Bioedusiana

http://jurnal.unsil.ac.id/index.php/bioed
DOI: https://doi.org/10.37058/bioed.v9i1.11666

Eksplorasi Miskonsepsi Materi Virus Berdasarkan Gender pada Siswa SMA di Malang

Exploration of Misconceptions about Virus Material Based on Gender among High School Students in Malang

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Abstrak

Sangat penting bagi siswa SMA untuk memahami konsep virus karena penerapan konsep pada materi virus berkaitan dengan kehidupan sehari-hari. Siswa masih menganggap virus sebagai sel. Tujuan dari penelitian ini adalah untuk mengevaluasi miskonsepsi materi virus pada siswa SMA di Malang berdasarkan gender dan untuk menentukan faktor-faktor yang menyebabkan miskonsepsi tersebut. *Four-tier diagnostic multiple-choice test* adalah alat yang digunakan. Tes ini menghasilkan lima kategori keputusan: *scientific conception*, *knowledge deficit*, *false positive*, *false negative*, dan *misconception*. Metode sampling *purposive random sampling* digunakan dalam penelitian ini. Dalam penelitian ini, sampelnya adalah 477 siswa dari sekolah menengah atas di Malang yang telah mempelajari materi virus. Teknik deskriptif kuantitatif untuk analisis data dengan Uji T tidak berpasangan. Instrumen *Four-Tier* terbukti valid dengan rentang nilai 0.411-0.767 dan reliabel dengan nilai 0.835. Hasil penelitian menunjukkan bahwa persentase miskonsepsi siswa perempuan sebesar 56.1% dan siswa laki-laki sebesar 43.9%. Nilai Uji T tidak berpasangan adalah 0.017(<0.05), yang menunjukkan bahwa ada perbedaan signifikan dalam miskonsepsi siswa perempuan dan laki-laki.

Kata kunci: Miskonsepsi; *Four-Tier Diagnostic Test;* Virus; Gender

Abstract

High school students must comprehend the notion of viruses since the application of principles found in virus content is tied to everyday conduct. Pupils continue to have misconceptions regarding viruses because they mistakenly believe that they are cells. This study aims to investigate the causes of misconceptions about virus material among Malang high school students by analyzing the misconceptions depending on gender. A four-tier diagnostic multiple-choice test was the tool utilized. The five decision categories on a four-tier diagnostic multiple-choice test are scientific conception, ignorance, false positive, false negative, and misperception. In this study, purposeful random sampling was combined with a survey method. Four hundred and seventy-seven Malang high school students who have studied virus material made up the sample for this study. Using an independent sample T-test, descriptive quantitative data analysis was the method employed. The four-tier diagnostic multiple-choice test was found to be reliable (0.835) and valid (0.411-0.767) in terms of value range. The findings indicated that male and female students had different percentages of misconceptions 56.1% and 43.9%, respectively. Independent sample T-test findings yielded a significant value of 0.017(<0.05) suggests that there is a substantial discrepancy in the beliefs held by male and female students.

***Keywords**: Misconceptions, Four-Tier Diagnostic Test; Virus; Gender.*

Article History
Received: Juni 26th, 2024; Accepted: August 6th, 2024; Published: August 30th, 2024
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INTRODUCTION

Biology learning contains several complex concepts and is interconnected with daily life (Sharon & Baram-Tsabari, 2020). Biology materials are interrelated and the key to understanding other concepts. One of the complex biology learning materials is virus material. Viruses are smaller in size and their body structure is very simple when compared to bacteria. In addition, viruses do not have cellular components and do not replicate outside their host cells. The characteristics of viruses that cannot be seen by the eye without special tools result in the formation of students' abstract thinking that develops into misconceptions (Zulfia et al., 2019).

Different scholars have given different definitions of misconceptions in different works of literature. According to Çuçin et al. (2020), concepts irrelevant to scientific concepts are called misconceptions. Misconceptions are the inequality of concepts and perceptions understood by students and experts because they conflict with the initial understanding received. Students' perceptions that are not by the concept can have an impact on conceptual errors that can damage the basis of knowledge resulting in misconceptions (Tumanggor et al., 2020). These misconceptions are described as students' insights that give meaning and are formed from their experiences (Harso et al., 2021). Usually, students make their translations of the concepts they learn.

