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The Comprehension of Deaf Students on Solid Geometry Concept through Blended Learning: Case Study

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Abstract

This study aimed to describe the comprehension of deaf students on solid geometry concept through blended learning. This case study used mix method with a pre-experimental design. The subjects of this study were deaf XI-graders in SMALBN across Bali and mathematics teachers. The study instruments were observation, interviews, and tests. The test used was valid with a reliability coefficient of 0.87 to then the results were analyzed using descriptive and inferential analysis. The results showed that the conceptual knowledge of students before the implementation of the blended learning model was 50% or did not meet the passing grade. However, after implementing the blended learning model the total number of students met the passing grade was 75%. The increase in the number of students meeting the passing grade did not show significant differences.

Keywords: Blended learning, geometry, conceptual knowledge, deaf students.s

Introduction

In the 2013 curriculum, mathematics is given at every level of education, to develop thinking skills, positive attitudes, and a creative spirit because of the importance of mathematics in life (Pandiangan, et al, 2020). This makes mathematics one of the basic sciences, both applied and reasoning so it has an important role in efforts to master science and technology (Rosdiana et al. 2019; Ningsih et al. 2019; Yunita, et al., 2019; Satoto et al., 2013). In the 2013 curriculum structure, for special-needs high school students, skills education gets a portion of 70% and other fields including mathematics only 30%.

The pandemic has required teachers and students to be able to use technology in learning. Learning from home has urged schools and teachers to use a different approach and learning system. (Bielinis, 2019). In the face-to-face learning process, one of the models suitable to the curriculum and government regulations is the blended learning model where learning is delivered online, while discussions are carried out face-to-face offline, so students will be trained and gain knowledge on their own (Ayasrah et al., 2022). According to Bervell and Umar (2020), the blended learning model combines several delivery strategies to provide the best and most productive experience. Then, what about special-needs students?

Law Number 8 of 2016 stipulates that persons with disabilities or special needs experience physical, intellectual, mental, and/or sensory limitations for a long time; so that interacting with the environment can experience obstacles and difficulties to participate fully and effectively with others. Special-needs students require special treatment, especially in terms of learning, apart from being limited in communication and knowledge; they also have limitations in learning mathematics.

The success of students in mathematics learning cannot only be seen and measured by how students are able to calculate or memorize formulas but can be seen and measured by their ability to understand a concept. The fact shows that learning outcomes in mathematics of deaf students are still very low (Astuti, 2013), and lower than normal students (Tanridiler, & Uzuner, 2015). This is predictable because conceptual knowledge in mathematics is low (Kang, 2023; Özgen, 2021). Likewise, with learning outcomes in geometry, students experience difficulties in learning geometry at almost all levels of education (Rosdiana, et al. 2019; Altan & Temel, 2023).

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Therefore, Bruner recommended that students should learn through active participation using concepts and principles to gain knowledge independently, one of the models suitable during a pandemic is a blended learning model that combines online and offline learning.

According to Gimenez, et al. (2005), deaf students have difficulty with geometric material, especially in generalizing shape properties; where they need more time than other students. Duffin & Simpson (2002) stated that students' understanding is seen from the ability to: (1) solve problems, (2) explain concepts, meaning students can recall what has been communicated to them; (3) use the concept in new content; (4) develop or rearrange a concept that has been learned. Having an understanding of a concept means that students have the ability to solve each problem correctly.

Based on preliminary data from mathematics teachers in SLBN in Klungkung, deaf students also have high curiosity about learning mathematics. However, they are a bit slow in understanding the material due to communication difficulties, so teachers need to repeat the topics that have been taught. In a pandemic situation, students experience learning difficulties because it is done online, and without the help of media or teaching aids for deaf students to understand a mathematical concept. This learning process certainly contradicts the opinion stating that deaf students are known as visual learners because they access more information with their eyes (Archbold, 2015; Marschark, et al, 2012). Monotonous learning can make students unable to develop the concept of fractions, squares, blocks, and others (Zhang, et al, 2014: 258). This causes students to only understand concepts limited to symbols without understanding the value of symbols in daily activities.

