JPII 11(3) (2022) 500-510

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

IMPLICATIONS OF ONLINE LEARNING: TRENDS OF SCIENCE MISCONCEPTIONS ABOUT FORCES IN ELEMENTARY SCHOOL

E. Munastiwi*[1], B. Saputro[2], S. Fatonah[3], E. Suhendro[4]

[1,3,4]Universitas Islam Negeri Sunan Kalijaga, Indonesia
[2]Universitas Islam Negeri Salatiga, Indonesia

DOI: 10.15294/jpii.v11i3.37696

Accepted: July 15th 2022. Approved: September 29th 2022. Published: September 30th 2022

ABSTRACT

This study aims to understand the tendency of science misconceptions about "forces" and to distinguish the influence of school origin on students' misconceptions. The research method is a quantitative experimental survey. A total of 83 fourth-grade elementary school students from public school 1 (School A), private school 2 (School B), and private school 3 (School C) were involved in this study. Data is collected through online surveys. Teachers and researchers formulated question instruments in the form of quizzes. Before being distributed, the synchronization and verification stages of the material are carried out. Then the quiz is distributed to students via WhatsApp during an online class. After 15 minutes, students return the answers to the class teacher in photos via WhatsApp to be evaluated and graded. The results show that the average level of students' misconceptions was relatively low. However, the level of individual misconceptions tended to be high, proving that the development of learning practices needs to pay attention to conceptual understanding. Students misconceptions should not occur, especially in science learning. This study concludes that there are differences in the level of misconceptions between clusters in science learning. Students in each cluster experienced similar obstacles. The researchers suggest an effort to adjust the learning model on the instructional, interaction, supervision, and independent learning models.

Keywords: individual; misconception; obstacle; performance; teaching

INTRODUCTION

The COVID-19 outbreak, which has lasted more than a year, has significantly impacted educational practice in Indonesia (Rulandari, 2020). One of the visible impacts is the implementation of online learning, which is the new normal in educational practice (Callo & Yazon, 2020). Unfortunately, implementing online learning in response to the COVID-19 pandemic has created new problems for students, especially at the elementary level (Putri et al., 2020). One obvious indication is the decline in student achievement and the increase in misconceptions (Callis-Duehl et al., 2018). This indication needs attention from stakeholders in the education sector because education aims not only for students to draw the correct conclusions but also to build conceptual understanding from their knowledge.

The decline in performance in teaching and learning activities is an essential issue for today's online learning practice (Mahdy, 2020). Lack of interaction between teachers and students causes students to be stressed because of difficulties in receiving and understanding lessons (Pozo-Rico et al., 2020). In conventional educational practice, teachers have adequate time and space to teach, monitor, and evaluate students. Thus, students can obtain optimal educational services. However, the restrictions on social activities due to the COVID-19 pandemic prompted a policy to prohibit implementing educational activities as usual (face-to-face) so that comprehensive teaching activities were impossible (Mukhtar et al.,

***Correspondence Address**
E-mail: erni.munastiwi@uin-suka.ac.id

2020). Educational curriculum adjustments are made to overcome learning achievement problems by implementing online education practices (Adedoyin & Soykan, 2020; Tria, 2020). Therefore, the preparation of an educational curriculum related to lesson plans is adjusted to the situation and conditions. The form and content of lesson plans are simplified.

The current practice of online education is a manifestation of the practice of remote emergency education during the COVID-19 pandemic (Bozgun et al., 2022; Ndzinisa & Dlamini, 2022). However, the online education practice that is suddenly applied can affect learning performance. One of the leading causes is the unpreparedness of infrastructure and the lack of skills of educators and students in carrying out online learning practices (Garad et al., 2021). The increase in students' misconceptions is one indicator that shows a decline in learning performance (Tam, 2022). Misconceptions occur when students fail to understand a phenomenon's principle or working mechanism (Handhika et al., 2015; Üce & Ceyhan, 2019). This misconception causes students to be unable to provide a comprehensive explanation of the phenomenon. The increase in students' misconceptions during online learning practices decreases learning intensity (Tam, 2022). A further implication of misconceptions is the students' inability to implement and uncover concepts, ideas, and mechanisms based on known phenomena (Liu & Fang, 2016). Misconceptions have the potential to occur as a result of emergency learning situations and conditions.

Science is a subject that has the potential to experience a significant increase in misconceptions due to the practice of online education. Misconceptions are often found in science learning, even in conventional educational practices (Brault Foisy et al., 2015; Tompo et al., 2016). The occurrence of misconceptions in science learning is higher in the group of beginner learners (Vosniadou & Skopeliti, 2017; Liu & Fang, 2021). In the education curriculum in Indonesia, science is officially taught for the first time in the fourth grade of elementary school, making scientific concepts new to them. Science is knowledge about specific components, principles, and mechanisms that we can find in our daily activities (Saefudin & Saputri, 2018). Therefore, failure to understand conceptions in science subjects will affect students' abilities later. Science is a collaboration between several subjects, including physics, chemistry, and biology. This subject is vital in developing students' scientific characters for the later development of science and technology (Stuckey et al., 2013). Students are trained to think critically and work systematically and measurably through science.

