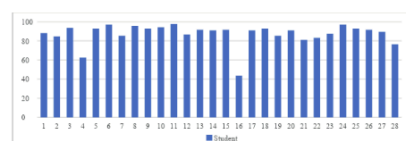


Figure 3: Students' metacognitive ability test results at the end of the entire cycle.

In Figure 3 shows the classical completeness value, for the final test the entire cycle is 93%, while the classical absorption of students is 88%. Students' metacognitive abilities in providing varied and detailed answers. It is in accordance with indicators of metacognition ability, namely aspects of planning problem solving strategies, algorithm processes, and feed back. So it can be concluded that the Flipped Classroom learning process assisted by the Quipper School application can improve students' metacognition skills in trigonometric concepts.

Based on the distribution of students' mathematical resilience questionnaires, three criteria of student resilience were obtained, namely high, medium and low. The number of students in the high category is four people, 20 students are in the medium category, and four students are in the low category. Students' metacognitive abilities are reviewed based on mathematical resilience, which can be seen in the Figure 4:

Figure 4 shows that students who belong to the category of high mathematical resilience have an average metacognitive ability score in the first cycle of 84%, in the second cycle 79%, and at the end of the entire cycle 88%. Meanwhile, students

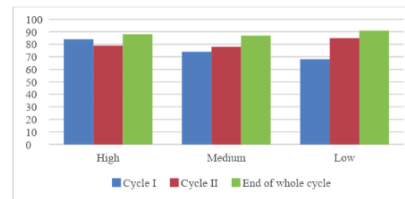


Figure 4: Metacognition ability based on mathematical resilience.

who belong to the category of moderate mathematical resilience have an average metacognitive ability of 74% in the first cycle, 78% in the second cycle, and 87% at the end of the entire cycle. Meanwhile, students who belong to the category of low mathematical resilience have an average metacognitive ability of 68% in the first cycle, 85% in the second cycle, and 91% at the end of the entire cycle. The average percentage of students' attitudes during the Flipped Classroom learning assisted by the Quipper School application with the interpretation that the majority of students 66% gave a positive attitude. 34% give a negative attitude. There is an increase in students' metacognitive abilities based on mathematical resilience in the high, medium, and low categories through Flipped Classroom learning assisted by the Quipper School application.

Flipped Classroom learning assisted by the Quipper School application can improve students' metacognition skills in trigonometric concepts. According to the findings [3] revealed that learning mathematics assisted by Quipper School can improve student achievement in class XII [31] that Flipped Classroom interactive learning assisted by the Quipper School application integrates asynchronous and synchronous learning so that students are actively involved at home to understand, investigate, analyze material and solve problems in teaching materials, student worksheets, and learning videos, before implementing classroom learning as preparation for face-to-face sessions [10, 32]. Quipper School is a ready-to-use web-based Learning Management System (LMS) or Virtual Learning Environment (VLE) that enables educators to manage, document, track, report, and deliver course material. This makes Quipper School usable by educators or educational institutions that have limited expertise in the field of information and technology, so that Flipped Classroom learning can be an alternative meaningful online learning method. This is because, the videos given by the teacher can be repeated anytime and anywhere. In addition, Flipped Classroom also allows students to learn according to their own abilities, so that students come to class in a state of preparation

[33]. Thus technological advances can help the learning process more effective and efficient. There is an increase in students' metacognitive abilities based on mathematical resilience in the high, medium and low categories through Flipped Classroom learning assisted by the Quipper School application. According to the findings [34] stated that the Quipper school application has a positive impact on learning activities, learning achievement, and students' mathematical resilience in terms of increasing student learning activities [35] thus the contribution is quite high from mathematical resilience to develop an attitude assessment rubric in mathematics learning. This is an example of a trigonometry problem used to analyze students' metacognitive abilities:



Figure 5: Example of multiplication problems in trigonometry cases.

$$T(a, t) = e^{2 \sin(\frac{a+t}{2})} \cos(\frac{a-t}{2})$$

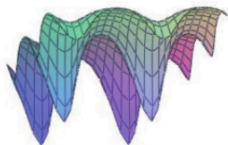


Figure 6: Trigonometry problems contextually.

4. CONCLUSION

Students' metacognitive abilities during the Flipped Classroom learning process assisted by the Quipper School application have improved in each cycle well. There is also an increase in students' metacognitive abilities in terms of mathematical resilience

criteria in the high, medium and low categories through Flipped Classroom learning assisted by the Quipper School application quite well.

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