Based on previous studies, online learning alone is considered ineffective, because students still need directions from teachers, and direct learning in class through face-to-face is still very much needed by students, especially deaf students. Several studies in Indonesia also show that online learning has a negative impact on the motivation and learning outcomes of students (Basa & Hudaidah, 2021; Yohannes et al., 2021; Yunitasari & Hanifah, 2020). On the other hand, there are also those who reveal that online learning does not provide the same results, and sometimes shows contradictory results (Baltà-Salvador et al., 2021). However, on the other hand, Francis & Jacobsen (2013) showed that online discussion is an effective medium for improving the ability to write mathematical ideas, as well as De Noyelles & Foster (2015) stated that online discussion forums can build a sense of togetherness and cooperation. In addition, online learning has a positive impact on motivation and learning outcomes (Khurriyati et al., 2021; Chaidir, 2021; Yuliana, 2021), and students have positive perceptions of online learning (Dewi, et al, 2021). This indirectly shows that online learning contributes to the psychological factors of students. Especially in Bali, the combination of online and offline learning has in fact not been widely implemented as a whole and systematically for various reasons (Sudiarta, & Mahayukti, 2019). Then, what if this blended learning model is implemented in deaf special schools?

Based on the problems above, this study is interested in examining conceptual knowledge in geometry through the implementation of the blended learning model, because according to Kazu and Demirkol (2014), students who combine online and face-to-face learning achieve better learning outcomes. Albhnsawy and Aliweh (2016) stated that activities in the blended learning model offer many opportunities for teachers and students to receive feedback and exchange views. Ross and Bruce (2009) also affirmed that developing effective learning strategies both on-line and offline requires a continuous process as an effort to overcome learning difficulties, which was emphasized again by Surjono, et al (2017) that blended learning provides more benefits for students in terms of their achievements and higher participation rates.

In relation to the things described above, the problem studied in this study is how is the understanding of deaf students on solid geometry concepts (beams and cubes) after the implementation of the blended learning model?

Mathematics Learning for Deaf Students

One type of student with special needs is deaf students. They physically look like normal students, but problems occur when they engage in conversations because they find it difficult to follow conversations due to hearing loss (Marschark, et all, 2012; Convertino, et al, 2009; & 2015; Kemmery, & Compton, 2014). Although some deaf students do not lose their ability to hear, many deaf students tend to accept a secondary disability, namely deaf speech which results in a different range of intelligence from low to genius (Archbold, 2015; Koen, 2003). This is due to the low acquisition of information and understanding compared to normal students (Easterbrooks, 2011). As a result, deaf students need more time to learn to connect between mathematical concepts used in problem-solving (Pagliaro, & Ansell, 2012; Hyde, et al, 2003; Widodo, 2019). Mathematics learning for deaf students has the same goal as mathematics learning for normal students, namely for students to be able to think systematically, logically, analytically, creatively, critically and be able to collaborate. One topic that really needs mathematics is conceptual knowledge of geometry. Geometry is mathematics material taught at every level of education. Geometry is a branch of

mathematics to help students understand the properties and relationships between geometric elements (Ramdhani, 2017; Nurhasanah & Puspitasari, 2022). Clement & Battista (2004) stated that the purpose of learning geometry is to develop logical thinking, develop spatial intuition, continue to study mathematics further, and interpret arguments mathematically (Ghani & Zulkarnaen, 2020; Tahmir et al, 2019). In addition, geometry is the most relevant part for measuring problem solving abilities (Safrina, et al., 2014; Listiani, 2020; Aini & Suryowati, 2022).

Nevertheless, deafness does not necessarily mean that deaf students cannot follow the learning process. To obtain information, deaf students use senses that still function, such as the senses of sight, touch, taste, and smell. Therefore, their hearing problems can also be overcome with visual abilities, but for deaf students, study habits affect information acquisition, because they often get less information than normal students (Marschark, et al, 2017).

Conceptual Knowledge

Comprehension is an ability of a person to know and understand something (Netriwati, 2018). To understand something, one must be able to remember and recognize it. Understanding is very different from memorizing (Abidin & Tohir, 2019). Conceptual knowledge has a deeper meaning than memorization. Understanding a concept means restating using own language while memorizing only imitating what has been learned so that the pronunciation will be exactly the same as what is read (Umbara et al., 2021). Therefore conceptual knowledge is a very important part of the mathematics learning process. Conceptual knowledge is a very important skill component in learning. Conceptual knowledge is more meaningful when students construct it themselves. National Council of Teacher of Mathematics (NCTM) 2000 suggested that there are several things used in assessing the conceptual knowledge of students, namely as follows. 1. Restate the concept that has been learned in words only. 2. Identify which are examples or non-examples of the concept. 3. Apply concepts correctly in various situations (Maccini & Gagnon, 2002).

