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Differences in high school students' mathematical representation ability in homogeneous classes: Which is better?

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Abstract: Mathematical representation is one of the higher-order thinking skills needed by students in analyzing physics cases as a form of proving the truth of understanding. Referring to the inconsistencies in the results of research on mathematical representation involving gender and the phenomenon of the high ability of female students in heterogeneous classes, it is suspected that there is a relationship between class type and mathematical representation. This study aims to analyze the increase in students' mathematical representation abilities in terms of gender differences in homogeneous classes. The research subjects consisted of class X high school students in Bantul, Indonesia, consisting of 26 boys and 27 girls. The research instrument was 5 physics questions that referred to indicators of mathematical representation. Data analysis to find out how the category of mathematical representation increases using the N-Gain index. The results of this study were (1) the improvement in the ability of the male students' mathematical representation in the medium category was superior to that of the female students, (2) the improvement in the ability to make mathematical expressions and use visual representations was better for the male students, and (3) the ability of the female students in terms of making image representations better than male students. This research implies that further research is needed to be related to the causes of students' misinterpretation in dealing with physics test.

Keywords: mathematical representation; gender differences; homogeneous class

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Introduction

Physics lesson is one of the exact sciences at the upper secondary level in Indonesia. This lesson is the basis for the development of modern technological science by utilizing the concepts and principles of natural phenomena (Azis et al., 2021; Wanwisa Wattanasin et al., 2021). Apart from studying nature through observation and study of natural phenomena (Dahlia et al., 2020; Silaban & Jumadi, 2022), physics also provides some principles of life for humans, such as harmonization and balance so that they can interact as social beings properly (Bandura, 1997; Harisman et al., 2023). This kind of thing fosters students' self-confidence because they can explore various physical phenomena around them (Herliana et al., 2022; Pals et al., 2023; Yanti et al., 2020). The results of interviews with several students of MA Ali Maksum show that there is a trend of student interest in studying science, especially interest in physics because it is loaded with contextual evidence and has a correlation with everyday life (Adeika et al., 2023; Saklressy et al., 2021).

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The processes carried out by students in exploring phenomena can take various forms, one of which is modeling phenomena in the form of mathematical representations (Romansyah & Taqwa, 2023; Santosa, 2022; Srivani & Murugappan, 2023) The use of representation in learning can be used to improve the quality of learning, minimize student learning obstacles (Masrifah & Amiroh, 2023; Wilujeng & Hidayatullah, 2021), increase understanding, and minimize conceptual errors (Soeharto et al., 2019). The type of representation that can be used is strongly influenlasianced by the student's ability to interpret the phenomenon.

National Council of Mathematics Teachers (1989) states that representation is a fundamental subject for students in mathematical communication skills (Fatimah et al., 2020). This representation is in the form of a student's way of thinking in configuring one aspect with another as a whole. An example is the wave function $y(t) = A. \sin(\omega t)$ is one of the mathematical representations in the form of a function, where this function can be represented by a sine graph or a wave image over time. Other forms of representation can be in the form of explanatory text, symbols, mathematical forms, pictures, tables and graphs, or a combination of these is a variety of representations that can be used in communicating the mathematical aspects of a natural phenomenon (Kusumaningsih et al., 2019; Mondal et al., 2023)

Representation is divided into two, namely internal representation in the form of a person's mental tendency to configure mathematical information from a problem. This representation is a cognitive process that cannot be observed so the conclusion of this representation ability is reviewed from the verbal and behavioral side of students (Felmingham et al., 2023; Yadav & Lal, 2023). These two outputs originating from students are referred to as external representations which the teacher can conclude as a mapping of internal representations to their students. Teachers can do this through teaching activities in class, daily interactions, or their tendency to solve problems (Nesi et al., 2022; Schiering et al., 2023).

The urgency of mastering mathematical representation abilities cognitively is used to estimate, audit, and exercise control over the process of solving mathematical problems in physics lessons. Mathematical representations can help build an understanding of physics concepts and build strong memories of meanings and ideas (Rahmawati et al., 2022) Giving challenges to think and reason about the mathematical forms of physical phenomena, along with communicating the results through text or verbally will foster an accurate and logical understanding. This indicates that representation can be a tool for students in explaining concepts, communicating ideas, reflecting, or developing problem-solving strategie (Sahara et al., 2020; Ziadat & Sakarneh, 2022). Furthermore, Monika (2014) states that learning conducted by teachers should use various kinds of representational models (Lamanepa et al., 2022), such as mathematical representations for physics learning in classes with students of different genders.