Virus material is one of the many materials in biology learning that requires more understanding because It is necessary for students to be able to explain how the shape and structure are and students still think the virus is a cell (Fikri et al., 2022). Students' understanding of the concept of viruses can be used as a provision in social life. Students need to gain knowledge about virus material, especially diseases caused by viruses, how they are transmitted, how to prevent and how to treat them. Students who have a scientific concept of viruses will know the steps taken if they are infected with diseases caused by viruses. Students who experience misconceptions about virus material can have an impact on their knowledge and demand of behavior in daily life.

Many factors can cause misconceptions to occur such as less attractive learning media, the way teachers deliver material, and student demographic factors such as gender (Bouzid et al., 2022). Students who have a weak grasp of scientific principles and attempt to understand the world around them may have misconceptions (Duda & Adpriyadi, 2020). Students who experience

misconceptions usually modify and even reject a scientific explanation of the phenomenon (Ardiyanti & Utami, 2017).

Gender biologically there are 2 types of sex, namely male and female (Cislaghi & Heise, 2020). Gender is a social structure that distinguishes between women and men based on roles and responsibilities (Audina, 2022). Based on cultural aspects, gender is perceived as feminine and masculine traits (Martínez-Marín et al., 2021). In this study, the concept of gender refers to the definition proposed by Lindqvist et al. (2021), namely the gender of female and male.

In the field of education, gender includes roles that can influence student achievement, experience, and participation (Adi Pratama et al., 2023). Gender bias that occurs during the learning process can affect learning outcomes (Farisiyah et al., 2022). Gender is often a neglected variable that causes misconceptions, while gender has a significant contribution to students in receiving and processing information (Dersch et al., 2022). Therefore, the difference in misconceptions between female and male students is interesting to study further.

Differences between male and female students can be seen from several aspects such as learning styles, classroom interactions, and how to process information (Issa & Khataibeh, 2021). Female students tend to be more thorough and careful in making decisions. Meanwhile, male students tend to be quick in making decisions and taking risks even though they pay less attention to small details (Aston, 2023). This difference can affect their understanding of learning materials and can lead to misconceptions.

Misconceptions that persist in students can also interfere with subsequent conceptions and have an impact on the application of a concept in everyday life. The way to overcome misconceptions is to identify where the conceptual errors experienced by students are. Identifying misconceptions is an important step in reducing misconceptions that occur (Martawijaya et al., 2023). Many tools can be used to measure misconceptions, such as concept maps, interviews, and diagnostic tests (Suriani et al., 2023).

The four-tier test is one type of diagnostic test. A four-level diagnostic test is what the four-tier test is (Tumanggor et al., 2020). A query about the content is the first level. In the second level of belief, the respondent is questioned if they are confident in their response from the first level. The rationale behind the response to the first-level query comes from the third level (Kaltakci-Gurel et al., 2017a). The respondent is asked if they are confident in their response from the third level at the fourth level of trust.

The focus of this study is to establish the way high-school students in Malang misread different virus materials due to their gender. Teachers may apply these findings as an inspiration to develop relevant easily understood virus-related lesson plans for the students they teach.

METHOD

Quantitative research using the survey method is the approach utilized. The research was conducted in February and March of 2024. 48900 Malang Raya high school seniors made up the study's population. Purposive random sampling was the method of sampling that was employed. High school students from Malang City, Batu City, and Malang Regency who had taken viral material were the respondents who were chosen. The following formulas using the Slovin formula were executed to determine the quantity of samples.

$$n = \frac{N}{1+N(e)^2}$$

Description:

n = Number of samples

N = Total population

e = Sampling error, usually 5%

The Slovin formula estimate reveals that 477 students are the total quantity of samples obtained, with 397 students qualifying as the minimum sample size. SMAN 1 Malang City, SMAN 7 Malang City, and SMAN 9 Malang City are the schools that are in use in the Malang City region. SMAN 1 Singosari was the area under Malang Regency, and SMAN 2 Batu City was the area under Batu City.

The research procedure is described as follows.

1. The researcher developed the four tiers diagnostic test and questionnaire.
2. Researchers validated the results of the instrument developed by experts.
3. Carrying out empirical tests containing validity, reliability, differentiation of questions, and difficulty levels of questions.
4. Make revisions related to the results of the instrument trial.
5. Carry out data collection.
6. Analyze the results of data collection.
7. Make a discussion.