Method

Research Design

This study used a mix-method, a combination of quantitative and qualitative studies. According to Creswell (2012), the mix-method combines two study methods, namely quantitative and qualitative into a study activity, so that the data obtained will be more comprehensive, valid, reliable, and objective.

Population and Sample

The population is the total sample, namely mathematics teachers of XI-graders and XI-graders at SMALB N 1 Klungkung. This study used a one-group pretest-posttest design with a control group. The pretest (O1) was carried out before being given treatment and the posttest (O2) was carried out after being given treatment in this case, blended learning (Creswell, 2012).

Data Collection

Data were collected through documentation, interviews, observations, conceptual knowledge tests, and triangulation.

Data Analysis

To analyze quantitative and qualitative data, this study used descriptive and inferential statistics. In this case, quantitative

Table 1: Conceptual Knowledge Indicator

Indicator	*Score*	*Category*
Declare re-concept which has studied in your own words	2	Restate concepts that have been learned with own words correctly.
	1	Restate concepts that have been learned with own words but not quite right.
	0	Misrepresenting a concept.
Identify example or not example of concept	2	Identify which is an example or not an example of a concept correctly.
	1	Identify which is an example or not an example of a concept but is not yet appropriate.
	0	Incorrectly identified which includes examples or not an example of a concept.
Apply right concept correctly in various situation known information.	4	Applying concepts in various situations calculation and the final answer is correct.
	3	Correctly apply concepts in various situations, most of the calculations are correct and the answers are wrong.
	2	Correctly apply concepts in various situations, but the calculation and final answer is wrong.
	1	It is not entirely correct to apply the concept in various situations.

data analysis was used as the first method, while qualitative data analysis could explain more deeply about quantitative data. Qualitative data has more advantages than quantitative data because qualitative data is richer in terms of description and explanation (Miles, et al, 2013).

Findings

Based on the results of document, it was found that there were 6 students from SMALB B of 9th grade at SLBN 1 Klungkung, consisting of 4 boys and 2 girls. The following presents the results of interviews with students, who were assisted by accompanying teachers as follows. 1) As many as 83.3% said that mathematics teachers were fun, 16.7%, 2) Regarding the models and methods used by teachers, only 33.33% of students were in good condition, while 66.67% said that they were confusing. 3) There were 66.67% of students who said they were happy with online learning, but 33.33% of them said it was boring, 4) According to students learning mathematics online was pretty good (33.33%), students who expressed doubts doubt as much as 50% and those who say it was not good as much as 16.67%, 5) Problem faced by students when learning online 50% of students was the quota and 50% did not have cellphone and quota. 6) The process of implementing online learning was done by taking assignments to school and studying at home online were stated by 33.33% of students, and those who visited their homes were 50%, and 16.67% stated students who studied at school, 7). During the pandemic, 83.23% of students studied at home guided by their parents, 16.67% of them were guided by their older siblings. 8) Only 50% of the material delivered by teachers during the pandemic was understood, 33.33% of students said they sometimes understood, and 16.67% of students did not understand. 9). From the test questions related to cubes and blocks material that were given that were 66.67% of students who stated that they had difficulty understanding the surface area of cubes and blocks, while 33.33% stated that they had difficulty determining the volume of blocks and cubes. 10) During the pandemic, teachers gave learning videos to students, it turned out that 67.67% of students said they did not like it and 33.33% said they liked being given videos, 11) As many as 33.33% of students said they liked videos containing pictures, writing, in sign language, but 66.67% stated that they liked videos that only contained pictures and writing, and 100% of students wanted offline learning.

Observation of Offline Mathematics Learning Process

The results of observing learning activities during used conventional models, the learning process is more dominated by teachers and after the new volume material is implemented in blended learning model (online material) and offline discussion, but the discussion was dominated by teachers. It is due to the limitations of the students, but during the discussion the teachers used teaching aids in the form of blocks or cubes, so the students' responses were better, but it seemed that students were still confused in solving the questions, if their knowledge was different from the examples given by the teachers. These results showed that conceptual knowledge of students was still low and needs to be improved. Therefore teachers were trying to create a learning process that can involve students actively and help applying the concepts with students real-life experiences, so that students will be understand more the concepts and be able to see the benefits of mathematics. (Utari, 2019).

Test Results

During the test, there were only 4 deaf students involved, because 2 students were rarely present at school, or responded online, therefore these students were more often visited at their homes. Students involved in the study receive learning that was adapted to circumstances (online and offline) with a blended learning model.

