Analysis of Students' Learning Loss in Math in Padang City, Indonesia

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Abstract

COVID-19 caused the learning process to change from a face-to-face learning process to a distance learning process by using various applications. However, this learning process is also considered less effective in math because students' conceptual understanding is imperfect. The imperfection of this concept caused students to experience *learning loss*. This research aimed to analyze students' *learning loss* in elementary schools in mathematics subjects. This research used a qualitative research design with a case study type of research. This research involved 280 fifth-grade students from 4 elementary schools. The research results showed that students experienced *learning loss* in understanding geometry and fraction concepts. Students cannot solve math problems if the problem contains two concepts at once. According to the students, they did not understand these three topics well because when studying these topics, they carried out a distance learning process. Based on these findings, researchers concluded that students experienced *learning loss* in the high category, with 82% students affected. This study highlights the need for teachers to address *learning loss* that students experience in geometry and fraction materials. Thus, mathematics teachers can prepare learning tools to help students overcome *learning loss*.

Keywords: Pandemic, COVID-19, Math, Learning Loss

INTRODUCTION

A phenomenon that occurred at the end of the second decade of the 21st century, known as the COVID-19 pandemic, drastically changed all human activities, including education. The impact of the COVID-19 pandemic was felt directly by Indonesia in all sectors, including the education sector. On March 24, 2020, the entire learning process must be carried out from home known as distance learning. Distance learning, also known as e-learning or online learning, is a learning method that does not require students and instructors to be in the exact physical location (Belousova et al., 2022; Sayginer, 2023). It allows students to access learning materials, attend lectures, and participate in learning activities via the internet and other communication technologies (Cano, 2022; Turan-Güntepe et al., 2023).

The distance learning process provides many benefits to students and teachers (Altawalbeh & Al-Ajlouni, 2022; Köprülü et al., 2022). Benefits obtained by teachers and students include a more flexible learning process (Kotrikadze & Zharkova, 2021; Viktoria & Aida, 2020), training teachers' and students' technological literacy, providing students with sensitivity to change, and others (Belousova et al., 2022; Fresen, 2018). However, there are several disadvantages received by teachers and students in the distance learning process. These disadvantages are limited personal contact (Kantos et al., 2022; Mamluah & Maulidi, 2021), poor communication between students and teachers, independent learning provides obstacles for students (Debes, 2021; Lamanauskas & Makarskaitė-Petkevičienė, 2021;

Semenets-Orlova et al., 2022), and *learning loss* (Dron, 2022; Farhan & Lismandasari, 2022).

The learning process is fundamental in students' lives. Through the learning process, students can shape their knowledge, abilities, skills, and future (Mangera et al., 2023; Pereira & Gomes, 2022; Trongtorsak et al., 2021). However, there are times when students lose abilities as a result of the distance learning process or other consequences known as *learning loss*. This phenomenon is a phenomenon that students in Indonesia first encountered after the COVID-19 pandemic.

Learning loss is a term that describes the decline in learning abilities and academic achievement that occurs in students over a certain period (Munro, 2022; Todd & Romine, 2018). This phenomenon can occur in various situations, such as long holidays, changes in schools or learning environments, or emergency conditions such as pandemics (Lalas, 2021; Reynolds, 2022). *Learning loss* can be defined as a condition where students' abilities are interrupted due to an imperfect understanding of a concept. This is caused by the incomplete information students receive during the teaching and learning process (Farhan & Lismandasari, 2022; Kurniawan & Budiyono, 2021). Pratiwi (2021) said that *learning loss* is a phenomenon where students' knowledge does not reach the knowledge it should have, which occurs as a result of a teaching and learning process that is not optimal and incomplete. Students' lost abilities or skills range from half a year to one year (Toker, 2022; Zhdanov et al., 2022).

Learning loss is a condition of loss of knowledge and skills and a decline in student understanding due to the learning process not taking place as it should (Hanafiah et al., 2022; McNeish & Dumas, 2021). Nowadays, *learning loss* is one of the concerns teachers have for students (Rhamdan et al., 2021). This is because students who are expected to understand a concept perfectly can only understand a small part of the expected concept. Thus, it can be said that *learning loss* is a big problem in preparing Indonesia's golden generation (Muthmainnah & Rohmah, 2022; Widyasari et al., 2022).

Learning loss is a common phenomenon in countries with sub-tropical climates. This phenomenon is generally associated with the "summer phenomenon," which is a term that refers to an event where students often forget content between the end of the school year and the beginning of the next school year due to long holidays (Agarwala et al., 2022; Blaskó et al., 2021; de Leeuw et al., 2023). However, for Indonesia, *learning loss* is a new phenomenon that occurred as a result of the COVID-19 pandemic. *Learning loss* is experienced by every student, from elementary to senior high school.