Gender differences in class are common in the learning process in Indonesia. It can be seen that in general, classes are filled with male and female students, except for schools with independent autonomy, such as schools with an Islamic boarding school system (Damopolii et al., 2023; Nawas et al., 2023). Social construction is suspected to be the cause of the community's assumption that men are characterized by masculine traits and women are feminist so it has an impact on students' cognitive abilities. The learning process in classes with boys and girls sometimes encounters obstacles, including the disruption of mental conditions and acceptance of learning material due to the closed assumption of self-acceptance by the opposite sex (Darmaji et al., 2022; Mawaddah et al., 2018).

Sari (2019) presented the results of her research on differences in student learning outcomes between heterogeneous and homogeneous classes. There is no significant effect of class differences on the learning outcomes obtained. While the results of other studies show that male students tend to be proficient in dissecting and understanding a problem given in the form of a story or eyeglass description, while female students are more proficient in performing mathematical operations on physics test questions using weapons training (Idrizi et al., 2023; Siregar et al., 2023). The results of further research were presented by Arifin (2023) who revealed the fact that male students had higher anxiety about not being able to carry out mathematical operations than female students. This has an impact on their ability to solve problems that require careful analysis and mathematical calculations.

Research findings in two cities in Indonesia, namely Padang and Surakarta, reveal that male students have lower self-confidence in solving mathematical cases than female students. This condition is influenced by their ability to plan solutions, monitor the solution procedures created, and re-evaluate the resulting solutions (Arifin & Kismiantini, 2023; Barokah et al., 2020). This irony is in line with the results of research in secondary schools in Germany which shows that the low enthusiasm of male students in accepting the challenge of a problem results in minimal understanding of concepts (Schürmann & Quaiser-Pohl, 2022). One of the reasons is that male students have a high level of embarrassment about reciting or just asking the teacher for re-explanation. This was revealed in a study at Islamic boarding schools in Malaysia which revealed that female students were more confident in asking questions and had high levels of collaboration in peer teaching (Din et al., 2016; Moses et al., 2021). This is different from the behavior of male students who prefer to remain silent and try to understand the lesson material themselves. This kind of condition is thought to be one of the causes of their enthusiasm being at a low level.

The tendency to understand material independently has positive and negative aspects. One of them is increasing holistic understanding because you are not distracted by peers (Reupert et al., 2023). The impact can be seen in analyzing the problem given so that the information contained can emerge. However, this suggests that there is concern that the mathematical operations carried out have the potential to cause inaccuracies due to the absence of colleagues to help with the mathematical process, especially in terms of the accuracy of the operations carried out (Istiyono et al., 2019). Female students experience different conditions, where they prefer to study using a group system because it helps them to review the resulting mathematical solutions (Maji et al., 2023). Apart from that, female students have a high level of social jealousy if they get different results from their study partners(Avonts et al., 2023; Ghazu, 2023).

This phenomenon certainly raises a question mark related to how the mathematical representation abilities of male and female students differ. The ability to dissect and find mathematical variables of male students is better than that of female students, but the accuracy and thoroughness in the mathematical representation of female students are better than that of male students (Psaki et al., 2018). These results indicate that men are superior in giving answers logically, and women are better in the scientific method aspects of accuracy and thoroughness in heterogeneous classes (Aliyah et al., 2020). In other words, the inconsistency of the results obtained involves heterogeneous classes so that inequality does not yet emerge. This only occurs in heterogeneous classes or also applies to homogeneous classes. Based on this explanation, it is suspected that there is a link between homogeneous and heterogeneous class types and the ability to represent mathematically, which is related to solving physics problems. The aim of this research is to analyze students' mathematical representation abilities in the case of momentum and impulse material physics in the tenth grade in terms of male and female homogeneous classes.

Method

This research uses a *quasi-experiment* method where research subjects undergo a *pretest* first, then treatment is carried out as an action stimulus and ends with a *posttest* to determine the improvement in results due to the stimulus given (Taylor, 2023). The research sample used 53 class X subjects at MA Ali Maksum consisting of 26 men and 27 women. The instrument used is a mathematical representation ability test on Momentum, Impulse, and Collision material. This test consists of 5 questions where each question interprets the indicators of mathematical representation. After the increase in classification is measured, the results will be grouped according to the classification of increasing students' mathematical representation abilities, namely low, medium, and high. The classification that has been obtained is then divided based on gender, namely male and female students with low, medium, and high classifications.

Data analysis used descriptive analysis to explore how the students' mathematical representations were. Guidelines for scoring can be seen in Table 1.