The instruments used are four-tier diagnostic multiple-choice tests (FTDMCT). The four-tier diagnostic test in this study was used to measure the level of student misconceptions on each item. The instrument contained 15 multiple choice questions where each question item contained 4 levels

of questions. Use the following formula in descriptive data analysis to estimate the proportion of students who have gender-based misconceptions.

$$P = f/N \times 100\%.$$

Description:

P= Percentage number

f= Total frequency of each answer

N= Total number of respondents

Meanwhile, data analysis to determine the difference in misconceptions between female and male students used the independent sample T-test. The results are said to have a significant difference in the sig value. <0.005. Assessment of the instrument four-tier diagnostic multiple choice test (FTDMCT) is calculated from each level. The correct answer at each level is given a score of 1, while the wrong answer is given a score of 0. Furthermore, the total score of each category is calculated as the percentage of each category according to Table 1.

According to Kaltakci-Gurel et al. (2017), the four-tier diagnostic test has 5 categories, namely: a) Lack of Knowledge (LK), b) Scientific Concept (SC), c) Misconception (MSC), d) False Positive (FP) and False Negative (FN). However, this research focuses on the misconception category.

Table 1. Four-Tiers Test Answer Level Decision

First Tier	Second Tier	Third Tier	Fourth Tier	Category
True (1)	Sure (1)	True (1)	Sure (1)	*Scientific Conception* (SC)
True (1)	Sure (1)	True (1)	Not Sure (0)	*Lack of Knowledge* (LK)
True (1)	Not Sure (0)	True (1)	Sure (1)	*Lack of Knowledge* (LK)
True (1)	Not Sure (0)	True (1)	Not Sure (0)	*Lack of Knowledge* (LK)
True (1)	Sure (1)	False (0)	Sure (1)	*False Positive* (FP)
True (1)	Sure (1)	False (0)	Not Sure (0)	*Lack of Knowledge* (LK)
True (1)	Not Sure (0)	False (0)	Sure (1)	*Lack of Knowledge* (LK)
True (1)	Not Sure (0)	False (0)	Not Sure (0)	*Lack of Knowledge* (LK)
False (0)	Sure (1)	True (1)	Sure (1)	*False Negative* (FN)
False (0)	Sure (1)	True (1)	Not Sure (0)	*Lack of Knowledge* (LK)
False (0)	Not Sure (0)	True (1)	Sure (1)	*Lack of Knowledge* (LK)
False (0)	Not Sure (0)	True (1)	Not Sure (0)	*Lack of Knowledge* (LK)
False (0)	Sure (1)	False (0)	Sure (1)	Misconception (MSC)
False (0)	Sure (1)	False (0)	Not Sure (0)	*Lack of Knowledge* (LK)
False (0)	Not Sure (0)	False (0)	Sure (1)	*Lack of Knowledge* (LK)

False (0)	Not Sure (0)	False (0)	Not Sure (0)	*Lack of Knowledge* (LK)

Source: (Kaltakci-Gurel et al., 2017b)

RESULT AND DISCUSSION

Result

In this study, the data used were the answers to the four-tier diagnostic multiple choice test (FTDMCT) questions. The four-tier diagnostic multiple choice test (FTDMCT) instrument was developed from CP phase E, namely, students can create solutions to problems based on local, national, or global issues related to understanding viruses and their role. The material developed from CP phase E is the characteristics of viruses, reproduction, and diseases caused by viruses in humans, how to prevent diseases caused by viruses, and how diseases caused by viruses are transmitted.

The pilot test of the four-tier diagnostic multiple choice test instrument was conducted at SMAN 7 Malang City in classes X.8 and X.9. Each class contained 35 students, so the total respondents used for testing the instrument were 70 students. Instrument testing was carried out as follows: validation test, reliability test, difficulty test, and question differentiator test. The test results of validation, reliability, difficulty, and differentiator test questions can be seen in Table 2.

Table 2. Results of Validity Test, Reliability Test, Differentiation Test, and Problem Difficulty Test

Question Item	Validity		Reliability		Question Distinguishing Power		Difficulty Level	
	Coefficient Value n	Category	Coefficient Value N	Category	Discrimination Index si	Category	Index Success	Category
Q1	0.447	Moderate	0.835	High	0.341	Good	0.43	Medium
Q2	0.452	Moderate			0.354	Good	0.31	Medium
Q3	0.411	Moderate			0.315	Good	0.26	Difficult
Q4	0.493	Moderate			0.423	Good	0.86	Easy
Q5	0.546	Moderate			0.450	Very Good	0.49	Medium
Q6	0.731	High			0.664	Very Good	0.49	Medium
Q7	0.681	High			0.607	Very Good	0.60	Medium
Q8	0.725	High			0.659	Very Good	0.60	Medium
Q9	0.767	High			0.712	Very Good	0.66	Medium
Q10	0.730	High			0.664	Very Good	0.57	Medium