One of the subjects studied by students in elementary school is mathematics (Brewster & Miller, 2023; Deringöl, 2022; Kaskens et al., 2023). As one of the compulsory subjects in elementary school, students are expected to be able to understand and master this subject well. However, most elementary school teachers in Padang City are concerned about the statement that many students in Padang City, Indonesia, experience *learning loss* in this subject. However, until now, no research has attempted to uncover the phenomenon of *learning loss* in elementary school students in this subject in Padang City, Indonesia. Research on *learning loss* has been widely conducted in Indonesia by several researchers, such as *learning loss* in college students (Kurniawan & Budiyono, 2021; Noviantari & Faridhoh, 2021; Parahita et al., 2022), *learning loss* in the Merdeka Curriculum (Jojor & Sihotang, 2022), and *learning*

loss in high school students (Aryanti, 2023). However, until now, there has been no research on elementary school students' *learning loss* in mathematics in Padang City, Indonesia.

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Research on *learning loss* in elementary schools is one of the essential things to do. This is because teachers at the next level can prepare various things to help students overcome their *learning loss* (Muskita et al., 2022). This preparation can only be done if the students are known to be experiencing *learning loss* (Donnelly & Patrinos, 2022; Muskita et al., 2022). Research on *learning loss* in mathematics in elementary schools is also fundamental. This is because mathematics is one of the subjects that is often avoided by students (Song et al., 2023). After all, it is considered a complex subject. If mathematics is adequately studied, it will be found that this subject is one of the subjects that is very important for students to understand. If teachers at the next level know that some students are experiencing *learning loss*, teachers can prepare learning tools to help students overcome *learning loss*. Thus, research is needed to analyze elementary school students' *learning loss* in mathematics. Therefore, this study aims to analyze and reveal the phenomenon of elementary school students' *learning loss* in mathematics in Padang City, Indonesia.

METHODS

This research was conducted to determine the extent of student *learning loss* in mathematics subjects after the COVID-19 pandemic. Through research, student *learning loss* in mathematics subjects will be revealed. Therefore, a qualitative research design was employed, which allowed researchers to consider all research documents holistically. A case study approach was used to specifically investigate the *learning loss* in mathematics among elementary school students post-pandemic.

A case study is a type of research that attempts to reveal various facts and phenomena that occur in society. Apart from that, case studies attempt to explore, understand, and explain various facts and phenomena that occur in the classroom (Sartono & Karso, 2020). In this research, researchers attempted

to reveal and explain the facts and phenomena of elementary school students' *learning loss* in mathematics after the COVID-19 pandemic.

This research involved fifth-grade elementary school students as respondents. The number of students used as respondents in this research was 280 students. Respondents were drawn from 4 elementary schools: State Elementary School 11 Lubuk Buaya (112 respondents), State Elementary School Percobaan Padang (56 respondents), State Elementary School 01 Ulak Karang (56 respondents), and Elementary School Pembangunan UNP (56 respondents). These schools are considered among the best elementary schools in Padang, and serve as model schools in the region.

This research used tests as a tool for collecting data. The researchers administered math problems to the respondents to gather data. The test consisted of ten questions covering three mathematical topics: two-dimensional figures, fractions, and three-dimensional figures. Before the questions were given to students, the researcher first conducted validation which aimed to convince the researcher that the questions used as a data collection tool were suitable for use. This validation was conducted by three experts with relevant expertise. The results of this test provided the main data in this research.

The data obtained from the test were then analyzed to explore and reveal the facts and phenomena related to elementary school students' *learning loss* in mathematics following the pandemic. Before analyzing the data, the researchers checked the accuracy of the data, organized it, encoded it, and classified it (Soon & Lauridsen, 2021; Watson-Held et al., 2024). These steps were taken to facilitate the data analysis process. The analysis was conducted based on the specific mathematics topics in the test, in line with the coding performed earlier. The results of the analysis were then described descriptively to illustrate the extent of *learning loss* in mathematics among elementary school students. In general, *learning loss* categories can be divided into three (see Table 1) (Syamsiah & Pada, 2023).