Table 1. Guidelines for Scoring Mathematical Representational Ability

Mathematical Representation Indicators	Achievement Indicators	Question Number
Mathematical model or expression	Solving problems involving mathematical expressions	1, 2
Representation in the form of images	Representing data or obtaining information from image representation	3, 4
	Create images to clarify the problem	5

Data analysis to determine the increase in students' mathematical representation abilities is obtained from the normalized N-Gain value index as follows:

$$N - Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score} \quad (1)$$

The results are then grouped according to the criteria of the normalized *N-Gain* index (g) (Zhan et al., 2023) as follows:

$g > 0{,}7$: High
$0{,}3 < g \leq 0{,}7$: Medium
$g \leq 0{,}3$: Low

Results and Discussion

The results of data analysis in terms of class differences homogeneously can be seen in the following figure. Figure 1 shows students' mathematical representation abilities based on homogeneous classes according to the criteria for increasing mathematical representation abilities according to Saifuddin (2020).

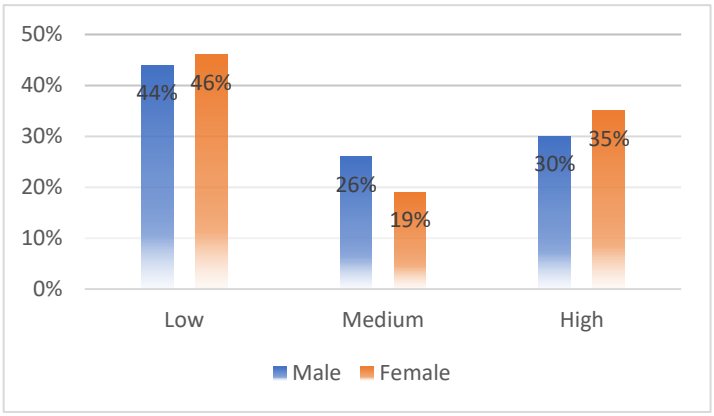


Figure 1. Improvement of Representational Ability in Homogeneous Classes of Males and Females

Figure 1 shows that there are 44% of male students and 46% of female students who have a low increase in representation. Different results were obtained by the medium category, where 26% of male students were in this category, while for female students it was slightly below that with a percentage of 19%. The criteria for increasing high representation were obtained by 30% of male students and 35% of female students. So that the increase in representation ability at low and high predicates is dominated by women. In contrast, male students get more dominating in the moderate predicate than female students.

After knowing the percentage of increased representation ability obtained, the next step is to analyze the increase in students' mathematical representation abilities based on the indicators of mathematical representation that have been compiled. The results of data analysis on students' mathematical representation abilities based on indicators during the pretest implementation can be seen in Figure 2.

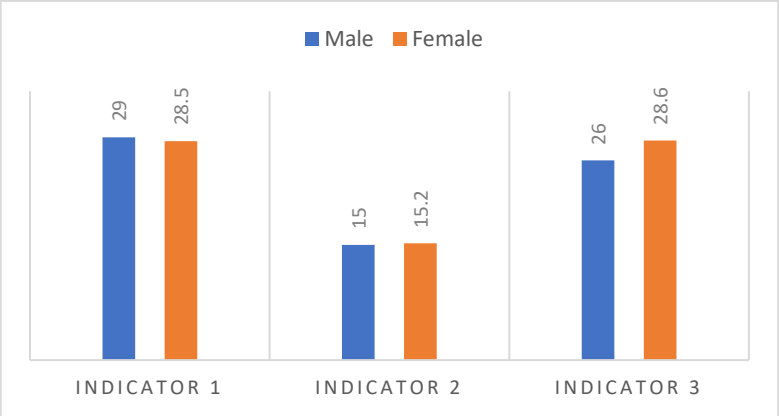


Figure 2. Mathematical Representation Ability during Pretest

Based on the picture, male students have superior representation abilities only on indicator 1. This finding shows that the representational abilities in making mathematical expressions on indicator 1 questions are higher than female students. This difference indicates conformity with the results of research by Adeyemo (2010) which states that the mathematical representation abilities of male students in terms of making mathematical expressions are higher than female students with a low significance value (Miola et al., 2023). The results and data analysis on the implementation of the posttest can be seen in Figure 3.