Understanding the concept of knowledge is an essential part of the learning process. Conception is the theoretical aspect of a phenomenon (Ring-Whalen et al., 2018). Conception is needed to construct a reasonable deduction or argument that leads to the correct answer (Gurel et al., 2015). Conceptual understanding is also needed in science learning because the learning involves various objects, principles, and mechanisms (So et al., 2019). Therefore, misconceptions among students, especially at the elementary level, receive serious attention (Yang & Lin, 2015). This statement is supported by many studies on conception, such as developing instruments, prevalence, causing factors, and strategies to avoid misconceptions (Kumandaş et al., 2019; Zhang et al., 2019). Understanding the factors that cause misconceptions is needed to determine the right strategy to overcome students' misconception problems (Azid et al., 2022). Increased exploration related to misconceptions is currently very relevant due to online education practices applied in various places. The existence of provisions for online learning, of course, fundamentally changes the education model, which is feared to impact students' learning performance (González & Bonal, 2021).

Misconception assessment is essential, especially in online education during the COVID-19 pandemic (Wahyono & Susetyarini, 2021). Fundamental changes in educational practice due to the COVID-19 pandemic are proven to significantly impact changes in students' learning performance (Andersen et al., 2022). Although this change is understandable, improvement efforts must be continued to maintain learning performance optimally under any conditions (Gamage et al., 2020; Hall et al., 2020). These efforts include reducing the symptoms of misconceptions in students. Therefore, accurate information related to students' misconceptions is needed as a reference for evaluation. Teachers must make appropriate teaching materials by considering causing factors of misconceptions (Özerem, 2012). Thus, the effectiveness of online teaching activities can be increased.

Misconceptions in science are often found at various levels of education (Kumandaş et al., 2019). Vosniadou and Skopeliti (2017) found that third and fifth-grade students did not understand the scientific conception of the day and night cycle. It is triggered by the students' knowledge only obtained from reading. The misconceptions occur not only in students but also in teachers or prospective teachers (Saribas & Ceyhan, 2015;

Taban & Kiray, 2021). Students' misconceptions of similar causes regarding force and energy were also reported by Liu and Fang (2021). Their research shows that practice can reduce misconceptions, but it only applies to the conception of basic to low-level knowledge. Referring to other research results, Zajkov et al. (2017) find that textbooks can be a source of students' misconceptions because the misconceptions in the book or the low taxonomy of exercise questions are not proportional to the level of student's cognitive development.

Kurniawati et al. (2019) found misconceptions in physics learning related to Newton's law in tenth-grade students. On the other hand, Prodjosantoso et al. (2019) found that most tenth graders also experienced misconceptions in learning chemistry about ionic and covalent bonds. The misconception about adsorption in first-year university students (Nandiyanto et al., 2022) is caused by differences in the information received during school. These findings indicate that misconceptions occur because students do not receive the information correctly. According to Erman (2017), several factors cause misconception, such as incomplete information, difficulty in understanding the basic concept of the learned topic, and lack of effective communication between teachers and students. This emphasizes the potential of misconception occurrence during the COVID-19-driven remote learning.

The research results of Zhang et al. (2019) on the concept of energy find that various factors, such as personal experience, cognitive abilities, and social interaction, contribute to the complex learning process that forms misconceptions. This finding indicates a broader risk of misconceptions during online learning practices. Along with the massive integration of online learning, experimental-based science teaching is also experiencing obstacles (Kelley, 2020). On the other hand, online learning demands students to study independently (Morris, 2021). The learning process without adequate assistance has resulted in broader misconceptions (Cukurova et al., 2018).

The COVID-19 outbreak has driven the engagement of the online education model. Unfortunately, online education has a greater vulnerability in causing misconceptions. Wendt and Rockinson-Szapkiw (2014) found that students exposed to online learning environments have an increased misconception compared to the traditional learning environment.

Science is a complex subject for elementary school students. Therefore, a comprehensive explanation is needed so students can understand it well. Unfortunately, comprehensive teaching is difficult in today's conditions when teaching and learning activities must be carried out online. This situation raises the question of the trend of misunderstanding among grade 4 elementary school students, especially in the science subject. The research questions of this study are: 1) How is the misconception occurring in 4th-grade elementary school students? 2) How significant is the difference in schools' performance in overcoming misconceptions in science? Therefore, this study aims to understand the tendency of misconceptions in science subjects and to distinguish the impact of school origin on the misconceptions of 4th-grade elementary school students. The occurrence of misconceptions due to online learning practices is inevitable, but how high the level of misconceptions occurs is a parameter that needs a more in-depth evaluation. On the other hand, the pattern of education applied to each school is thought to influence students' understanding ability in online education.

METHODS

This research was conducted through an experimental survey referring to Smyth et al. (2019). Experimental surveys are conducted based on treatment designs or specific conditions. The study was carried out through the following stages: 1) experiment design, 2) data collection (misconception assessment), 3) data processing and 4) data analysis. Step by step process of the research is shown in Figure 1.

