Flipped classroom research trends in mathematics learning in Indonesia

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Abstract. This study aims to analyse the trends and contents of flipped classroom research in mathematics learning in Indonesia based on articles that reported on national and international journals and proceedings since 2015-2019. The content analysis was used as a methodology. Twenty articles were analysed in term of methodologies, technology or instructional media, students attitude, and challenges encountered. The research was conducted by using the internet exploration by the keywords related to flipped classroom in mathematics learning. The result of the analysis were interpreted using descriptive analysis and percentages. This analysis found that various methodologies were practiced in flipped classroom research in Indonesia, but limited technology or instructional media were used for its practice. The use of flipped classroom in mathematics learning yielded a positive impact on students’ achievement when compared to the traditional classroom. Mixed results of student attitude toward flipped classroom in mathematics learning were discovered. Challenges of implementing flipped classroom were identified categorized into student-related challenges, teacher-related challenges, and operational challenges. Finally, some recommendations for future research are provided.

1. Introduction

In this modern era, the process of mathematics learning should be to utilize technology as one of the instructional media. Harsa [1] states that in this era, apply technology in learning process is important to increase students’ interest and attention, especially in mathematics learning. Using technology in learning process is effort to increase the quality of learning [2]. In line with that, Hock [3] states the development of technology makes students must have literation technology skills. Therefore, integrating technology as instructional media is very important. Integrating technology in learning process also creates a positive attitude of students [4]. In line with this, Heid [5] stated that integrating technologies given students opportunities to real problems and they enabled to identify the concepts. Furthermore, learning strategy with technology is one of the characteristics of 21st- century learning goals.
The integration of technology in learning process contributes to increasing students’ achievement. Technology creates integrative learning that can motivate students to learn, create active learning and deeper understanding with mathematics topics [6]. Furthermore, in the regulation of Educational and Culture Ministry of Indonesia No 22. In 2016 concerning about process standard states that technology in learning process aims to create efficient and effective learning. Also, Budiana, Sjafrirah and Bakti [7] state that learning says effective when it can facilitate students to act in the learning process with various learning resources. Students can find the various learning resources with use technology, for example, the internet.

Integration of technology as instructional media related to the learning model which teachers used. Therefore, teacher must consider about how and with which learning model could be reflected the integration technologies in learning environment [8]. Blended learning is the learning model that uses technology in its practice. This is related to Thorne [9] states that blended learning is a learning model to integrate technology through online learning and students’ interaction. Blended learning combines the best characteristic of classroom learning and online learning to use technology to increase student independence and make active learning [10].

Blended learning model categorizes into some parts, namely flex model, self-blend model, rotation model, and enriched-virtual model. Flipped classroom learning is one part of rotation model [11]. This learning model flips the traditional learning model, the learning topics given to students before classroom learning, usually online [12]. In flipped classroom model, teacher delivers to learning content outside the classroom and the class time uses for active learning by students collaborate and interact with each other [13]. Flipped classroom is a learning model that is purposed to create active learning. It means students must be more active than the teachers. In class activities, teacher acts as student facilitator [14]. Flipped classroom model usually use the short instructional video and other learning resources through technology before classroom learning as a substitute for the teacher’s explanation in class [15].

Flipped classroom research has become familiar topics in various field of studies included mathematics [16]. The result of flipped classroom research in mathematics learning shows a positive result. Research from Hung, Sun, and Liu [17] in a secondary school in China shows that the flipped classroom learning model with MOOCs increase students’ outcomes and motivation. In line with this research, Bhagat, Chang, and Chang [18] show that flipped classroom learning model in college student in Taiwan with instructional video also increase motivation and students’ achievement. Furthermore, the research result from Lo and Hew [19] in secondary students with Moodle shows that flipped classroom increase students’ achievement in mathematics learning.