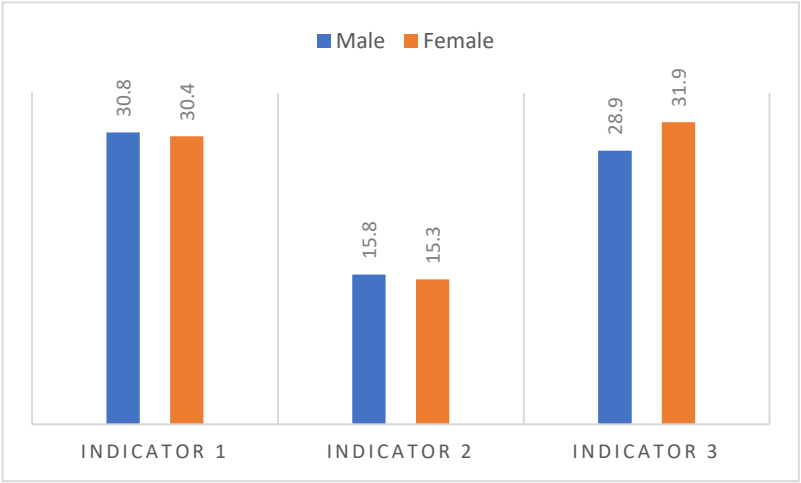


Figure 3. Mathematical Representation Ability during Posttest

Figure 3 shows different results from the pretest results. The homogeneous class of men and women experienced an increase in mathematical representation abilities with a value that was not too significant. However, there was a difference in that male students experienced a higher increase in their representation abilities on the 2 indicators, namely indicator 1 and indicator 2. Meanwhile, the increase in the representation of female students was relatively small, namely 1.9 for indicator 1 and 0.1 for indicator 2. This contrasts with the findings of Adeyemo (2010) which revealed that men's visual representation abilities in using image illustrations were lower than women. The discrepancy between these findings prompted the researchers to review the scoring guidelines used to scan and analyze the data.

Table 1 also shows that the ability of mathematical representation is influenced by the correctness of the answers (accurate) and the completeness of the representation aspects given in the answers to the questions (correct and complete get a score of 20). This is to the results of Zakiri's research (2018) which states that the profile of mathematical communication in students is divided into completeness, fluency, and accuracy of answers. The research found that the profile of male students' mathematical communication abilities was superior to that of female students. So that the

ability of mathematical representation is influenced by a gender-based mathematical communication profile which is reinforced by Mawaddah (2023) where students in homogeneous classes are more expressive in presenting their thoughts because there is no mental turmoil due to perceptions of the opposite sex. This is thought to be the cause of the higher male students' mathematical representation than female students.

Then an analysis of written answers from students in each homogeneous class was carried out in the low-ability category. Determination of students with low representation ability is based on the number of students in the low category compared to the other two categories.

Indicator problem 1:

Fressbie bermassa 0,5 kg dilempar ke arah pemukul dengan kecepatan 12,5 m/s. Kemudian bola berbalik arah dengan kecepatan 37,5 m/s dari arah datangnya bola. Berapakah impuls yang terjadi?

The answers given by students can be seen in Figure 4.

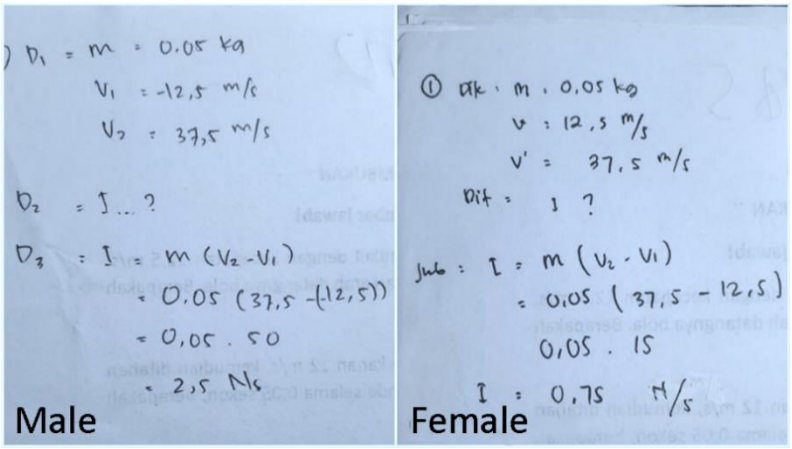


Figure 4. Student representation in answering posttest questions

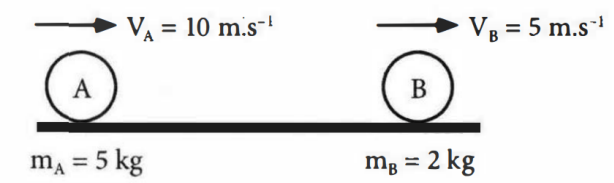
Figure 4 shows that both students' answers begin by writing down the magnitude data presented in the problem. Then male students enter this quantity into the impulse equation as a change in momentum by considering the direction of the velocity vector so that the results are 2.5 Ns which corresponds to the solution of the problem to get a score of 20. The correctness of male students' answers is influenced by their thoroughness in expressing the illustration text on the problem becomes a mathematical expression in vector analytic operations. This is consistent with the characteristics of kinematics material which requires students to think holistically and analytically (Dina Handayani et al., 2023; Romansyah & Taqwa, 2023).

