



Comparison of Synchronous and Asynchronous Online Learning to the Mathematics Learning Outcomes of Grade VI Students at Public Elementary School 2 Tonja North Denpasar District

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Abstract. This research is a comparative quantitative study, which is carried out to find out the comparison of mathematics learning outcomes between students who follow synchronous and asynchronous online learning and also to find out students' responses to the implementation of synchronous and asynchronous online learning. This study sample amounted to 53 grade VI students at Public Elementary School 2 Tonja. Sampling technique using a saturated sampling technique. The method used is an experiment, with measuring instruments in the form of pre-tests and post-tests and questionnaires that go through the validity test of empirical content, and validity, difficulty tests and different power tests. The data obtained is an ordinal scale, which is processed with the help of the IMB SPSS Version 23 program. The theories used to analyze this problem are constructivism theory, behaviorism theory and cognitive learning theory. First, the outcomes of students' math education were shown to be significantly different for those who engaged in synchronous online learning compared to those who engaged in asynchronous online learning. Students' arithmetic learning outcomes improve more in synchronous online learning than in asynchronous online learning for two main reasons. Thirdly, the statistics from the questionnaire indicate that students are more likely to strongly agree with synchronous online learning than with asynchronous online learning.

Keywords: Online Learning, Synchronous & Asynchronous, Math Learning Outcomes

1 Introduction

In light of the current pandemic situation involving the COVID-19 virus, the government has instituted regulations and policies restricting community activities, such as

working and attending school from home at the same time (Work from Home and School from Home, respectively). Consistent hand washing, mask use, space precautions, avoidance of congregated areas, and restricted mobility (5M) are all part of the policy's execution. All gatherings and gatherings are restricted or eliminated and replaced with online systems (online) or online media.

With systematic changes in these various activities, and referring to the Circular Letter of the Minister of Education and Culture No. 3 of 2020 concerning the Prevention of COVID-19 in education units, and No. 3962 / MPK. A / HK / 2020, the learning activities that were originally carried out directly were transferred and carried out through the network (online), to suppress the very fast spread of the coronavirus. Teaching and learning activities are replaced or transferred with online learning.

Under such conditions, various elements of education are required to replace the system in the teaching and learning process. Learning WAS carried out by utilizing various platforms as learning media. Teachers and learners are updating their learning systems, with various ways of habituation and adaptation that are appropriate and possible to apply. In this online learning, teachers are required to innovate to choose various ways used so that learning competencies and objectives can be achieved optimally. Therefore, various platforms range from video conferencing-based applications, as well as non-conferencing.

Online learning activities are expected to be able to encourage the emergence of the skills of educators and also students to think critically, creatively, technologically literate, independent, collaborative, and communicative. Online learning must include several things, namely models, media, and instructional strategies for online learning (Atsani, 2020). These things will create links that can support online learning. As a result, teachers have the responsibility of selecting the most appropriate medium for online instruction. Two types of online learning may be conducted using this medium: synchronous and asynchronous. It is envisaged that students participating in both synchronous and asynchronous learning would place an equal amount of importance on learning activities that enable them to still acquire a learning experience that is in bylearning goals, enjoyable, and successful.

In synchronous learning, students will be invited to take part in online learning directly through social media platforms, video-based applications, and audio conferences. In contrast, asynchronous learning is usually done through applications that are not conference-based, because it does not require real interaction at the same time. Students are allowed to practice independence in understanding the teaching material at a time that is convenient for them due to flexible asynchronous learning.

However, the two forms of online learning are not necessarily able to be applied easily and thoroughly. The challenges that have arisen in the application and implementation of online learning have been very complex since it was first started. These obstacles and challenges are not only felt by students but also by teachers (educators), educational institutions, and parents. There are several obstacles to adopting online learning, whether synchronously or asynchronously, because of the lack of technical knowledge on the part of instructors and students (Purnama, 2020).

In addition, judging from the situation of students what usually occurs is the problem of internet quota which of course due to the implementation of this learning, the need for internet quota is increasing. Then what arises from parents is that with this pandemic, of course, parental involvement is very dominantly needed. Meanwhile, not all parents are capable or have the ability, and the same time in guiding their children, let alone replace teachers to monitor and foster their children at home.

This is a challenge for teachers, especially in the context that will be discussed, namely that mathematics learning certainly requires more specific adaptations in online learning. Considering that mathematics subjects essentially require comprehensive interaction and guidance to students, to relate various materials to problems and daily activities. Moreover, mathematics learning, which from the beginning has been considered complicated. Some children love mathematics only at the beginning of their acquaintance with simple mathematics (Ruseffendi, 2006). However, the more the level increases, the more difficult mathematics learning will be, thereby reducing the interest of students. In addition, some children not even been able to understand mathematics learning, and there is a misconception that children do not really understand the concepts of the material itself. Mathematics is considered a difficult, and complicated science. This means that mathematics learning requires more treatment in online learning.