Table 1. Category of *learning loss*

Category	Indicator
High	More than 74% of respondents experience *learning loss*
Middle	Respondents experience *learning loss* between 62% to 74%
Low	Less than 62% of respondents experience *learning loss*

RESULTS AND DISCUSSION

Researchers conducted an in-depth analysis of the data obtained after respondents completed the questions. This was done to ensure the accuracy of the results concerning student *learning loss* in mathematics. The questions covered three topics: two-dimensional figures, fractions, and three-dimensional figures. These topics were part of the curriculum that respondents had studied in previous classes during distance learning. The results of the analysis of student *learning loss* on these three topics are as follows.

Two-Dimensional Figure

Two-dimensional figures are one of the mathematics topics that students must understand. The concept of two-dimensional figures is one of the topics studied by students in elementary school from third to sixth grade. This topic is very helpful for students in their daily life (Budiarto et al., 2021; Masfingatin et al., 2020). This is because students in their lives often face the concept of two-dimensional figures. For example, the concept of two-dimensional figures can help students divide paper into square or rectangular shapes, and there are many more examples of using the concept of two-dimensional figures in students' lives. Therefore, understanding and mastering this topic is a must for students (Pradana & Sholikhah, 2023; Sari et al., 2023).

Based on the analysis, the researchers found that 196 respondents experienced *learning loss* in the topic of two-dimensional figures. This can be seen in the respondents' answers to questions about flat figures. In answering the two-dimensional figure question, the respondent's answer was not by the two-dimensional figure concept. In a picture question, respondents must find the perimeter of a triangle based on the Figure 1.
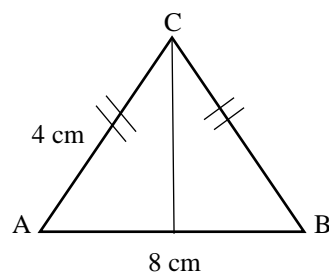

Figure 1. Question of triangle

Respondents answered the question above by incorrectly adding the lengths of sides AC and AB, while ignoring side BC because it was not explicitly labeled with a length. As a result, the respondents' answer was only 12 cm (see Figure 2). To get the correct answer to the question above, the respondent should add up side AB, side AC, and side BC. The length of side BC should be inferred to be equal to that of side AC, as both sides were marked with the same symbol "\\".
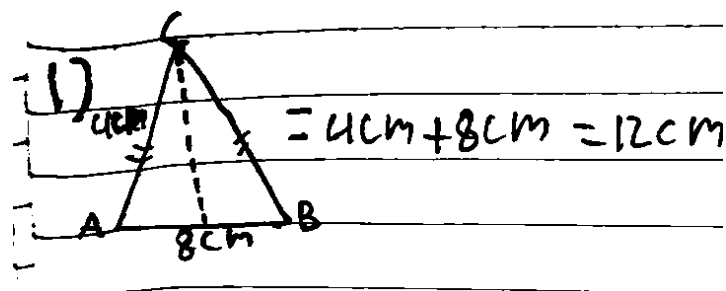

Figure 2. Student's answer about two-dimensional figures

Additionally, respondents also demonstrated *learning loss* when applying the formula for two-dimensional figures. In another question, respondents were asked to determine the area of a rectangle whose length was 50 meters and its perimeter was 120 meters. Some respondents incorrectly answered by dividing the perimeter by the area of the rectangle, while others multiplied the length by the perimeter. Both approaches resulted in incorrect answers. These two answers cause respondents not to get the correct results.

To correctly solve this problem, respondents should have first used the formula for the perimeter of a rectangle to find the width. Once the width was determined, they could then calculate the area by multiplying the length by the width. Besides these two questions, there were three questions about other two-dimensional figures, and the majority of respondents answered these three questions in the same way as the previous two questions. Based on these findings, the researchers concluded that students experienced a significant degree of high *learning loss* on the topic of two-dimensional figures, with 80% of respondents showing difficulties.

Based on the findings above, it was determined that students experienced the lowest *learning loss* on the topic of two-dimensional figures. This concept is one of the concepts that is considered very difficult for students to understand (Cumino et al., 2021; Yazici Arici et al., 2023). This is also evident from the test results and student recognition regarding this topic. Therefore, every teacher is expected to be able to conduct a learning process that can help students understand this topic well and in-depth (Aydemir et al., 2023; Trongtorsak et al., 2021). In addition, the learning process must also be able to help students overcome their *learning loss* on this topic.

Fraction

Fractions are one of the essential topics in math. This topic is a topic that must be understood and mastered by students (Low et al., 2020; Tossavainen & Helenius, 2024). This is because fractions are one of the topics in mathematics that students will always encounter in their lives (Abbas et al., 2022; Laidin & Tengah, 2021). For example, students can apply the concept of fractions when dividing a pizza or apples, among other situations. Therefore, understanding and mastering fractions is a must for students. Fractions are typically introduced to students in elementary school, starting from grade 3 and continuing through grade 6.