The female students have also done a mathematical representation by writing down the data from the problem illustrations and choosing the right equation to get the problem solved. However, female students have not carried out a comprehensive analysis of the direction of motion of objects, so they do not give a negative sign (-) to the velocity component that reverses direction. So that the result is 0.75 Ns which is not by the problem solution.

Meanwhile, female students have also made mathematical representations by writing down data from the problem illustrations and choosing the right equations to get the problem solutions. However, female students have not carried out a comprehensive analysis of the direction of motion of objects, so they do not give a negative sign (-) to the velocity component that reverses direction. So that the results of 0.75 Ns are obtained which are not by the problem solution.

Indicator problem 2:

Gambar di bawah ini menunjukkan benda A dan B sebelum bertumbukan dengan data kecepatan dan massa tertera. Apabila setelah tumbukan terjadi, kecepatan A menjadi 7 m/s ke kanan, kemanakah arah gerak B dan berapa nilai kecepatannya?



The answers given by students can be seen in Figure 5.

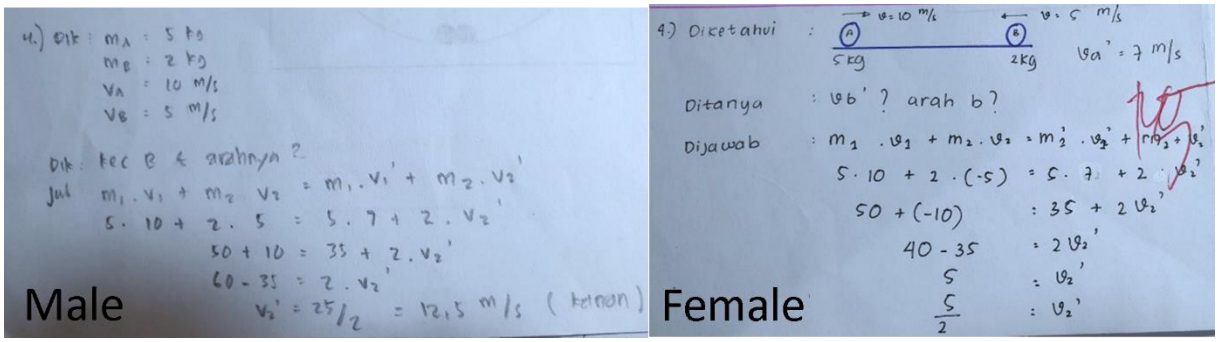


Figure 5. Student representation in answering posttest questions

Figure 5 shows the answers of male students according to the problems given. Students write down data according to the phenomena and perform calculations correctly according to the rule of inline vector resultants. However, male students did not make representations of pictures on their answer sheets. The problem presents both objects moving to the right before the collision and object A moving to the right after the collision with a speed of 7 m/s. This information implies that object B as an object that is pounded must move to the right with an increasing speed because it gets the additional speed from object A. Male students are more thorough in translating and exploring information from the illustrations given so that the solution is obtained v_B = 12.5 m/s and move to the right.

The female student's answer showed her misinterpretation because she made a re-sketch with incorrect image information. This misinterpretation occurs in the direction of vector vB which moves to the left where the illustration of the problem shows that vector vB moves to the right. This has an impact on the destruction of the conception of physics when entering variables into the equation of the Law of Conservation of Momentum. However, the information about the questions is given in full and the mathematical operations are carried out correctly so that a score of 5 is obtained.

The results of the two answers on two different indicators show differences in students' mathematical representations which have an impact on the correctness of the solutions given. Mathematical representation includes elements of mathematical communication so that there is a correlation between mathematical representation abilities and students' mathematical communication profiles. Zakiri (2018) revealed that there are several profiles of mathematical ability, such as precision and accuracy shown in the accuracy of the interpretation given. One of the obstacles in solving physics problems in this study is the accuracy of the mathematical interpretation used to produce wrong answers for female students (Dixit, 2023; Kaushanskaya et al., 2013). In addition, aspects of accuracy also affect students' mathematical communication profiles, such as re-checking the variables that enter the equation and re-examining the correctness of procedures and the results of mathematical operations in problem-solving.