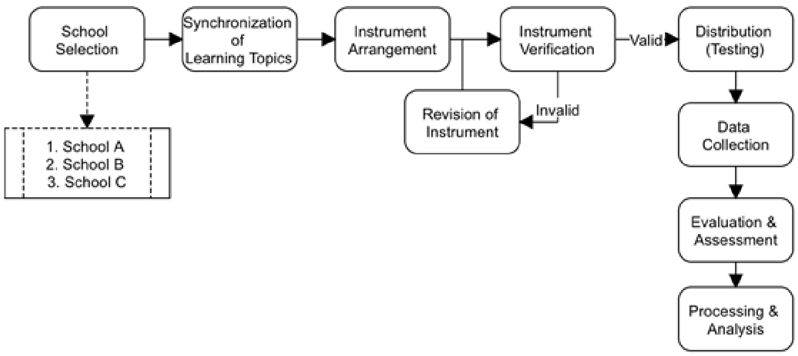

Figure 1. Research Flow

A single-factor, independent measures design was applied in the experiment. The independent variable of this research was the group of respondents based on the categories of public and private schools. Differences in learning outcomes have been identified between the school types (Thapa, 2015; Baum & Riley, 2019). Due to the different circumstances, teachers from both school types attain different chances of self-development and attitudes toward teaching practice (Qoyyimah, 2018). From the students' side, differences in schooling, parenting, and access to technology between public and private schools during the COVID-19 pandemic emphasize the distinction of learning achievements (Ullah & Ali, 2021).

The participants of this study were 4th-grade elementary school students from public school (School A), private school 1 (School B), and private school 2 (School C). The characteristics of the school cluster are as follows: 1) School A is a government-owned public school, accredited A; 2) School B is a private school owned by an Islamic foundation, accredited A; 3) School C is a private school owned by a Catholic foundation, accredited A. Basis school groupings selected are favorite schools with A accreditation from different managers: the government or state schools, Islamic foundation private schools, and Catholic foundation private schools.

School samples were taken through convenience sampling. Convenience sampling was used due to its easiness of recruitment and the willingness to participate of the selected volunteers (Brodaty et al., 2014). The schools were also determined purposively to represent each cluster. The consideration for selecting the school sample was that the quality of the schools is good and equal. A total of 80 students were involved in this study, including 30 participants from School A, 28 from School B, and 22 from School C. Inclusion criteria are students who have studied science with the same learning topic. The learning topic delivered during the research was "forces."

Data was collected through an online survey. Carrying an online survey is considered as a flexible method and advantageous for the researcher and participants (Braun et al., 2021). The test instrument was prepared jointly by teachers and researchers about learning for students. The instrument used in the research was a one-level diagnostic test, where students were expected to explain the question items. The questions were formulated based on the material in the textbooks used as fourth-grade learning materials related to gravitational force, magnetic force, electric force, and frictional force. Instrument validation was carried out through peer-to-peer discussions with subject teachers from each school. The validated test instruments were sent to students. The instrument consisted of seven second-level questions with two independent answers in the form of conceptual answers and conclusions. Therefore, students were likely to answer only one of the two expected answers correctly. As feedback, students sent their worksheets in digital format, either scanned or photos. The teacher then forwarded the answer to the researchers. The research instrument used in the study is presented in Figure 2.

1. What will happen if a stone is thrown upwards? Tell!
2. Why can a compass be used as a guide?
3. When the cable connecting the lamp to the power source is cut, what will happen? Why?
4. Why do we need gravity?
5. What forces act on the wheels of the car as they move? Tell!
6. Can static electricity be used to light a lamp? Why?
7. Why is muscle force needed when making pottery?

Figure 2. Research Instrument

Data analysis was performed using cross-tabulation with a chi-square test and ANOVA test. Cross-tabulation was used to identify the population of classified groups between variables (Atav et al., 2015). In this case, a comparison was performed between students' conceptual understanding and the concluding ability between clusters for the designated instrument. Instruments are arranged with consideration to adjust learning practices and learning objectives. The learning objectives are to find out the understanding of science concepts. Before being implemented, the instrument was validated by fourth-grade elementary school teachers and elementary school curriculum experts. Thus, whether the students' answers tend to be based on the correct concept understanding or not can be seen. ANOVA was used to measure the differences between the designed groups (Wang et al., 2017), in this case, compared the average achievement between schools in the context of understanding concepts and concluding. This information can be used to identify gaps in students' learning performance. Data analysis was performed using SPSS with a 95% confidence interval.

RESULTS AND DISCUSSION

In this case, the relevance between school clusters regarding students, curriculum, and materials taught to students to determine understanding of the science concepts studied were the same, namely: 1) the fourth-grade elementary school students; 2) the curriculum used is the 2013 elementary school curriculum; 3) material theme: about forces; 4) the number of questions is ten items. From the perspective of Piaget's theory of cognitive development, it is stated that there are four stages: 1) the sensorimotor stage (0-2 years); 2) the preoperational stage (2-7 years); 3) the concrete operational stage (7-12 years); 4) the formal operational stage (12-19). Thus, fourth-grade elementary school students are included in the third stage. According to Piaget, at this stage, children can solve hypothetical problems (Aubrey & Riley, 2019).

The observations' results show differences in the fourth-grade students' science learning outcomes regarding "forces." Data processing results show that misconceptions can be found in each student and question item. This finding indicates that all students cannot fully understand the given science material, and none of the question items are fully understood. However, despite experiencing misconceptions, students can conclude correctly. Therefore, students' achievements in conception are lower than the conclusion. These results indicate that a correct understanding of the concept is not required to draw correct conclusions. On the other hand, this finding also shows that understanding concepts tends to be more difficult than concluding.

Differences in students' ability to understand concepts and conclusions need to be understood more deeply. The first factor to be investigated is the difficulty of the questions. The students' level of completeness indicates the difficulty of the questions. Since the number of participants differed between clusters, the frequency distribution of students' conceptions and conclusions was analyzed according to their proportions. Table 1 shows the distribution of students' population respective to their conceptual understanding and conclusion-drawing performance.