The positive result from the flipped classroom research in various countries shows that flipped classroom potential to be an alternative learning model to increase the quality of learning process. So far, there is no articles about flipped classroom research trends in mathematics learning in Indonesia. Therefore, this study aims to analysis flipped classroom research trends in mathematics learning in Indonesia. It is related to methodologies that have been used in flipped classroom research, technology or instructional media have been used flipped classroom research, students’ attitude towards flipped classroom and the challenges of applying this flipped classroom model. This study also can facilitate in understanding about research trends of flipped classroom models in mathematics learning in Indonesia with the expectations that can improve the quality of the learning process.

2. Method
This study is content analysis that analyse twenty articles on flipped classroom in mathematics learning in Indonesia published from 2015-2019. Data was collected through the open-access website which includes
ERIC, Google Scholar, JSTOR and Sinta2. Content analysis process in this study consists of several steps to get validation of the study [20]. The steps are the following: firstly, the analysis starts with categorized flipped classroom articles included in mathematical research. Secondly, through categorization in the first step twenty articles were obtained published from 2015-2019 which were articles in mathematics learning in Indonesia. Thirdly, the main points to analyse are methodology, technology or instructional media, student attitude and challenge in flipped classroom practice. The results of the analysis were interpreted using descriptive analysis. Fourthly, data were analysed then described systematically beginning from methodologies, technology and media, student attitude towards flipped classroom and challenges of flipping the class. Then, concluded and suggested future flipped classroom research in mathematics learning in Indonesia.

The flipped classroom researches in mathematics learning have been in various countries and showed that positive results on students’ achievement. This study aims to analyse flipped classroom research trend in mathematics learning in Indonesia through twenty articles published in 2015-2019. The analysis of this study addresses the following research questions:
1) What methodologies have been used in flipped classroom in mathematics learning in Indonesia?
2) What technology or media have been used for applying the flipped classroom in mathematics learning in Indonesia?
3) How students attitude towards flipped classroom in mathematics learning in Indonesia?
4) What are the challenges of applying the flipped classroom in mathematics learning in Indonesia?

3. Result and Discussion
This study analyses twenty flipped classroom articles in mathematics learning in Indonesia published in 2015-2019. Table 1. shows an summary of flipped classroom articles in mathematics learning in Indonesia.

| Study | Research Method | Subject grade level | Technology/Media | Students’ Achievement |
|-------|-----------------|---------------------|------------------|----------------------|
| [21]  | Experiment      | VII                 | -                | Self-regulated and achievement |
| [22]  | R&D             | VIII                | LMS Kelase       | Visualization skills |
| [23]  | R&D             | High School         | Webquest         | -                    |
| [24]  | R&D             | XI                  | -                | Attitude, responsibility, and learning skills. |
| [25]  | Literature review | -                  | LMS              | -                    |
| [26]  | Experiment      | Senior High School  | Instructional video | Learning outcomes |
| [27]  | Mix method      | VIII                | -                | Learning outcomes |
| [28]  | Experiment      | -                   | Instructional video | Concepts understanding |
| [29]  | Experiment      | XI                  | -                | Learning outcomes |
| [30]  | Case study      | High School         | Instructional video | Self-regulated |
| Reference | Methodology                          | Grade  | Resource            | Outcome                                      |
|------------|-------------------------------------|--------|---------------------|----------------------------------------------|
| [31]       | Classroom action research           | High School | Instructional video | Learning outcomes                           |
| [32]       | Experiment                          | High School | Instructional video | Learning outcomes                           |
| [33]       | Literature review                   | -      | -                   | Representation skills                        |
| [34]       | Mix method                          | VIII   | Edmodo              | Problem solving and critical thinking skills |
| [35]       | Experiment                          | X      | Instructional video | Communication mathematics skills             |
| [36]       | Classroom action research           | XII    | -                   | Concepts understanding                       |
| [37]       | Experiment                          | X      | -                   | Sel-regulated                                |
| [38]       | Qualitative                         | High School | University LMS      | Motivation and attitude towards mathematics  |
| [39]       | R&D                                 | XI     | Instructional video | -                                            |
| [40]       | Experiment                          | High School | Youtube            | Problem solving skills                      |

Table 1. shows this learning model implement from secondary school to high school. However, not all studies state about their participants, based on the available information we get that majority of participants flipped classroom research in mathematics learning in Indonesia is students in Senior High School \( (n = 7) \), followed by students in High School \( (n = 6) \) and students in Junior High School \( (n = 4) \). In following sections, we describe our finding based on our research questions (i.e., methodology, technology or media, student attitude, and the challenges of using flipped classroom).