These obstacles are influenced by various things, male students have an orientation to be able to work independently rather than in groups. This tendency is initiated by their individualistic attitude so that they are free to imagine the supplements they provide without fear of being intimidated by their co-workers (Zambrano R. et al., 2023). This freedom has an impact on processing information, mastering concepts, and the ability to make correlations between concepts at a higher level (Ebadi et al., 2023). However, this behavior takes a long time (dos Santos et al., 2023). Apart from that, the homogeneous class conditions where there is a separation between male and female classes mean

they are not burdened with the adrenaline rush of impressing female students with their achievements (Dimitratos et al., 2021).

The opposite happens to women where female students tend to work in groups. The group work model has one advantage, namely aspects of accuracy and speed of work at a high level. Collaboration between female students can improve learning outcomes because there is checking of work results between friends so that the correctness of the results of mathematical operations is relatively high (Bazrgar et al., 2023). The group work model has the disadvantage that students with high cognitive abilities tend to dominate so that freedom of imagination is low because the majority will only depend on them (Hine et al., 2022). Other students also tend to adapt to the concepts proposed so that other views on the concepts they face are minimal and they also worry when they differ from their colleagues (Tan et al., 2023). This is allegedly the cause of female students having high mathematical representation in the aspect of precision and accuracy, but having a low level in the aspect of imagining or creating alternative illustrations in solving the physics problems they face (Anggraini et al., 2023; Fahuzan & Santosa, 2018; Supratman et al., 2023). This is in accordance with findings by Aliyah (2020) where male students have better abilities than female students in terms of mathematical interpretation of the illustrations provided. This condition is thought to be the cause of male students' mathematical representation ability scores being slightly higher than female students in homogeneous classes.

Conclusion

Based on the results of the data analysis that has been done, it can be concluded that there are insignificant differences in the ability of mathematical representation in the male and female homogeneous classes. the increase in the representation ability of male students was higher than that of female students in the medium group. The increase in the ability of female students was higher in the low and high groups. The increase in the ability to make mathematical expressions and use visual representations in the form of auxiliary illustrations for boys is higher than that for female students. Different results were obtained by female students in terms of expressing and making pictures based on the questions being tested. The ability to make image representations for female students is superior to that of male students, but this is often accompanied by misinterpretation of questions. It is recommended to conduct research related to the causes of students' misinterpretation in solving physics test.

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References

Adeika, B. I., Ariyibi, A., Oni, A., Owolabi, O. A., Olude, A. I., Pramanik, S. K., Abiodun, P. O., Efe, F., Abedoh, H., & Bista, K. (2023). Increasing Student Motivation and Learning by Adopting the Experiment-Centric Pedagogy: A Case of Undergraduates in Biology. *ASEE Annual Conference and Exposition, Conference Proceedings*.

Aliyah, H., Kusmayadi, T. A., & Fitriana, L. (2020). Students' mathematical communication skills of the straight line equation based on gender in junior high school. *Journal of Physics: Conference Series*, *1538*(1), 012082. https://doi.org/10.1088/1742-6596/1538/1/012082

Anggraini, R., Mauliana, R., Kumala, T., Azan, S. A., & Fadhly, N. (2023). GENDER DIFFERENCES IN TRAFFIC RISK BEHAVIOR AMONG MOTORCYCLISTS IN INDONESIAN CITY. *Journal of Applied Engineering Science*, *21*(3), 853–858. https://doi.org/10.5937/jaes0-43102

Arifin, Z. A. I., & Kismiantini. (2023). Gender differences in mathematics anxiety and relation to mathematics achievement of Indonesian students. *AIP Conference Proceedings*, *2556*(1). https://doi.org/10.1063/5.0110256/2879535

Avonts, M., Bombeke, K., Michels, N. R., Vanderveken, O. M., & De Winter, B. Y. (2023). How can peer teaching influence the development of medical students? a descriptive, longitudinal interview study. *BMC Medical Education*, *23*(1). https://doi.org/10.1186/s12909-023-04801-4

Azis, K., Panda, F. M., & Budiarti, I. S. (2021). The Influence of Extrinsic Learning Motivation Toward Physics Learning Outcomes of the Tenth Graders of Jayapura Muhammadiyah SHS During the Covid-19 Pandemic. *Impulse: Journal of Research and Innovation in Physics Education*, *1*(1), 1–10. https://doi.org/10.14421/IMPULSE.2021.11-01

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

Barokah, I., Budiyono, B., & Saputro, D. R. S. (2020). Students metacognition in solving mathematical problems based on gender differences. *Journal of Physics: Conference Series*, *1469*(1), 012158. https://doi.org/10.1088/1742-6596/1469/1/012158