Table 1. Evaluation Based on Students' Performance Questions

No	Cluster	Proportion (%)	
		Students with Correct Conceptions	**Students with Correct Conclusions**
1.	School A	13.33 – 90.00 (51.90 ± 27.88)[a]	53.33 – 96.67 (83.33 ± 14.66)[a]
2.	School B	0.00 – 92.86 (59.69 ± 34.24)[b]	57.14 – 96.43 (83.16 ± 16.20)[a]
3.	School C	0.00 – 72.73 (50.65 ± 29.27)[a]	45.45 – 95.45 (79.22 ± 19.26)[a]
	Total	0.00 – 92.86 (54.08 ± 29.30)	45.45 – 96.67 (81.91 ± 16.07)

Note: Rows in the same column with different letters show significant differences.

Refer to the result presented in Table 1, students' answering abilities ranged from 0 – 92.86% (mean: 54.08 ± 29.30%) and 45.45 – 96.67% (mean: 81.91 ± 16.07%) in concepts and conclusions. These results indicate that students' ability to understand the concept of "forces" ranges from very low to very high. However, their ability to conclude was in the medium to very high category.

Based on Table 1, there are variations in students' conceptual understanding of "forces." However, most of the students can give the right conclusion. In general, each cluster's average level of misconception is around 50%. The data obtained show a question where none of the students from School B and School C had the correct conception. Data analysis with chi-square shows a significant difference in the proportion of conception. However, the comparison of the conclusion does not show a significant difference. Data analysis shows the F index of 4.670 ($p = 0.010$) and 2.016 ($p = 0.134$) for conception and conclusion, respectively. Based on the analysis results, students' conceptions of "forces" in School B were significantly higher than in the other two schools. However, students' conceptual understanding in School A and School C does not differ significantly.

In addition to conception, students' achievement at the conclusion is much higher. The analysis results show that students' average conceptual understanding level is 64.77±31.52%.

Unfortunately, these results indicate a high level of misconceptions, so more attention is needed to develop students' conceptual understanding. Based on the data, question number 4 (Q4) showed the highest number of students misconceptions, followed by question number 7 (Q7), which had more than 50%. The misconceptions found in other questions are less than 50% in the order of Q5 - Q2 - Q3 - Q6 - Q1. These results indicate that students cannot understand conceptions only on specific topics. Referring to the list of questions in Appendix 1, misconceptions are found in gravitational and muscle forces.

Students' individual achievements were analyzed to understand their understanding of the "forces" theory. The data indicate that the three clusters have almost the same conditions. No students in all clusters achieved full marks for the conception assessment. Some students were even found only to get a minimum score. However, in conclusion, students can at least answer half of the questions. Details of students' achievements are presented in Table 2. Data analysis shows significant differences between students' achievement in conception and conclusion in each cluster. Statistical analysis using ANOVA showed the F index of 62,723 (p = 0.000), 36.297 (p = 0.000) and 23,419 (p = 0.000) for Schools A, B, and C. This figure shows that students' conceptual understanding is much lower than their conclusion understanding.

Table 2. Students' Individual Achievements

No	Cluster	Achievement Score	
		Conception	**Conclusion**
1.	School A*	1 - 6 $(3.63 \pm 1.10)^a$	3 – 7 $(5.83 \pm 1.05)^a$
2.	School B*	2 – 6 $(4.18 \pm 1.06)^a$	4 – 7 $(5.82 \pm 0.98)^a$
3.	School C*	1 – 6 $(3.55 \pm 1.50)^a$	2 – 7 $(5.55 \pm 1.22)^a$
	Total	1 – 6 (3.80 ± 1.23)	2 – 7 (5.75 ± 1.07)

Note: *clusters with a significant difference between conception and final score achievement
- Rows in the same column with the same letters show insignificant differences.

Further analysis was carried out to evaluate differences in individual achievement between clusters with ANOVA. The results of the analysis show that there is no significant difference between student achievement between clusters in conception and conclusion. Statistical analysis with ANOVA shows F index of 2.146 (p = 0.124) and 0.546 (p = 0.582) for conception and conclusion, respectively. These results indicate that students' capacity in all clusters is relatively the same.

This study finds that the average level of misconceptions in all clusters of fourth-grade elementary school students in Yogyakarta was relatively the same. However, the level of individual misconceptions tended to be high. This finding proves that the development of online education practices during the COVID-19 pandemic needs attention to aspects of students' conceptual understanding. Students misconceptions should not be ignored because they are essential to learning, especially in science education (Yilmaz et al., 2018). Conception represents a deeper understanding of a learning topic. Rather than results, conceptual understanding focuses on principles and processes (Konicek-Moran & Keeley, 2015; Leonor, 2015). Therefore, misconceptions can cause difficulties in learning more complex topics. However, failure to understand the concept is not always followed by failure to conclude.

Misconceptions in science during online learning, as found in this study, indicate the need to develop learning strategies that can reduce misconceptions. Science is the knowledge that is open to broader possibilities. Many technological advances were created because of the development of science (Kolychev & Prokhorov, 2015). Therefore, equipping students with the correct conception is essential. Overcoming students' misconceptions is necessary to improve their understanding of learning (Zhang et al., 2019). Thus, the correct information is needed to determine the right strategy. Finding the core of the problem in teaching will be the right start to overcoming the problem.