### 3.1 Research methodologies of flipped classroom in mathematics learning in Indonesia

The first analysis explored to answer the first research question about the methodologies have been frequently employed in flipped classroom research in Indonesia. Various methodologies were used in flipped classroom articles that analysed. The result of analysis found the most frequent methodology in flipped classroom research in mathematics learning in Indonesia is experiment research. The experiment research focused on flipped classroom effectiveness in mathematics learning in Indonesia. Some research studies show that flipped classroom effective for increase students’ cognitive domains such as problem-solving skills [40], concepts understanding [28], learning outcomes [26,32] and students achievement [21]. Flipped classroom not only can increase student cognitive level but also can increase affective level such as learning independent [21,37] and students mathematics communication skills [35].

Another most frequently used method was research and development (R&D). Then flipped classroom R&D in mathematics learning in Indonesia still small in the last five years. From searching using relevant keywords, the researcher only found three flipped classroom articles in mathematics learning. One of the three articles develops instructional media for flipped classroom in mathematics learning. Masduki and Prayitno [23] were developed Webquest media for present instructional video as learning resource for students.
Another flipped classroom research methodologies in mathematics learning in Indonesia are literature review, qualitative, classroom action research and mix method. Table 2. shows the percentage of research methods of flipped classroom in mathematics learning in Indonesia from twenty articles published in 2015-2019.

| Research Method          | Percentage |
|--------------------------|------------|
| Experiment               | 40%        |
| R&D                      | 20%        |
| Literature review        | 10%        |
| Classroom action research| 10%        |
| Qualitative              | 10%        |
| Mix method               | 10%        |

3.2 Technology and media in flipped classroom research in mathematics learning in Indonesia

Flipped classroom research studies in mathematics learning in Indonesia show the limited technology used. The twenty articles analyzed in this study showed that most of the flipped classroom research in mathematics learning in Indonesia uses instructional video as media for students learn before joining to classroom [26,28,30–32,35,39]. Then, some flipped classroom research studies in high school (university) used the online platforms like Webquest and Youtube as instructional media for students to learn out of class.

Flipped classroom activities and learning are not only limited in classroom, but also out of the classroom. Therefore, technology in that research studies uses as instructional media for student learning out of class. Saputra and Mujib [28] use instructional video to increase students’ concepts understanding about mathematics. Yanuarto [30] states that not only for students’ preparation before joining in classroom learning, instructional video intended to increase students understanding that they can use technology as learning resource and create student responsibility to learn before join in classroom learning. Ulya, Isnarto, Rochmad and Wardono [34] uses Edmodo to solve problems in his class, namely the problem-solving skills and critical thinking skills of students. Harahap [40] uses Youtube in his research to create interactive learning, minimize direct instruction and maximizing peer instruction. Table 3. summarizes various technology or media have been employed in flipped classroom research in mathematics learning in Indonesia.

| Technology or Instructional Media | Percentage |
|----------------------------------|------------|
| Instructional video              | 66.67%     |
| LMS                              | 33.33%     |
| Youtube                          | 8.33%      |

3.3. Student attitude towards flipped classroom in mathematics learning in Indonesia

Students’ attitude towards flipped classroom analysis from their responses. Data collection through questioner, observation, and interviews by the researcher. The results of student attitude towards flipped classroom in mathematics learning in Indonesia show positive result. More specifically, twenty articles that
analysed in this study shows that three positive impacts that student feel, to form a positive attitude towards flipped classroom.