Bazrgar, A., Rahmanian, M., Ghaedi, A., Heidari, A., Bazrafshan, M., Amini, M., Bazrafshan, H., Ahmadpour, M., & Bazrafshan drissi, H. (2023). Face-to-face, online, or blended: which method is more effective in teaching electrocardiogram to medical students. *BMC Medical Education*, *23*(1). https://doi.org/10.1186/s12909-023-04546-0

Dahlia, D., Maison, M., & Nehru, N. (2020). Developing An Authentic Assessment Instruments of Psychomotor Domain For The Physics Learning on Measurement Materials in Class X SMA. *Journal of Science Education Research*, *4*(2), 44–48.

Damopolii, M., Shabir, M. U., & Burga, M. A. (2023). The Phenomenon of Punishment at Pesantren in South Sulawesi: An Islamic Law and Islamic Education Approaches. *Samarah*, *7*(3), 1643–1660. https://doi.org/10.22373/sjhk.v7i3.18207

Darmaji, D., Astalini, A., Kurniawan, D. A., & Rini, E. F. S. (2022). Gender analysis in measurement materials: Critical thinking ability and science processing skills. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *11*(1), 113–128. https://doi.org/10.24042/jipfalbiruni.v11i1.11509

Dimitratos, S. M., Hercules, M., Stephensen, C. B., Cervantes, E., & Laugero, K. D. (2021). Association between physiological stress load and diet quality patterns differs between male and female adults. *Physiology and Behavior*, *240*. https://doi.org/10.1016/j.physbeh.2021.113538

Din, N. M., Ayub, A. F. M., & Tarmizi, R. A. (2016). Influence of parental involvement and peer support on mathematics engagement among malaysian secondary school students. *Malaysian Journal of Mathematical Sciences*, *10*, 175–185.

Dina Handayani, ati, Djoko Lesmono, A., Handono Budi Prastowo, S., Supriadi, B., Mutia Dewi, N., History, A., Handayani, R. D., Lesmono, A. D., B Prastowo, S. H., Supriadi, B., & Dewi, N. M. (2023). Students' Computational Thinking Skills In Physics Learning: A Case study of Kinematic Concepts. *Indonesian Review of Physics*, *6*(1), 1–9. https://doi.org/10.12928/IRIP.V6I1.6464

Dixit, S. (2023). Gendered Memes: Stereotypical Representation to Agentic Counter-Conduct. In *Gender and Popular Visual Culture in India: 'Benevolent' Sexism and Disguised Discrimination*. https://doi.org/10.4324/9781003434092-11

dos Santos, E. B., Ball, G. F., Logue, D. M., Cornil, C. A., & Balthazart, J. (2023). Sex differences in song syntax and syllable diversity in testosterone-induced songs of adult male and female canaries. *Biology of Sex Differences*, *14*(1). https://doi.org/10.1186/s13293-023-00533-8

Ebadi, S., Amini, Z., & Gheisari, N. (2023). On the relationship between mobile-based extramural activities and vocabulary development of EFL learners: a mixed-method study. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00252-y

Fahuzan, K., & Santosa, R. H. (2018). Gender Differences in Motivation to Learn Math Using Role Play Game in Smartphone. *Journal of Physics: Conference Series*, *1097*(1). https://doi.org/10.1088/1742-6596/1097/1/012130

Fatimah, S., Johar, R., & Zubainur, C. M. (2020). Students' logical mathematical intelligence in completing mathematical problems with natural disaster context. *Journal of Physics: Conference Series*, *1470*(1). https://doi.org/10.1088/1742-6596/1470/1/012022

Felmingham, T., O'halloran, S., Poorter, J., Rhook, E., Needham, C., Hayward, J., Fraser, P., Kilpatrick, S., Leahy, D., & Allender, S. (2023). Systems thinking in local government: intervention design and adaptation in a community-based study. *Health Research Policy and Systems*, *21*, 90. https://doi.org/10.1186/s12961-023-01034-1

Ghazu, M. (2023). The Relationship between Men and Women: Ahlam Mosteghanemi's Point of View. *Dirasat: Human and Social Sciences*, *50*(3), 239–247. https://doi.org/10.35516/hum.v50i3.5409

Harisman, Y., Ashari, J., Amam, A., & Harun, L. (2023). The analysis application of the working backwards strategy in mathematic problem solving for senior high school students between gender. *AIP Conference Proceedings*, *2698*, 060024. https://doi.org/10.1063/5.0122627