Misconceptions in educational practice are closely related to school administrators and teachers (Halim et al., 2014). School management and teachers' strategies in teaching play a dominant role in building students' conceptions of new and old knowledge (Kelley, 2020; Azid et al., 2022). Given the current situation, the misconceptions in the fourth-grade elementary school found in this study are due to the transformations that occur in educational practice. Amid the COVID-19 pandemic, educational activities usually carried out through face-to-face offline classes must be carried out online through digital platforms (Pandey et al., 2021). Therefore, limited teacher-student interaction becomes an obstacle to teaching and learning activities (Wahyono & Susetyarini, 2021). Misconceptions are influenced by various aspects, including the role of school administrators, school management, learning infrastructure, and the role of teachers. Among all aspects, the most decisive is the teacher.

Since the outbreak of the COVID-19 outbreak, education has been disrupted globally. Husnah et al. (2020), Puspitasari et al. (2021), and Wahyono and Susetyarini (2021) state that misconceptions in science learning have been found in various studies, including due to the COVID-19 pandemic. Online education has become a global strategy to keep educational activities running. Unfortunately, developing and emerging countries are generally not prepared for such changes. Inadequate infrastructure, facilities, and systems are obstacles to online education practice. In addition, most teachers and students lack digital competence, adding to the complexity of the problem of online education. Education stakeholders in Indonesia have faced this condition since the COVID-19 outbreak. Thus, it can be assumed that unpreparedness is the primary cause of the disruption of education toward research objects (Martha et al., 2021; Munastiwi & Puryono, 2021; Suyadi & Selvi, 2022). Pandey et al. (2021) find that internet connection, inadequate learning materials, and methods used in online classes can be obstacles in conducting online education.

Unfavorable circumstances and learning models become essential factors that affect the students' conceptual understanding. Trotskovsky and Sabag (2015) even assume that teaching methods are the root of misconceptions. Conceptual understanding solely depends on the information students obtain. This information can be sourced from individual perceptions, reading materials, and the teaching received (Saribas & Ceyhan, 2015; Cukurova et al., 2018). Since learning models play an essential role in developing students' conceptions, teachers must periodically review and evaluate their teaching performance. Usually, students will gain an optimal conceptual understanding through a comprehensive explanation accompanied by hands-on practice (Kelley, 2020; Liu & Fang, 2021). However, it is not easy to do in online learning. Therefore, the learning model is an essential factor affecting conceptual understanding. The learning model has methods, media, strategies, and learning approaches.

Findings that show variations in misconceptions between clusters indicate differences in teaching methods (Trotskovsky & Sabag, 2015). There must be differences in school management because each school has a different background. Generally, private schools that are more advanced in technology adoption make students more familiar with communication and information technology-based devices (Ibáñez et al., 2020). Additional efforts are usually made to improve understanding of science subjects, such as using visual aids, conducting field observations, or laboratory practice (Monroe et al., 2019). Thus, the students will get more information and develop the correct conception. However, it cannot be done through online classes. Students may do individual observations or exercises, but that does not mean that students are not supervised. This activity will potentially lead to another misconception.

Given the insignificant difference in the mean of individual misconceptions, there must be a typical cause for the misconceptions. Students' competence in digital technology has contributed to misconceptions. According to Drane et al. (2021), the lack of students' technological competence is one of the causes of misconceptions. Using a smartphone or laptop for online learning was not a routine activity before the COVID-19 pandemic. Moreover, maybe not all students are familiar with smartphones or laptops. Thus, students face difficulties in conducting online learning. The rapid adoption of online learning systems triggers misconceptions caused by sudden and unexpected difficulties. Misconceptions in education need to be minimized as much as possible. Based on the findings of this study, it can be assumed that misconceptions in elementary schools in Yogyakarta have the exact cause. The teacher is responsible for overcoming students' misconceptions in today's conditions. Therefore, effective and efficient learning methods are needed to improve students' conceptual understanding (Wahyono & Susetyarini, 2021). One strategy that can be applied is to use several ways. Kolovou (2022) argues that using only one learning method can lead to misconceptions of knowledge. Therefore, varied learning methods are needed during the COVID-19 pandemic.

Misconceptions can become a bigger problem because they cannot be corrected or eliminated by embedding correct conceptions (Mason & Zaccoletti, 2021). The statement is proved by Vosniadou and Skopeliti (2017), who shows that scientific explanations of students who experience misconceptions tend to build new misconceptions. The arrangement of independent learning needs to consider the involvement of parents. Parents can be positioned as mentors or assistants for students. Junge et al. (2021) found that children's science knowledge was strongly related to parental interest and assistance in learning science. According to Ferguson (2022), conception is a perception based on evidence of acceptable reality. Thus, knowledge from parents can support students to understand concepts in science better because parents act as mentors for students.

CONCLUSION

There is a tendency for fourth-grade students to have a science misconception about "force" due to online learning. The purpose of this case is to find out the misconceptions that occur due to online learning. The population selected three favorite schools accredited A (excellent) managed by the government and private foundations. The results showed that the average of misconceptions was relatively low. The level of individual misconceptions tends to be high. It is proven that the development of learning practices needs to understand the correct concept. The science misconceptions of fourth-grade elementary school students in Yogyakarta due to the implementation of online learning on average range from 40.31 - 49.35% (40 < misconceptions 60%) in the medium category. There are differences in the level of misconceptions between clusters in learning about forces. The level of misconceptions in school A is medium, B is the lowest, while in school C is the highest. Although the level of misconceptions at the cluster level proved significant, there was no significant difference in misconceptions at the individual level. These findings indicate that students in each school cluster experience similar barriers in learning science, especially regarding "forces". Based on these findings, the researchers suggest an effort to adjust the learning model to reduce students' misconceptions in science learning. Improvements to the learning model can be made to the instructional, interaction, supervision, and independent learning models.