Student test scores were obtained from the results of test 1 (subject to the surface area of cubes and blocks) before blended learning and test results 2 (subject to the volume of cubes and blocks) after the implementation of the blended learning model. The data that had been collected as a whole as seen in Table 2.

It is previously known that the passing grade of mathematics for senior high school level was 75. It means that more students passed test 2 than when they took test 1. To be more certain whether the implementation of the blended learning model has a significant impact, then it is continued with hypothesis testing with non-parametric considering the very little data, the results of as seen in Table 3.

H0: there is no difference in the conceptual knowledge mathematics test scores for SMALB deaf students before and after the implementation of the blended learning model

H1: Students conceptual knowledge mathematics test scores at SMALB deaf before and after implementing the blended learning model

Table 2: Mathematics Test Score

No	*Student's Code*	*Gender*	*1st Test Score*	*2nd Test Score*
1	B1	L	75	62.5
2	B2	L	40	100
3	B3	L	80	100
4	B4	L	60	100

Table 3: Rank

		N	*Mean Rank*	*Sum of Rank*
Before - After	Negative Ranks	1[a]	1.00	1.00
	Positive Ranks	3[b]	3.00	9.00
	Ties	0[c]		
	Total	4		

Table 4: Statistical Table

	Before - After
Z	-1.461[a]
Asymp. Sig. (2-tailed)	.144

The Z table value for alpha = 0.05 with the one-tailed hypothesis was 1.64. From the output it was obtained that the calculated Z value was 1.46, thus the Z calculated value was smaller than the Z table, as well as seen in Table 03 from the sig. value = 0.144 > 0.005 so that there is not enough evidence to reject H0, it means that there was no difference in the conceptual knowledge mathematics test scores of SMALB deaf students in the cube and block material before the implementation of the blended learning model and after the implementation of blended learning. The ocumentation of the offline learning process for SMALB deaf students was presented as shown in Figures 01, 02, 03 and 04.

Discussion

Based on the results in Table 2, the number of students who met the passing grade after the implementation of the blended learning model was greater than before the implementation of the blended learning model. When viewed from the material tested in test 1, students need to master the arithmetic operations of addition and multiplication along with the formulas used to determine the surface area of cubes and blocks. However, the increase in the number of students who met the passing grade was not significant. It is due to several errors occurring in some students when performing addition operations when working on cube surface area problems. There were some careless students in writing area units. Compared to the second test, almost all of the students could make less mistakes when doing multiplication operations and were able to write volume units correctly.

The findings of this study can be said to be in line with the results of Jeffrey, et al (2014) that showed the students who used blended learning in algebra learning to get better results compared to students who used traditional learning models, even though at the beginning of the study the teachers objected to using technology but because of the demands of the pandemic, in the end teachers were forced to adapt. Furthermore, Mozelius and Hettiarachchi (2017) states that the blended learning model is better than the conventional model, and the majority of students who participate in blended learning obtained higher learning outcomes. Likewise Lin, et al (2014) showed positive student responses to mathematics learning using the blended learning model, it is because according to Dziuban, et al (2018), that the blended learning model can create an effective learning environment, efficient communication, easy access better, and good learning evaluation.

Besides that, according to Abramovits, et al (2012) that mathematics learning materials through online sources can increase student curiosity, although not significantly. According to several researchers such as Shukla, et al (2020), Hwang et al., (2020) & Lage-Cala et al (2020) that online learning has many advantages because it can be done anytime and anywhere, so it is not bound by space and time. (Pangondian et al., 2019). It is also supported by the findings of Eryilmaz (2015) that when learning is carried out online it results in the decrease of student understanding , presumably experiencing loss learning, but students learning more effectively in a blended learning environment that is in line with the previous study. Learning was done offline using student mathematical understanding and was categorized as moderate.

Another advantage of the blended learning model is the ability of teachers and students to know more about applying technology in learning (Rahmi, & Sofayunanto, 2020), and be able to foster student learning independence (Oknisih, et al, 2019), emphasized again Kuo, et al (2014) that online learning is more student-centered that causes them to be able to bring up responsibility and autonomy in learning. But the drawback of implementing the blended learning model that requires a lot of time to prepare, both in terms of teachers preparing learning tools that require teachers to improve their skills in using online learning tools, and also in terms of how students adapt to online learning during a pandemic, especially regarding students with special needs (Gleason, 2016). Teachers must be able to make connections between conceptual knowledge mathematics and objects in the real world (Hannah, et al, 2016:17). It is important because students feel that understanding a mathematical concept will help them in the future. Therefore in mathematics learning, teachers and students must be directly involved.