Q11	0.550	Moderate		0.475	Very Good	0.80	Easy
Q12	0.473	Moderate		0.401	Good	0.86	Easy
Q13	0.558	Moderate		0.468	Very Good	0.66	Medium

Table 3. Results of Validity Test, Reliability T, Differentiation Test, and Problem Difficulty Test Question 14 & 15

Question Item	**Coefficient Value n**	**Category**	**Reliability**	**Discrimination Index si**	**Category**	**Index Success**	**Category**
Q14	0.557	Moderate	0.835 (Category: High)	0.470	Very Good	0.69	Medium
Q15	0.565	Moderate		0.474	Very Good	0.60	Medium

The virus material misconception measurement was tested on 477 high school students in Malang. The number of female students was 271 students, while the number of male students was 206 students. Female students had 56.1% misconceptions, while male students had 43.9% misconceptions. The percentages of misconceptions in female students and male students can be seen in Figure 1.

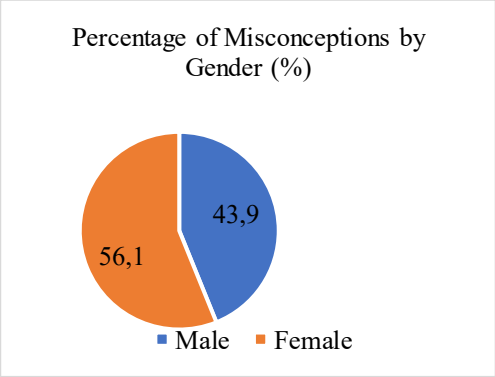

Figure 1. Diagram of the Percentage of Misconceptions in Students Based on Gender

The percentage of misconceptions between female and male students is classified as moderate misconceptions because it is in the range of 30%-60%. Misconceptions of virus material in female students are higher than in male students. The difference in misconceptions between male and female students is also supported by the results of the independent sample T-test in Table 3 and Table 4.

Table 3. Statistical Group Result Table

Gender	N	Mean	Std. Deviation	Std. Error Mean
Male	206	41.85	15.81	1.10
Female	271	45.39	15.94	0.96

Table 4. Result Independent Samples Test

Levene's Test for Equality Variances			T-Test for Equality Means					95% Confidence Interval of the Difference	
	F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Equal variances assumed	0.494	0.482	-2.406	475	0.017	-3.533	1.469	-6.419	-0.647
Equal variances not assumed			-2.408	443.300	0.016	-3.533	1.467	-6.416	-0.650

Discussion

Based on Table 1. the range of validity coefficients obtained is in the range of 0.411-0.767. The results of the validity test of the four-tier diagnostic multiple choice test instrument showed that 10 questions fell into the sufficient category and 5 questions fell into the high category. Questions that fall into the sufficient category are questions number 1, 2, 3, 4, 5, 11, 12, 13, 14 and 15. Questions in the high category are questions number 6, 7, 8, 9, and 10. This shows that the four-tier diagnostic multiple-choice test instrument is suitable for use as a data collection instrument (Utami, 2023). Based on the results of the reliability test that has been carried out, the reliability coefficient value of the four-tier diagnostic multiple choice test instrument is 0.835 and is in the high category. This shows that the four-tier diagnostic multiple-choice test instrument is accurately used as a data collection tool (Ketaren et al., 2024).

Based on the results of the question difficulty test, it can be seen that the four-tier diagnostic multiple choice test instrument has 11 questions in the medium question category, 3 questions in the easy question category and 1 question in the difficult question category. Questions that fall into the difficult category are number 3. Questions that fall into the easy category are questions number 4, 11, and 12. Questions that fall into the medium category are numbers 1, 2, 5, 6, 7, 8, 9, 10, 13, 14 and 15. Based on the results of the different test questions that have been carried out, the four-tier diagnostic multiple choice test instrument has 5 questions that fall into the good category and 10 questions that fall into the excellent category. Questions that fall into the good category are

questions number 1, 2, 3, 4, and 12. Questions that fall into the excellent category are questions number 5, 6, 7, 8, 9, 10, 11, 13, 14 and 15.