REFERENCES

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, 1–13.

Andersen, S., Leon, G., Patel, D., Lee, C., & Simanton, E. (2022). The impact of Covid-19 on academic performance and personal experience among first-year medical students. *Medical Science Educator*, *32*(2), 389–397.

Atav, R., Unal, P., Buzol Mulayim, B., Ozturk, Şe., Kazan, C., & Karaaslan, F. (2015). Determination of the most commonly recognized and used keratin-based luxury fibers. *Journal of Natural Fibers*, *12*(2), 169–184.

Aubrey, K.,& Riley, A (2019). *Understanding And Using Educational Theories.* United States, United Kingdom, New Delhi, and Singapore: SAGE Publication

Azid, N., Shi, L. Y., Saad, A., Man, S. C., & Heong, Y. M. (2022). The Covid-19 pandemic: Web 2.0 tools as an alternative instruction for science in secondary schools. *International Journal of Information and Education Technology*, *12*(6), 467–475.

Baum, D. R., & Riley, I. (2019). The relative effectiveness of private and public schools: Evidence from Kenya. *School Effectiveness and School Improvement*, *30*(2), 104–130.

Bozgun, K., Ozaskin-Arslan, A. G., & Ulucinar-Sagir, S. (2022). Covid-19 and distance education: Evaluation in the context of twenty-first-century skills. *The Asia-Pacific Education Researcher*, *0123456789*.

Brault Foisy, L.-M., Potvin, P., Riopel, M., & Masson, S. (2015). Is inhibition involved in overcoming a common physics misconception in mechanics? *Trends in Neuroscience and Education*, *4*(1–2), 26–36.

Braun, V., Clarke, V., Boulton, E., Davey, L., & McEvoy, C. (2021). The online survey as a qualitative research tool. *International Journal of Social Research Methodology*, *24*(6), 641–654.

Brodaty, H., Mothakunnel, A., de Vel-Palumbo, M., Ames, D., Ellis, K. A., Reppermund, S., Kochan, N. A., Savage, G., Trollor, J. N., Crawford, J., & Sachdev, P. S. (2014). Influence of population versus convenience sampling on sample characteristics in studies of cognitive aging. *Annals of Epidemiology*, *24*(1), 63–71.

Callis-Duehl, K., Idsardi, R., Humphrey, E. A., & Gougis, R. D. (2018). Missed opportunities for science learning: Unacknowledged unscientific arguments in asynchronous online and face-to-face discussions. *Journal of Science Education and Technology*, *27*(1), 86–98.

Callo, E. C., & Yazon, A. D. (2020). Exploring the factors influencing the readiness of faculty and students on online teaching and learning as an alternative delivery mode for the new normal. *Universal Journal of Educational Research*, *8*(8), 3509–3518.

Cukurova, M., Bennett, J., & Abrahams, I. (2018). Students' knowledge acquisition and ability to apply knowledge into different science contexts in two different independent learning settings. *Research in Science & Technological Education*, *36*(1), 17–34.

Drane, C. F., Vernon, L., & O'Shea, S. (2021). Vulnerable learners in the age of COVID-19: A scoping review. *The Australian Educational Researcher*, *48*(4), 585–604.

Erman, E. (2017). Factors contributing to students' misconceptions in learning covalent bonds. *Journal of Research in Science Teaching*, *54*(4), 520–537.

Ferguson, S. L. (2022). Teaching what is "real" about science. *Science & Education*, *0123456789*.

Gamage, K. A. A., Wijesuriya, D. I., Ekanayake, S. Y., Rennie, A. E. W., Lambert, C. G., & Gunawardhana, N. (2020). Online delivery of teaching and laboratory practices: Continuity of university programs during Covid-19 pandemic. *Education Sciences*, *10*(10), 291.

Garad, A., Al-Ansi, A. M., & Qamari, I. N. (2021). The role of e-learning infrastructure and cognitive competence in distance learning effectiveness during the Covid-19 pandemic. *Jurnal Cakrawala Pendidikan*, *40*(1), 81–91.

González, S., & Bonal, X. (2021). COVID-19 school closures and cumulative disadvantage: Assessing the learning gap in formal, informal and non-formal education. *European Journal of Education*, *56*(4), 607–622.

Gurel, D. K., Eryilmaz, A., & McDermott, L. C. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *EURASIA Journal of Mathematics, Science and Technology Education*, *11*(5), 989–1008.

Halim, L., Yong, T. K., & Meerah, T. S. M. (2014). Overcoming students' misconceptions on forces in equilibrium: An action research study. *Creative Education*, *5*(11), 1032–1042.

Hall, A. K., Nousiainen, M. T., Campisi, P., Dagnone, J. D., Frank, J. R., Kroeker, K. I., Brzezina, S., Purdy, E., & Oswald, A. (2020). Training disrupted: Practical tips for supporting competency-based medical education during the Covid-19 pandemic. *Medical Teacher*, *42*(7), 756–761.