First, from the result of questioner Rahayu [27] states both male students and female students feel that flipped classroom interesting and easier to understand that conventional learning. Students in that research state they feel more prepare for classroom learning with flipped classroom, because they learn about the topics before joining to class. In line with this research, Abidin [36] states that learning mathematics with flipped classroom can increase student enthusiastic in learning process.

Second, mathematics learning with flipped classroom shows that positive results such as student motivation and student attitude in the learning process [38]. This is because there are maximal teacher and peer support during the learning process in the classroom. Collaboration between teacher and student also shows enhancement, it is reflected from student activity such as ask and give respond during the learning process. This also indicates that mathematics learning with flipped classroom can make active learning.

The last, from the result of the student interview, found that instructional video help students to understanding the topics [39]. Instructional video and student worksheet developed help students to understand and motivate them.

### 3.4 Challenges of using flipped classroom in mathematics learning in Indonesia

Betihavas, Bridgman, Kornhaber, and Cross [41] state that, the challenges were categorized into three categories. They are from students, teacher, and operational challenges. Twenty articles that analysed in this study show the most frequent challenges come from students. Wulandari [25] states that some students feel uncomfortable studying with technology like computer and low motivation to study at home, the consequences they are not ready for classroom learning. In line with this research, Anwar and Musdi [35] state some students are not able to understand the lessons when they learn individually out of the class, so they join the learning classroom not seriously. Abidin [36] states that students do not want to convey their difficulties to the teacher when learning classroom. Consequently, active learning has not been able to be achieved [38].

Meanwhile, the challenge of implementing flipped classroom in learning from teachers is only about the teachers’ abilities to prepare instructional media that will be used by students for learning outside the classroom [25]. Furthermore, teachers need time to prepare instructional media. While the challenges of the operational implementation of the flipped classroom are related to the technology used (computer, smartphone, etc.). There are students, teachers or schools that do not have facilities such as computers or laptops to access the instructional media. Apart from the technology, the limited time in research resulted in changes in the achievement of students’ abilities not being seen significantly [28].

### 4. Conclusion

This study gives an overview of research methodologies, technology or media, student attitudes and challenges applying of flipped classroom in mathematics learning in Indonesia. The result shows that flipped classroom in mathematics learning can create active learning class because student can discuss with their knowledge which gets before learning classroom. This result related to the research result from [42]. All of twenty articles that analysed in this study give positive result for flipped classroom in mathematics learning to increase student cognitive and affective domain.

The findings in this study related to the theory of Bloom’s revised taxonomy for the cognitive domain [43]. Students get the lower cognitive domain (knowledge and comprehension) when they learn at home or out of class and get the higher cognitive domain (application, analysis, synthesis and evaluation) in
classroom activities. It is better than conventional learning in which students practiced lower cognitive
domain in the classroom by listening to teacher’s explanation, while other levels practiced through
homework.

However, from the positive result of applying flipped classroom in mathematics learning, there are some
challenges must be solved in future research. How researcher can solve the challenges from students,
teachers and operational. Future studies may not only focus on outside class activities but also in class-
activities. Twenty articles that analysed in this study did not explained how the flipped classroom activities
in the classroom. Therefore, needed the research that explains the learning process flipped classroom in the
class. How teachers manage their class and student activities in class.

The results of analysis twenty flipped classroom articles in mathematics learning in Indonesia since
2015-2019 show that limited the research and development (R&D) especially the development of
instructional media for flipped classroom. Then, the limited technology that uses in flipped classroom. Most
of the research studies only use instructional video as instructional media for student outside class activities.
Therefore, the future research can prepare for the instructional media for student outside class activities.
The aims to make learning in the classroom to be more effective.

In summary, the result of this study have contributed to better understanding of flipped classroom in
mathematics learning in Indonesia. Finally, perhaps the findings and discussion of this study will contribute
to deeper understanding of future research in the flipped classroom area.

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