Based on Table 3, it appears that the mean value of female students (45.39) is higher than male students (41.85), while in Table 4 the Sig. (2-tailed) a value obtained is 0.017 (<0.05). Based on this value, it can be said that there are differences in misconceptions between female and male students. These results are in line with the research of Soeharto & Csapó (2022) which states that there are differences in misconceptions based on gender.

This indicates that when working on the four-tier diagnostic test questions, female students answered more wrong than male students. Female students' mistakes in answering questions show that female students' mastery of concepts is lower when compared to male students. This finding is supported by the results of Kristyasari & Kusumaningrum (2023) which state that male students have high concept mastery in chemistry material. However, this contradicts the research of Bohori & Liliawati (2019) which states that female students' concept mastery is higher than male students in effort and energy materials.

Concept mastery is also related to students' critical thinking skills because if the value of concept mastery increases, students' critical thinking skills also increase. This statement is supported by the results of research by Sevtia et al. (2022) which showed an increase in the average concept mastery score followed by an increase in critical thinking scores. Critical thinking skills can also have an impact on misconceptions. This is supported by the results of research by Yolviansyah et al. (2022) which states that there is a relationship between misconceptions and critical thinking, if misconceptions are high then students' critical thinking skills are low.

The high percentage of misconceptions of female students indicates that the critical thinking skills of female students are lower when compared to male students. This finding contradicts the research of Cruz-Sandoval et al. (2024) which states that the average value of critical thinking skills of female students is higher than male students. However, this finding is also supported by the results of Ramdani et al. (2021) which states that male students' critical thinking scores are higher than female students. So it can be concluded that critical thinking ability can be one of the factors for misconceptions.

Another factor that can cause female students' misconceptions to be higher than male students is self-confidence (Nurussama & Hermanto, 2022). The view that male students are superior to female students can lead to a lack of confidence in female students. This is in line with the results of research by Olutola et al. (2023) which states that the mean value of self-confidence of male students is 63.91 greater than female students 62.72. Low self-confidence can cause students to

hesitate to ask the teacher when they encounter material concepts that are difficult to understand. When students refrain from asking questions, it will make them store misconceptions related to a concept. In addition, shyness when asking questions makes students not get the opportunity to clarify their understanding of an existing concept, so they will be stuck with the understanding of their own thinking.

Self-confidence is interrelated with motivation (Mulya et al., 2020). High motivation can increase self-confidence in students because they feel they have a basis that encourages them to improve an ability or skill (Bozgun & Akin-Kostereliogl u, 2023). High self-confidence can increase student motivation because students feel capable of achieving a target. Self-confidenceis an important factor in motivating students to learn (Pečiuliauskienė, 2023).

The mean value in Table 3 shows that female students' misconceptions are higher than male students, so it can be indicated that one of the factors for higher misconceptions in female students is that the learning motivation of female students is lower than male students. According to the results of research by Harso et al., (2021) showed that there is a significant relationship between motivation and misconceptions. However, this contradicts the results of Tanaka (2023) which states that female students' motivation scores are higher than male students. Another study also stated that gender has no effect on student motivation (Iwaniec, 2019).

Motivation is also interrelated with students' interest in learning (Harefa et al., 2023). Low student motivation can reduce interest in learning it can cause students to explore their understanding of a material concept (Alemayehu & Chen, 2023). When students already feel sufficient in understanding a material, it can cause misconceptions because they do not explore the concept in depth. These misconceptions may be used by students as a basis for understanding new concepts and cause ongoing misconceptions.

The results showed that the percentage of misconceptions of female students was greater than male students. The percentage value of misconceptions of female students is higher which indicates that female students are less able to connect their understanding with existing scientific concepts and new information because they do not feel interested in understanding the concept more deeply. This can indicate that female students' interest in learning is low because they feel uninterested in exploring new information and concepts which can cause misconceptions. Harefa et al. (2023) states that when students feel interested in a material this can increase interest in learning to explore a concept more deeply.

Findings related to indications of low female students' interest in learning that cause misconception contradict the results of Merayo & Ayuso (2023) which states that the percentage of female students' interest in learning is 15.3% higher than male students 23.4%. On the other hand, this finding is also supported by the results of Okeke et al. (2023) which states the mean value of the *post-test* results of female students' learning interest 62.76 related to mathematical logic material is lower when compared to male students 63.60.