Handhika, J., Cari, Suparmi, & Sunarno, W. (2015). External representation to overcome misconception in physics. *International Conference on Mathematics, Science, and Education 2015*, *2015*(ICMSE), 34–37.

Husnah, I., Suhandi, A., & Samsudin, A. (2020). Analyzing K-11 students' boiling conceptions with BFT-Test using Rasch model: A case study in the Covid-19 pandemic. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *5*(2), 225–239.

Ibáñez, M. B., Uriarte Portillo, A., Zatarain Cabada, R., & Barrón, M. L. (2020). Impact of augmented reality technology on academic achievement and motivation of students from public and private Mexican schools. A case study in a middle-school geometry course. *Computers & Education*, *145*, 103734.

Junge, K., Schmerse, D., Lankes, E.-M., Carstensen, C. H., & Steffensky, M. (2021). How the home learning environment contributes to children's early science knowledge—Associations with parental characteristics and science-related activities. *Early Childhood Research Quarterly*, *56*, 294–305.

Kelley, E. W. (2020). Reflections on three different high school chemistry lab formats during Covid-19 remote learning. *Journal of Chemical Education*, *97*(9), 2606–2616.

Kolovou, M. (2022). Lessons from the past: Reviewing how we teach science, what's changed, and why it matters. *Science & Education*, *31*(3), 855–859.

Kolychev, V. D., & Prokhorov, I. V. (2015). Conception, technology, and methods of development of university system of innovation projects commercialization based on effectuation. *Asian Social Science*, *11*(8), 44–51.

Konicek-Moran, R., & Keeley, P. (2015). *Teaching for conceptual understanding in science*. Arlington: NSTA Press, National Science Teachers Association.

Kumandaş, B., Ateskan, A., & Lane, J. (2019). Misconceptions in biology: A meta-synthesis study of research, 2000–2014. *Journal of Biological Education*, *53*(4), 350–364.

Leonor, J. P. (2015). Exploration of conceptual understanding and science process skills: A basis for differentiated science inquiry curriculum model. *International Journal of Information and Education Technology*, *5*(4), 255–259.

Liu, G., & Fang, N. (2016). Student misconceptions about force and acceleration in physics and engineering mechanics education. *International Journal of Engineering Education*, *32*(1), 19–29.

Liu, G., & Fang, N. (2021). The effects of enhanced hands-on experimentation on correcting student misconceptions about work and energy in engineering mechanics. *Research in Science and Technological Education*, 1–20.

Mahdy, M. A. A. (2020). The impact of COVID-19 pandemic on the academic performance of veterinary medical students. *Frontiers in Veterinary Science*, *7*, 1–8.

Martha, A. S. D., Junus, K., Santoso, H. B., & Suhartanto, H. (2021). Assessing undergraduate students' e-learning competencies: A case study of higher education context in Indonesia. *Education Sciences*, *11*(4), 189.

Mason, L., & Zaccoletti, S. (2021). Inhibition and conceptual learning in science: A review of studies. *Educational Psychology Review*, *33*(1), 181–212.

Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A., & Chaves, W. A. (2019). Identifying effective climate change education strategies: A systematic review of the research. *Environmental Edu-*

cation Research, *25*(6), 791–812.

Morris, T. H. (2021). Meeting educational challenges of pre-and post-COVID-19 conditions through self-directed learning: considering the contextual quality of educational experience necessary. *On the Horizon, 29*(2), 52–61.

Mukhtar, K., Javed, K., Arooj, M., & Sethi, A. (2020). Advantages, limitations, and recommendations for online learning during COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, *36*(COVID19-S4), S27–S31.

Munastiwi, E., & Puryono, S. (2021). Unprepared management decreases education performance in kindergartens during Covid-19 pandemic. *Heliyon*, *7*(5), e07138.

Nandiyanto, A. B. D., Hofifah, S. N., & Maryanti, R. (2022). Identification of misconceptions in learning the concept of the adsorption process. *Journal of Engineering Science and Technology*, *17*(2), 964–984.

Ndzinisa, N., & Dlamini, R. (2022). Responsiveness vs. accessibility: Pandemic-driven shift to remote teaching and online learning. *Higher Education Research & Development*, 1–16.

Özerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *Procedia - Social and Behavioral Sciences*, *55*, 720–729.

Pandey, D., Ogunmola, G. A., Enbeyle, W., Abdullahi, M., Pandey, B. K., & Pramanik, S. (2021). Covid-19: A framework for effective delivering of online classes during lockdown. *Human Arenas*, *0123456789*.

Pozo-Rico, T., Gilar-Corbí, R., Izquierdo, A., & Castejón, J.-L. (2020). Teacher training can make a difference: Tools to overcome the impact of COVID-19 on primary schools. An experimental study. *International Journal of Environmental Research and Public Health*, *17*(22), 8633.

Prodjosantoso, A. K., Hertina, A. M., & Irwanto, I. (2019). The misconception diagnosis on ionic and covalent bonds concepts with three-tier diagnostic test. *International Journal of Instruction*, *12*(1), 1477–1488.

Puspitasari, R., Mufit, F., & Asrizal. (2021). Conditions of learning physics and students' understanding of the concept of motion during the covid-19 pandemic. *Journal of Physics: Conference Series*, *1876*(1), 012045.

Putri, R. S., Purwanto, A., Pramono, R., Asbari, M., Wijayanti, L. M., & Hyun, C. C. (2020). Impact of the COVID-19 pandemic on online home learning: An explorative study of primary schools in Indonesia. *International Journal of Advanced Science and Technology*, *29*(5), 4809–4818.