Mathematics learning requires collaboration between learning and teaching activities, to develop the mindset of students in understanding and solving or looking for sociability in problems that will be implemented in everyday life. If you learn mathematics face-to-face (offline) alone, it is still difficult for students to understand, especially with online mathematics learning. That is the learning situation that occurs in this COVID-19 pandemic situation. This raises its dilemma for educators, that when carrying out online learning, they must still pay attention to the situation of students, both from psychological, economic, and so on aspects. Learning is a two-way process between educators and students that requires feedback on both parties (Darma, Karma, & Santiana, 2020). Despite this, learning still needs to be designed as much as possible to achieve learning objectives. Therefore, from learning there will be a transformation of knowledge (transferring knowledge) that is right on target and optimal.

However, in this online learning, there is a gap between what is expected in learning and what happens in its implementation. As well as online mathematics learning carried out at Public Elementary School 2Tonja, especially in grade VI. Where, this grade is divided into two grades, namely grade VI/A and grade VI / B. Each teacher / home room teacher in the grade, conducts monotonous learning, with only one learning media, namely the WhatsApp group. In addition, learning is carried out without a learning contract which should be used as a guide in online learning. The homeroom teacher only sends one E-Book, and in the learning activity, the teacher only informs the learning sub-themes to be taught. In online learning through WhatsApp groups, it is very rare for a reciprocal process to occur between teachers and students, even though sometimes students do not respond to the material sent by the teacher at all.

Based on these experiences and to face the possibilities that exist in the world of education in the future, the author feels the need to conduct experiments to compare these two treatments, to create solutions when online learning, especially in mathe-

matics subjects through synchronous and asynchronous online learning. As a result, the author is curious about the differences between the mathematical results of students who engage in synchronous and asynchronous online learning while in grades 6 (A) and 6 (B) at Public Elementary School 2 Tonja.

2 Method

The purpose of this research was to compare the effects of several independent factors on sixth-graders mathematical development while they were engaged in learning activities at Public Elementary School 2 Tonja. Students in sixth grade at Public Elementary School 2 Tonja in Tonja Village, North Denpasar District, Denpasar City, Bali Province, made up the study's population. The sample consists of sixth-graders from Public Elementary School 2 Tonja, broken down into two groups of equal size: those in grade VI/A (27 students) and those in grade VI/B (26 students). Both Kelas VI/A and Kelas VI/B will serve as experimental grades, with the former testing out synchronous online instruction and the latter exploring asynchronous options. This study's information was gathered using tests (both pre-test and post-test) and questionnaires. Mathematical outcomes exams and student surveys on their experiences with online and asynchronous education are among the research tools being developed at the moment. Descriptive analysis, tests for analytical assumptions (normality, homogeneity, and hypothesis), and tests for data validity (validity, reliability, difficulty, and difference) are among the methodologies and techniques used in this research.

3 Discussion

3.1 Comparison Synchronous and Asynchronous Online Learning on Mathematics Learning Outcomes of Grade VI Students at Public Elementary School 2 Tonja

The mathematics pre-test results of grade VI/A students are lower than the mathematics pre-test results of grade VI/B students but with a very slight difference. In other words, in this pre-test, the level of understanding of students' understanding of the material tested in the pre-test is the same. After the experiment is carried out, it is then continued by conducting a final test or post-test in the experimented grade. Based on the results of the post-test, the highest score of grade VI / A who took part in synchronous online learning was 100, the lowest score was 75, and the average score was 86. Meanwhile, in grade VI / B who took part in asynchronous online learning, obtained the highest score of 95, the lowest score of 55 and the average score of 80. Data on the results of pre-test VI/A and grade VI/B at Public Elementary School 2 Tonja can be descriptively seen in the table below.

Table 1. Frequency Distribution of Post-test Mathematics Learning Outcomes of Grade VI Students at Public Elementary School 2 Tonja on Synchronous and Asynchronous Online Learning

Predicate Range	Description	Frequency		Percentage (%)	
		Syn	Asynchronous	Syn	Asynchronous
89-100	Excellent	10	7	37%	27%
77-88	Good	16	10	59%	38%
65-76	Enough	1	8	4%	31%
0-64	Need Guidance	0	1	0	4%
Sum		27	26	100%	100%

The results of the post-test grade VI/A and VI/B. Where the results of learning mathematics in the post-test grade VI/A are higher than the post-test scores of grade VI/B.