Misconceptions can hinder students' ability to achieve knowledge of new concepts (Kaplar et al., 2021). Misconceptions can occur from a variety of sources. Misconceptions can occur when students form a perception of a concept with their own language and understanding (Özmen, 2024). Perceptions that are generated with their own knowledge without a theoretical basis from experts can cause misconceptions. In addition to reviews related to student motivation and interest in learning, another factor causing misconceptions is the role of the teacher.

CONCLUSION

According to the study's findings, there are 56.1% and 43.9% of misconceptions among male and female students, respectively. The misconceptions that arise go into the intermediate group since they range from 30% to 60% based on this proportion. Furthermore, the independent T-test results revealed that male students had a mean misperception rate of 41.89% and female students a mean value of 45.39, with a Sig. (2-tailed) value of 0.017 (<0.05). There is a substantial difference in the misconceptions carried by male and female students, per the results of the independent sample T-test. Misconceptions are a result of a combination of student interest in learning, motivation, and self-confidence.

REFERENCES

Adi Pratama, A., Rafli Faishal Wardana, M., & Alwi Fanani, A. (2023). Analisis Kemampuan Berpikir Kreatif Matematis Siswa Pada Materi Bangun Ruang Sisi Datar Ditinjau Dari Segi Gender. *Delta-Phi: Jurnal Pendidikan Matematika*, *1*(2), 172–182. https://doi.org/10.61650/dpjpm.v1i2.87

Alemayehu, L., & Chen, H. L. (2023). The influence of motivation on learning engagement: the mediating role of learning self-efficacy and self-monitoring in online learning environments. *Interactive Learning Environments*, *31*(7), 4605–4618. https://doi.org/10.1080/10494820.2021.1977962

Ardiyanti, Y., & Utami, M. R. (2017). Identifikasi miskonsepsi siswa pada materi sistem reproduksi. Biosfer: Jurnal Biologi Dan Pendidikan Biologi, 2(2), 18–23. https://doi.org/10.23969/biosfer.v2i2.574

Aston, K. J. (2023). 'Why is this hard, to have critical thinking?' Exploring the factors affecting critical thinking with international higher education students. *Active Learning in Higher Education*. https://doi.org/10.1177/14697874231168341

Audina, D. J. (2022). Kesetaraan Gender dalam Perspektif Hak Asasi Manusia. *Nomos : Jurnal Penelitian Ilmu Hukum*, *2*(4), 148–154. https://doi.org/10.56393/nomos.v1i6.602

Bohori, M., & Liliawati, W. (2019). Analisis penguasaan konsep siswa menggunakan Rasch Model pada materi usaha dan energi. *Prosiding Seminar Nasional Fisika 5.0*, 138–143.

Bouzid, T., Kaddari, F., & Darhmaoui, H. (2022). Force and motion misconceptions' pliability, the case of Moroccan high school students. *Journal of Educational Research*, *115*(2), 122–132. https://doi.org/10.1080/00220671.2022.2064802

Bozgun, K., & Akin-Kosterelioglu, M. (2023). Self-confidence as the predictor of metacognitive awareness in high school students. *Participatory Educational Research*, *10*(1), 375–388. https://doi.org/10.17275/per.23.20.10.1

Cislaghi, B., & Heise, L. (2020). Gender norms and social norms: differences, similarities and why they matter in prevention science. *Sociology of Health and Illness*, *42*(2), 407–422. https://doi.org/10.1111/1467-9566.13008

Cruz-Sandoval, M., Vázquez-Parra, J. C., Carlos-Arroyo, M., & Amézquita-Zamora, J. A. (2024). Student Perception of the Level of Development of Complex Thinking: An Approach Involving University Women in Mexico. *Journal of Latinos and Education*, *23*(2), 768–780. https://doi.org/10.1080/15348431.2023.2180370

Çuçin, A., Özgür, S., & Güngör Cabbar, B. (2020). Comparison of Misconceptions about Human Digestive System of Turkish, Albanian and Bosnian 12th Grade High School Students. *World Journal of Education*, *10*(3), 148. https://doi.org/10.5430/wje.v10n3p148

Dersch, A. S., Heyder, A., & Eitel, A. (2022). Exploring the Nature of Teachers' Math-Gender Stereotypes: The Math-Gender Misconception Questionnaire. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.820254

Duda, H. J., & Adpriyadi, A. (2020). Students' Misconception in Concept of Biology Cel. *Anatolian Journal of Education*, *5*(1), 47–52. https://doi.org/10.29333/aje.2020.515a