Qoyyimah, U. (2018). Policy implementation within the frame of school-based curriculum: A comparison of public school and Islamic private school teachers in East Java, Indonesia. *Compare: A Journal of Comparative and International Education*, *48*(4), 571–589.

Ring-Whalen, E., Dare, E., Roehrig, G., Titu, P., & Crotty, E. (2018). From conception to curricula: The role of science, technology, engineering, and mathematics in integrated STEM units. *International Journal of Education in Mathematics, Science and Technology*, *6*(4), 343–362.

Rulandari, N. (2020). The impact of the Covid-19 pandemic on the world of education in Indonesia. *Ilomata International Journal of Social Science*, *1*(4), 242–250.

Saefudin, A., & Saputri, A. E. (2018). Interpreting scientific approach in natural science subject for elementary school: An integrative study. *Unnes Science Education Journal*, *7*(1), 91–97.

Saribas, D., & Ceyhan, G. D. (2015). Learning to teach scientific practices: pedagogical decisions and reflections during a course for pre-service science teachers. *International Journal of STEM Education*, *2*(1), 7.

Smyth, J. D., Olson, K., & Stange, M. (2019). Within-household selection methods: A critical review and experimental examination. In P. J. Lavrakas, M. W. Traugott, C. Kennedy, A. L. Holbrook, E. D. de Leeuw, & B. T. West (Eds.), *Experimental Methods in Survey Research: Techniques that Combine Random Sampling with Random Assignment* (pp. 23–45). Wiley.

So, W. W. M., Chen, Y., & Wan, Z. H. (2019). Multimedia e-learning and self-regulated science learning: A study of primary school learners' experiences and perceptions. *Journal of Science Education and Technology*, *28*(5), 508–522.

Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of 'relevance' in science education and its implications for the science curriculum. *Studies in Science Education*, *49*(1), 1–34.

Suyadi, & Selvi, I. D. (2022). Online learning and child abuse: The Covid-19 pandemic impact on work and school from home in Indonesia. *Heliyon*, *8*(1), e08790.

Taban, T., & Kiray, S. A. (2021). Determination of science teacher candidates' misconceptions on liquid pressure with four-tier diagnostic test. *International Journal of Science and Mathematics Education*.

Tam, A. C. F. (2022). Students' perceptions of and learning practices in online timed take-home examinations during Covid-19. *Assessment & Evaluation in Higher Education*, *47*(3), 477–492.

Thapa, A. (2015). Public and private school performance in Nepal: An analysis using the SLC examination. *Education Economics*, *23*(1), 47–62.

Tompo, B., Ahmad, A., & Muris, M. (2016). The development of discovery-inquiry learning model to reduce the science misconceptions of junior high school students. *International Journal of Environmental and Science Education*, *11*(12), 5676–5686.

Tria, J. Z. (2020). The Covid-19 pandemic through the lens of education in the Philippines: The new normal. *International Journal of Pedagogical De-*

velopment and Lifelong Learning, *1*(1), ep2001.

Trotskovsky, E., & Sabag, N. (2015). One output function: a misconception of students studying digital systems – a case study. *Research in Science & Technological Education*, *33*(2), 131–142.

Üce, M., & Ceyhan, İ. (2019). Misconception in chemistry education and practices to eliminate them: Literature analysis. *Journal of Education and Training Studies*, *7*(3), 202.

Ullah, H., & Ali, J. (2021). Impact of Covid-19 pandemic on the schooling of public and private school students in Pakistan. *Education 3-13*, 1–10.

Vosniadou, S., & Skopeliti, I. (2017). Is it the Earth that turns or the Sun that goes behind the mountains? Students misconceptions about the day/night cycle after reading a science text. *International Journal of Science Education*, *39*(15), 2027–2051.

Wahyono, P., & Susetyarini, E. (2021). Misconceptions of biology education students in Biochemistry Course during the COVID-19 pandemic. *Jurnal Pendidikan Biologi Indonesia*, *7*(2), 104–110.

Wang, Y. F., Petrina, S., & Feng, F. (2017). VILLAGE-Virtual Immersive Language Learning and Gaming Environment: Immersion and presence. *British Journal of Educational Technology*, *48*(2), 431–450.

Wendt, J. L., & Rockinson-Szapkiw, A. (2014). The effect of online collaboration on middle school student science misconceptions as an aspect of science literacy. *Journal of Research in Science Teaching*, *51*(9), 1103–1118.

Yang, D. C., & Lin, Y. C. (2015). Assessing 10- to 11-year-old children's performance and misconceptions in number sense using a four-tier diagnostic test. *Educational Research*, *57*(4), 368–388.

Yilmaz, F. G. K., Özdemir, B. G., & Yasar, Z. (2018). Using digital stories to reduce misconceptions and mistakes about fractions: an action study. *International Journal of Mathematical Education in Science and Technology*, *49*(6), 867–898.

Zajkov, O., Gegovska-Zajkova, S., & Mitrevski, B. (2017). Textbook-caused misconceptions, inconsistencies, and experimental safety risks of a grade 8 physics textbook. *International Journal of Science and Mathematics Education*, *15*(5), 837–852.

Zhang, T., Chen, A., & Ennis, C. (2019). Elementary school students' naïve conceptions and misconceptions about energy in physical education context. *Sport, Education, and Society*, *24*(1), 25–37.