3.2 Assumption Test Result Data

1. Normality Test

Kolmogorov-smirnov value in the questionnaire results processed has a significance value of $0.071 > 0.05$ which means synchronous and asynchronous online learning are declared to be normally distributed.

2. Homogeneity Test

The homogeneity test results on the questionnaire data obtained a significance value of $0.081 > 0.05$ which means that the questionnaire data was also declared homogeneous.

3. Test the Hypothesis

Hipotesis tested in the study, namely:

H0: There is no difference in mathematics learning outcomes in synchronous and asynchronous online learning for grade VI students at Public Elementary School 2Tonja, North Denpasar District

H1: There are differences in mathematics learning outcomes in synchronous and asynchronous online learners of grade VI students at Public Elementary School 2 Tonja, North Denpasar District

The results show that there is a difference between synchronous and asynchronous Online learning in the mathematics learning outcomes of sixth-grade students at Public Elementary School 2 Tonja. With the data obtained, namely the value of sig. (2-tailed) $0.016 < 0.05$. So from these results, it is stated that H0 is rejected and H1 is accepted, meaning that there is a significant difference in synchronous and asynchronous online learning on the mathematics learning outcomes of sixth-grade students at Public Elementary School 2 Tonja, North Denpasar District. In synchronous and

asynchronous learning there are differences in the implementation. The differences in the implementation of synchronous and asynchronous online learning are:

1. In synchronous online learning, participants meet at a prearranged time and discuss topics that aren't too complex for the sake of establishing rapport. Asynchronous learning, on the other hand, takes place while dealing with complicated situations that can't be arranged in advance.
2. Synchronous online learning is adopted because it has the potential to increase students' dedication and motivation because of the short turnaround time for responses. Asynchronous online learning, on the other hand, is conducted because it gives students time to think before responding since the sender is not expecting an instantaneous response.
3. Video conferencing, instant messaging, chat, and virtual face-to-face are all examples of synchronous online learning tools. Online asynchronous learning, meanwhile, takes place via channels including email, message boards, and weblogs.
4. In synchronous online learning, students are encouraged to work in groups as a means of getting to know one another, sharing ideas, and organizing coursework, while teachers use video conferencing to convey themes from the literature in a condensed form. Asynchronous online learning, on the other hand, requires students to engage in self-reflection, peruse journal blogs, and critically evaluate the ideas presented by their peers in online discussion forums (Wangi, Inayah, & Hasibin, 2022).

Besides that, it is also influenced by various factors, one of which is student learning motivation, which will eventually affect their learning outcomes. An increase in student learning motivation will be followed by an increase in student learning outcomes (Ismail, 2015). Therefore, it is very important to determine the right learning strategy, one of which is choosing the appropriate learning media and supporting the learning motivation of students. Learning motivation has a greater role than just a moderator but acts as a mediator for learning outcomes (Prabowo, 2016). This means that if students have high motivation and enthusiasm for learning, of course, this will tend to encourage students to obtain maximum learning results.

In the implementation of online learning, the synchronous learning model is very good in influencing the increase in student learning motivation. There is an increase in student learning motivation through learning using Zoom meetings in grade IV students at SDN 1 Cepokomulyo" (Triyaswati, Danik, & Nafiah, 2020). Therefore, with the right learning model, high learning motivation, and good learning style in online learning, of course, the opportunity to obtain maximum learning results is also very large.

The advantages of synchronous learning implementation on mathematics learning outcomes are supported by research which states that learning outcomes and effectiveness in grades with Zoom webinar treatment are better than grades that are discussed with WhatsApp groups (Kusuma, Wijaya, & Hamidah, 2020). Likewise, research conducted concludes that synchronous e-learning is the most effective form of e-learning, and recommends that e-learning be conducted in this fashion by providing

interactive synchronous tutorial concepts, theory, and analytical models, individual learning projects that include personal reflection on assigned readings, and synchronous chat tools to facilitate face-to-face communication between students and instructors (Shahabadi & Uplane, 2015).

When viewed from the average score of mathematics learning outcomes, it certainly appears that synchronous online learning provides higher learning outcomes. This is because the direct involvement of students in learning, and gives a good impression on students, this is because the implementation of synchronous online learning provides a great opportunity for stimulus and response.