Based on the researcher's analysis, it was found that a higher number of respondents experienced *learning loss* in the topic of fractions compared to the previous topic, with 218 respondents affected. Respondents' *learning loss* can be shown from their answers in solving questions about fractions. The researchers observed that the respondents' answers did not align with the correct concepts of fractions. For instance, in a question that required solving mixed operations involving ordinary fractions, percentages, and decimals (e.g., "$\frac{1}{2} + \frac{1}{4} - 20\% + 0{,}2$"), respondents were asked to solve these different types of operations. The questions shown in Figure 3.

In a coloring contest, students are asked to color a square picture. 20% of the square should be colored green, ¼ blue, 1/3 yellow, 0.2 black, and the rest red. Calculate the portion of the square that is colored red.

Figure 3. Example of fraction questions

In this question, the majority of respondents added the ordinary fraction ($\frac{1}{2}$) to the ordinary fraction ($\frac{1}{4}$). After adding these two fractions, many respondents then incorrectly subtracted $\frac{3}{4}$ from 20% without converting the percentage to an ordinary fraction or converting $\frac{3}{4}$ into a percentage. As a result, the majority of respondents were unable to complete correctly. To correctly solve this problem, respondents should have first converted the percentage to an ordinary fraction or converted the fraction ($\frac{3}{4}$) to a percentage before performing the subtraction. The final result should then be added to 0.2 (see Figure 4).

Figure 4. Student's answer about fraction

In another question, respondents were asked to determine the remaining portion of a red square if 20% was green, $\frac{1}{4}$ was blue, $\frac{1}{3}$ was yellow, and 0,2 was black. In this question, 218 respondents were unable to complete this question till the end. Most respondents only added the ordinary fractions $\frac{1}{4}$ and $\frac{1}{3}$ without conducting operations on other fractions (see Figure 5a). Respondents should carry out operations such as "1-(20% + $\frac{1}{4}$ + $\frac{1}{3}$ + 0,2)" or use other methods which can solve the problem (see Figure 5b).

(a)   (b)

Figure 5. Student's answer about fraction

In this question, researchers found that respondents did not experience *learning loss* in ordinary fractions. However, in the others, respondents experienced high *learning loss*, i.e., 78%. According to respondents, during the distance learning process, they rarely practiced solving questions about decimal fractions and percentages. Based on the findings above, the researchers concluded that students experienced high *learning loss* on the topics of percent and decimal fractions.

Based on the findings above, students also experienced a significant *learning loss* on the topic of fractions. This topic is also considered difficult for students to understand (Sukasno et al., 2024; Tastepe, 2023). This was proven by the test results and students' recognition of fractions. The difficulty in understanding fractions stems from a lack of in-depth comprehension of the concept (Resnick et al., 2023). In addition, students also do not understand the types of fractions well. On the one hand, students need to understand the types of fractions in depth to understand fraction operations. On the other hand, students need to understand the basic concept of fractions to understand the types of fractions (Braithwaite & Siegler, 2021; Johar et al., 2024). Therefore, the learning process must be designed to help students understand fractions accurately and thoroughly. Thus, students can overcome their *learning loss*.

A learning process that is unapplied well will cause problems with students' understanding of a particular concept (Banat, 2022; Mulhamah et al., 2023). By understanding that the topic of fractions is difficult for students to understand, a teacher should implement a learning process that supports students in understanding this topic (Huang et al., 2022; Tastepe, 2023). This is crucial because an ineffective learning process can exacerbate *learning loss* in students.

Three-Dimensional Figure

Three-dimensional figures are one of the topics that students study in elementary school, typically from third to sixth grade. Like the two topics above, this topic is also an essential topic that students in elementary school must understand and master. The concept of geometric shapes is fundamental in mathematics and is something that students will encounter throughout their lives (Nursyahidah et al., 2023; Tessema et al., 2024). For example, students can use this concept to determine the amount of water that should be put into an aquarium. Students can also use this concept to determine the amount of syrup that can be held in a bottle, and there are many other uses of this concept in life. Therefore, it is crucial for students to understand and master the concept of geometric shapes (Hu et al., 2019; Ilgün et al., 2023).