Based on the results of the interviews, it showed that students less understood the concept of geometric material. Based on the results of the interviews, it was also found that students had not been able to develop the requirements

needed to solve the problem because the students were still fixated on memorizing formulas. Students only imitated the way of solving given by the teacher and have difficulty when they find questions with different solutions. Furthermore, it was also found that students lacked conceptual knowledge on several mathematics topics, even though students need mastery of conceptual knowledge to understand the material being taught and subsequent material. It is in line with Susanto (2013: 209) that states that understanding and mastering a material or concept is a prerequisite for mastering the next material.

Therefore teachers should be smart in selecting learning models and media that support the learning process. It is because according to Mariya, et al. (2013), learning effectiveness is not only determined by the learning model used, it is also important to use the right media to maximize students' learning outcomes. The use of manipulative learning aids accompanied by the application of appropriate learning models is expected to help teachers grow student understanding (Sugiman et al., 2018).

Visuals and lip reading play an important role for deaf students in understanding a problem (Marschark, et al, 2017). The use of visual-spatial schematic representation is a stronger positive predictor of mathematics problem solving performance for deaf students (Giustolisi, & Emmorey, 2018). Deaf students use the power of their visual activity as their strength in the learning process to improve language and communication development (Marlatt, 2014). However, they are generally slower at processing the information than normal students (Akram, 2013).

Based on interviews about the experiences of deaf accompanying teachers at the Klungkung SLB, many teachers complained about the difficulties of deaf students in geometry material. Students found it difficult to distinguish names between shapes. They considered all of them the same based on the shapes they observe. While the results of class observations that the author did when the teachers taught the material geometric shapes of blocks and cubes, there were deaf students who already understood blocks based on what they encountered in everyday life. Even though they took a long time to give their answers, when asked about blocks and how to calculate the contents of blocks, they used sign language and practiced with their body movements, with block and cube framework objects, and with blended learning to make students interested in learning mathematics (Pane, et al, 2014).

However, from the results of interviews with students, two of them did not understand when asked why they could not state their reasons. But students' minds had reflected the concept of blocks. However, from other geometric shapes, they still have difficulty distinguishing, for example between a cube and a block, they answer that it is a block. It is because cognitive development is not only closely related to intelligence or intelligence, but the hearing and communication skills for deaf students generally besides hearing loss also affects communication skills. Through all these stimuli or sensory information will be received for further transmission to the brain.

In learning activities, teachers must care and assist the students in developing conceptual knowledge (Barmby et al., 2014: 18). A good understanding of mathematical concepts will help students solve problems in mathematics and in other disciplines as well as problems in student daily activities. A good understanding of mathematical concepts will also help students think and reason in the formal world (Hannah et al., 2016: 16). A good understanding of mathematical concepts also helps students to develop careers into further studies, such as science and technology (Rasila et al., 2015: 150). Teachers only emphasize knowledge of mathematics to students but did not see the concepts students have. Teachers only view mathematics as a collection of knowledge that did not change to be taught and learned (Barmby, et al, 2014: 4).

Understanding the concept that is likened to the foundation of a building, where to build the next floor, the foundation of the building must be strong (Nugraheni & Sugiman, 2013:13). If students understand a concept correctly, it will be easier for students to understand the concept in the next lesson. Tuomainen (2016) revealed that the blended learning model can increase (1) student enthusiasm for learning because of the convenience and flexibility of time management; (2) student learning preferences; and (3) student independence to be more independent and responsible for their own learning.

Conclusion

Based on the results, conceptual knowledge of students on solid geometry material showed that only 50% of students met the passing grade before implementing the blended learning model, whereas after implementing blended learning, 75% of students met the passing grade and 25% did not meet the passing grade. However, this increase did not show a significant difference, even so, the results of this study are expected to make a small contribution to how blended learning can be used for deaf students in SMALB as an effort to increase the conceptual knowledge of students.

For teachers and schools, this study will serve as input on the conceptual knowledge of students during the pandemic, so that it can be a reference for finding alternative solutions to improving the conceptual knowledge of students and can be used as a contribution to thinking about being able to

always improve conceptual knowledge of students. For future researchers, this study is only on solid geometry material, therefore it is better to study other materials as well.

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