Farisiyah, U., Retnawati, H., Hassan, A., Putro, N. H. P. S., & Mubarok, E. S. (2022). Pengaruh segregasi gender terhadap hasil belajar matematika dan bahasa Inggris. *Measurement In Educational Research (Meter)*, *2*(2), 52. https://doi.org/10.33292/meter.v2i2.190

Fikri, R. A., Suwono, H., & Susilo, H. (2022). Online three-tier diagnostic test to identify misconception about virus and COVID-19. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *8*(2), 129–141. https://doi.org/10.22219/jpbi.v8i2.18895

Harefa, D., Sarumaha, M., Telaumbanua, K., Telaumbanua, T., Laia, B., & Hulu, F. (2023). Relationship Student Learning Interest To The Learning Outcomes Of Natural Sciences. *International Journal of Educational Research & Social Sciences* , *2*(4), 240–246. https://doi.org/10.51601/ijersc.v4i2.614

Harso, A., Wolo, D., & Damopolii, I. (2021). Kontribusi Pengetahuan Awal Dan Motivasi Belajar Terhadap Miskonsepsi Siswa Pada Pembelajaran Fisika. *ORBITA: Jurnal Pendidikan* , *7*(2), 351–358. https://doi.org/10.31764/orbita.v7i2.5791

Issa, H. B., & Khataibeh, A. (2021). The Effect of Using Project Based Learning on Improving the Critical Thinking among Upper Basic Students from Teachers' Perspectives. *Pegem Journal of Education and Instruction*, *11*(2), 52–57. https://doi.org/10.14527/pegegog.2021.00

Iwaniec, J. (2019). Language learning motivation and gender: The case of Poland. *International Journal of Applied Linguistics (United Kingdom)*, *29*(1), 130–143. https://doi.org/10.1111/ijal.12251

Kaltakci-Gurel, D., Eryilmaz, A., & McDermott, L. C. (2017). Development and application of a four-tier test to assess pre-service physics teachers' misconceptions about geometrical optics. *Research in Science and Technological Education*, *35*(2), 238–260. https://doi.org/10.1080/02635143.2017.1310094

Kaplar, M., Lužanin, Z., & Verbić, S. (2021). Evidence of probability misconception in engineering students—why even an inaccurate explanation is better than no explanation. *International Journal of STEM Education*, *8*(1).https://doi.org/10.1080/02635143.2017.1310094

Ketaren, M. A., Girsang, K., Manurung, M., & Ginting, E. R. B. (2024). Uji Validitas Dan Uji Daya Beda Soal Buatan Pilihan Ganda Dengan Tes Sumatif Siswa Kelas IV UPT SD Negeri 065013 Medan. *Jurnal Pengabdian Masyarakat Bangsa*, *1*(11). https://doi.org/10.59837/jpmba.v1i11.706

Kristyasari, M. L., & Kusumaningrum, I. A. (2023). Analysis of Misconceptions in View of Gender Differences in Chemistry Learning. *PAEDAGOGIA*, *26*(1), 1. https://doi.org/10.20961/paedagogia.v26i1.67569

Lindqvist, A., Sendén, M. G., & Renström, E. A. (2021). What is gender, anyway: a review of the options for operationalising gender. *Psychology and Sexuality*, *12*(4), 332–344. https://doi.org/10.1080/19419899.2020.1729844

Martawijaya, M. A., Rahmadhanningsih, S., Swandi, A., Hasyim, M., & Sujiono, E. H. (2023). The Effect Of Applying The Ethno-Stem-Project-Based Learning Model On Students' Higher-Order Thinking Skill And Misconception Of Physics Topics Related To Lake Tempe, Indonesia. *Jurnal Pendidikan IPA Indonesia*, *12*(1), 1–13. https://doi.org/10.15294/jpii.v12i1.38703

Martínez-Marín, M. D., Martínez, C., & Paterna, C. (2021). Gendered self-concept and gender as predictors of emotional intelligence: a comparison through of age. *Current Psychology*, *40*(9), 4205–4218. https://doi.org/10.1007/s12144-020-00904-z

Merayo, N., & Ayuso, A. (2023). Analysis of barriers, supports and gender gap in the choice of STEM studies in secondary education. *International Journal of Technology and Design Education*, *33*(4), 1471–1498. https://doi.org/10.1007/s10798-022-09776-9