Based on the researchers' analysis, it was found that more respondents experienced *learning loss* on this topic compared to the two previous topics. Respondents who experienced *learning loss* on this topic were 230 respondents. This shows that this topic has quite a big influence on students' *learning loss* in Padang City, Indonesia. The analysis of respondents' answers revealed that they did not properly understand this concept. In one question, respondents had to determine the volume of a cube whose surface area was 300 cm^2. The majority of respondents incorrectly answered with "$\sqrt[2]{300}$", and were unable to find the correct answer.

In this question, the correct answer should be "$300 \div 6 = 50$ cm". After determining the cube's edge length, the respondent can then calculate the volume as $50\ cm \times 50\ cm \times 50\ cm = 125.000\ cm^3$. Thus, the respondent will find the volume of the cube. Student's answer about this

question shown in Figure 6.

Figure 6. Student's answer about three-dimensional figures

Based on the respondents' confession, they answered "$\sqrt[2]{300}$" because "300 cm^2" has square "2", so the respondents thought that the answer was "$\sqrt[2]{300}$". Then, in other questions, respondents had to calculate the volume of a cube-shaped pool. The pool's length of edge was 4 meters, and a quarter of the pool was filled with water. Respondents had to find the volume of the pool that was not filled. The majority of respondents only answered with $4\ m \times\ 4\ m \times 4\ m$ so they could not find the correct final answer (see Figure 7).

(a)   (b)

Figure 7. Student's answer about three-dimensional figures

In this question, respondents should answer by carrying out operations such as $(4\ m \times\ 4\ m \times 4\ m) - ((\frac{1}{4} 4\ m) \times\ 4\ m \times 4\ m)$. Respondents could also solve the problem by illustrating the question with pictures or analyzing an image to deduce the correct answer. Other methods could also have been used to approach the problem.

Based on the respondents' confessions who answered incorrectly, they did not know how to use "$\frac{1}{4}$" in this question. Although they admitted that they had studied fractions and geometric shapes in 4th grade, they did not understand how to use "$\frac{1}{4}$" in the problem. Based on the findings above, the researchers concluded that students experienced high *learning loss* on this topic, i.e., 87%.

The findings above illustrate that students' *learning loss* in elementary schools in Padang City, Indonesia, can be categorized as high. Researchers identified that one of the primary reasons for this significant student *learning loss* is the suboptimal learning process in previous years. During this period, the learning process was conducted through distance learning, which did not allow students to gain an in-depth understanding of the concepts being taught. As a result, students have experienced considerable *learning loss*.

Addressing the high *learning loss* among students is the responsibility of every teacher, who must ensure that learning topics are taught in depth following the COVID-19 pandemic. This situation is also the responsibility of researchers and other researchers to find strategies, approaches, method, or learning models that can help students get out of a state of *learning loss*. Researchers and other researchers are also expected to find learning methods or models to anticipate *learning loss* in the future.

Based on the findings above, researchers concluded that students experienced significant *learning loss* in the topic of three-dimensional figures. Of the three topics examined in this research, this topic had the highest number of students affected by *learning loss*. Based on test results and student confessions, researchers found that students experienced a *learning loss* in understanding the concept of three-dimensional figure. This topic is one of the topics that is considered difficult in math (Aydemir et al., 2023; Zhang et al., 2020). Therefore, teachers are expected to be able to conduct learning processes that help students understand this topic post-pandemic (Juman et al., 2022) especially for students at elementary schools (Yegorina et al., 2021). The *learning loss* observed in this topic was largely attributed to the less effective learning processes during the COVID-19 pandemic. A less effective learning process will cause students' understanding of a concept to be imperfect (Doz et al., 2022; Gómez-García et al., 2021).

The findings above prove that *learning loss* at elementary schools, especially in Padang City, is real, and it can be said to be high. This should be a primary focus for teachers and researchers, who must work together to find solutions to address these challenges. Moreover, it is essential for teachers and researchers to develop strategies to prevent such *learning loss* from occurring in the future.

CONCLUSION

Based on the analysis of the results and discussion above, it can be concluded that students in Padang City, Indonesia, experience significant *learning loss*. This *learning loss* is evident in three mathematics topics: two-dimensional figures, fractions, and three-dimensional figures. Students experienced the lowest *learning loss* on the topic of two-dimensional geometric shapes and the highest on the topic of three-dimensional geometric shapes. The research indicates that one of the primary factors contributing to student *learning loss* is the ineffective learning process during the COVID-19 pandemic. The findings of this study can serve as a reference for teachers in designing effective learning processes that can help students reduce and eliminate *learning loss*. Additionally, this study highlights the importance of addressing *learning loss* in geometry and fractions, enabling mathematics teachers to develop targeted learning tools to help students overcome these challenges.

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