In addition, it is also supported by response questionnaire data that has been filled in by students related to the implementation of synchronous and asynchronous online learning. In filling out the questionnaire, the responses of students are certainly influenced also by the interests, motivations, abilities, and readiness of the students themselves. As stated by students when participating in online learning, students said that it is easier to understand the material when learning is carried out through Zoom meetings, but of course the obstacles faced sometimes make it difficult for students to join online grades through zoom. The implementation of online learning is influenced by obstacles faced by students such as signals, and quota prices (Purniawan & Sumarni, 2020). This is not a very serious obstacle for students, but because of the ease of learning through WhatsApp groups that teachers are accustomed to, making students less proficient in using synchronous online learning media based on video conferencing, the obstacles faced by students increase.

Synchronous learning occurs at the same time for all participants. It's a great way for students and instructors to work together in real time, exchange resources, and make use of modern technology (Ogbonna & Grace, 2019). The benefits of a synchronous learning environment include real-time information sharing and learning, as well as access to instructors for the purpose to ask questions and receive responses (Skylar, 2009). This is certainly a forum and an important need for students in online learning situations. The fact that usually happens is that when online learning through WhatsApp groups or Google Classroom (asynchronous learning media) is when learning occurs, students do not directly receive the teaching material, but will usually go through intermediaries, both parents and siblings.

This is certainly less effective, due to the lack of direct student involvement, thus providing a longer distance between students, moreover asynchronous learning provides more flexible time. This allows learners to enjoy too much flexibility and work with the pace style that they have on the facilities provided for asynchronous learning (Coogle & Floyd, 2015). When there is a distance shyness decreases, and this reduces the fear and trust of learners towards the teacher, and the demands in learning are reduced (Perveen, 2016). The lack of trust and closeness to the teacher certainly affects the motivation and attitude of students in learning. Therefore, in online learning, especially in mathematics subjects that require interaction and collaboration, it will certainly be better if it is carried out synchronously. By conducting synchronous learning, it allows students to become a student-centered environment (student center) and students can provide their answers and responses, according to learning activities (Arniti, 2020).

The above opinions are supported by research conducted by Skylar (2009) which states that:

"The results of this analysis suggested that both types of lectures are effective in delivering online instruction. In addition, almost three-fourths (30 of the 41 students) of the students indicated that they would rather take an online course that uses synchronous web conferencing lectures than an online asynchronous text-based lecture course. This finding suggests the importance of interactivity on student satisfaction in a course. Lastly, the research study supports the finding that students participating in an online course perceive an increased level of their technology skills".

As long as e-learning methods are in sync, learners have real-time engagement, which tends to be associated with learner satisfaction, learner learning, and lower levels of friction. Such synchronous interactions can help avoid miscommunication and learners have immediate feedback (Mick & Middlebrook, 2015). In other sources, there is research conducted in the form of interview results which states that "students say that they prefer when the teacher sends material in the form of videos or PowerPoints before learning and then the teacher holds a video conference via Zoom meeting" (Amadea, Kezia, & Margaretha, 2020). This makes it easier for students to still understand the subject matter, because at the age of 7-11 years old students still need guidance, and cannot go too far to understand something abstract, therefore they still need a direct explanation from the teacher.

Based on the description above, the results of this study prove that there are significant differences in the implementation of synchronous and asynchronous online learning on the mathematics learning outcomes of grade VI students at Public Elementary School 2 Tonja, North Denpasar District. So that implies that:

- 1 The selection of models and media in online learning is very important to support learning activities to remain effective and able to achieve maximum learning outcomes, in online learning carried out in grade VI Public Elementary School 2 Tonja the results of learning mathematics in synchronous online learning are higher than the learning outcomes in asynchronous online learning.
- 2 Teacher creativity is needed to design and create an online learning atmosphere that remains attractive and can increase student learning motivation. Online learning must still ensure interaction, stimulus, and response between educators and students, and between one learner and another.
- 3 The importance of understanding the character, preferences, abilities, and readiness of students as a learning and educational center in the implementation of online learning, so that in the selection of models and online learning media teachers can choose the right model and media and according to the needs of students.
4. The use of synchronous online learning is essentially inseparable from each other, but teachers need to regulate the intensity of its use according to the needs and abilities of teachers and students.

4 Conclusion

The study concludes, based on the evidence presented and discussed, that:

1. There is a significant difference between the mathematics learning outcomes of students, who take part in synchronous online learning and students who take part in asynchronous online learning.
2. The mathematics learning outcomes of students who take part in synchronous online learning are higher than the learning outcomes of students who take part in asynchronous online learning.
3. Based on the data from the questionnaire results, it was implied that the responses of students who chose to strongly agree with synchronous online learning were higher than those of students who took part in asynchronous online learning.

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