Mulya, G., Setia Lengkana, A., & Author, C. (2020). Pengaruh Kepercayaan Diri, Motivasi Belajar Terhadap Prestasi Belajar Pendidikan Jasmani. *Competitor: Jurnal Pendidikan Kepelatihan Olahraga*, *12*(2), 83–94. https://doi.org/10.26858/cjpko.v12i2.13781

Nurussama, A., & Hermanto, H. (2022). Analisis Miskonsepsi Siswa Pada Materi Pecahan Ditinjau Dari Teori Konstruktivisme. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(1), 641. https://doi.org/10.24127/ajpm.v11i1.4697

Okeke, A. M., Egara, F. O., Orga, A. C., & Nzeadibe, A. C. (2023). Effect of symbolic form model on students' interest in logic content of the mathematics curriculum. *Pedagogical Research*, *8*(2), em0159. https://doi.org/10.29333/pr/13077

Olutola, A. T., Adamu, D. R., & Okonkwo, C. O. (2023). Self-Confidence as Correlate of Senior Secondary School Students' Academic Performance in English Language. *British Journal of Education*, *11*, 76–85. https://doi.org/10.37745/bje.2013/vol11n37685

Özmen, K. (2024). Health Science Students' Conceptual Understanding of Electricity: Misconception or Lack of Knowledge? *Research in Science Education*, *54*(2), 225–243. https://doi.org/10.1007/s11165-023-10136-3

Pečiuliauskienė, P. (2023). Instructional clarity in physics lessons: Students' motivation and self-confidence. *Cogent Education*, *10*(2). https://doi.org/10.1080/2331186X.2023.2236463

Ramdani, A., Jufri, A. W., Gunawan, Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5e learning cycle integrated with local wisdom. *Jurnal Pendidikan IPA Indonesia*, *10*(2), 187–199. https://doi.org/10.15294/jpii.v10i2.29956

Sevtia, A. F., Taufik, M., & Doyan, A. (2022). Pengembangan Media Pembelajaran Fisika Berbasis Google Sites untuk Meningkatkan Kemampuan Penguasaan Konsep dan Berpikir Kritis Peserta Didik SMA. *Jurnal Ilmiah Profesi Pendidikan*, *7*(3), 1167–1173. https://doi.org/10.29303/jipp.v7i3.743

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, *104*(5), 873–894. https://doi.org/10.1002/sce.21581

Soeharto, S., & Csapó, B. (2022). Exploring Indonesian student misconceptions in science concepts. *Heliyon*, *8*(9). https://doi.org/10.1016/j.heliyon.2022.e10720

Suriani, N. W., Wola, B. R., Komansilan, R., Komansilan, A., & Susilawati, A. (2023). Do Prospective Science Teachers Experience Misconceptions? Identification Using A Digital Biological Macromolecules Three-Tier Test (Bm-3t). *Journal of Engineering Science and Technology Special Issue On*, *18*(6), 51–60. https://jestec.taylors.edu.my/Special%20Issue%20ISCoE%202022_4/ISCoE%204_07.pdf

Tanaka, M. (2023). Motivation, self-construal, and gender in project-based learning. *Innovation in Language Learning and Teaching*, *17*(2), 306–320. https://doi.org/10.1080/17501229.2022.2043870

Tumanggor, A. M. R., Supahar, Kuswanto, H., & Ringo, E. S. (2020). Using four-tier diagnostic test instruments to detect physics teacher candidates' misconceptions: Case of mechanical wave concepts. *Journal of Physics: Conference Series*, *1440*(1). https://doi.org/10.1088/1742-6596/1440/1/012059

Utami, Y. (2023). Uji Validitas dan Uji Reliabilitas Instrument Penilaian Kinerja Dosen. *Jurnal Sains Dan Teknologi*, *4*(2). https://doi.org/10.55338/saintek.v4i2.730

Yolviansyah, F., Siregar, J., & Maison. (2022). The Relationship of Critical Thinking Skills and Misconceptions on Science Learning. *Thinking Skills and Creativity Journal*, *5*(2), 52–61. https://doi.org/10.23887/tscj.v5i2.45465

Zulfia, F. A., Susilo, H., & Listyorini, D. (2019). Virus-bacteria diagnostic test (vbd-test) in identifying biology teacher's misconception. *Biosfer*, *12*(2), 144–156. https://doi.org/10.21009/biosferjpb.v12n2.144-156