Herliana, F., Farhan, A., & Made Astra, I. (2022). The Relationship of Motivation and Self-regulated Learning through Blended Learning in the Covid-19 Era. *JIPF (JURNAL ILMU PENDIDIKAN FISIKA)*, *7*(1). https://doi.org/10.26737/jipf.v7i1.2137

Hine, B., Bates, E. A., Mackay, J., & Graham-Kevan, N. (2022). Comparing the Demographic Characteristics, and Reported Abuse Type, Contexts and Outcomes of Help-Seeking Heterosexual Male and Female Victims of Domestic Violence: Part I – Who Presents to Specialist Services? *Partner Abuse*, *13*(1), 20–60. https://doi.org/10.1891/PA-2021-0009

Idrizi, E., Filiposka, S., & Trajkovikj, V. (2023). Gender impact on STEM online learning- a correlational study of gender, personality traits and learning styles in relation to different online teaching modalities. *Multimedia Tools and Applications*, *82*(19), 30201–30219. https://doi.org/10.1007/s11042-023-14908-x

Istiyono, E., Mustakim, S. S., Widihastuti, Suranto, & Mukti, T. S. (2019). Measurement of physics problem-solving skills in female and male students by physteprоss. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 170–176. https://doi.org/10.15294/jpii.v8i2.17640

Kaushanskaya, M., Gross, M., & Buac, M. (2013). Gender differences in child word learning. *Learning and Individual Differences*, *27*, 82–89. https://doi.org/10.1016/J.LINDIF.2013.07.002

Kusumaningsih, W., Saputra, H. A., & Aini, A. N. (2019). Cognitive style and gender differences in a conceptual understanding of mathematics students. *Journal of Physics: Conference Series*, *1280*(4), 042017. https://doi.org/10.1088/1742-6596/1280/4/042017

Lamanepa, G. H., M Maing, C. M., Ursula Jawa Mukin, M., & Bunga Naen, A. (2022). The Role of Visual Representation for High School Physics in Teaching of Classical Mechanics. *JPPPF*, *8*(1). https://doi.org/10.21009/1

Maji, S., Mitra, S., & Asthana, M. K. (2023). 'Treading the no woman's land': the gender-STEM dynamics in higher education in premier institutions of India. *European Journal of Engineering Education*. https://doi.org/10.1080/03043797.2023.2168518

Masrifah, M., & Amiroh, D. (2023). The multi-representational ability profile of physics students in the interactive multimedia assisted problem-based learning during the Covid-19 pandemic. *Momentum: Physics Education Journal*, *7*(2), 188–200. https://doi.org/10.21067/mpej.v7i2.7501

Mawaddah, Ahmad, A., & Duskri, M. (2018). Gender differences of mathematical critical thinking skills of secondary school students. *Journal of Physics: Conference Series*, *1088*. https://doi.org/10.1088/1742-6596/1088/1/012054

Miola, L., Meneghetti, C., Pazzaglia, F., & van der Ham, I. (2023). Gender-related differences in environment learning: Examining task characteristics and spatial beliefs. *Learning and Individual Differences*, *106*, 102342. https://doi.org/10.1016/J.LINDIF.2023.102342

Mondal, S., Murmu, T., Chakravarty, K., Sarkar, A. K., & Sasmal, S. K. (2023). Mathematical modelling of HIV-1 transcription inhibition: a comparative study between optimal control and impulsive approach. *Computational and Applied Mathematics*, *42*(8). https://doi.org/10.1007/s40314-023-02473-w

Moses, P., Tey, T. C. Y., & Cheah, P. K. (2021). STEM and Non-STEM Students' Perception towards Work Environment and Career Prospect. *29th International Conference on Computers in Education Conference, ICCE 2021 - Proceedings*, *1*, 157–162.

Nawas, A., Darmawan, I. G. N., & Maadad, N. (2023). Indonesian secular vs. Madrasah schools: assessing the discrepancy in English reading and listening tests. *Language Testing in Asia*, *13*(1). https://doi.org/10.1186/s40468-023-00266-w

Nesi, Y. M. D., Kusairi, S., & Nafisah, A. W. L. (2022). Analysis of student perceptions of problem-solving learning and peer assessment. *Momentum: Physics Education Journal*, 73–85. https://doi.org/10.21067/mpej.v6i1.6005

Pals, F. F. B., Tolboom, J. L. J., & Suhre, C. J. M. (2023). Development of a formative assessment instrument to determine students' need for corrective actions in physics: Identifying students' functional level of understanding. *Thinking Skills and Creativity*, *50*. https://doi.org/10.1016/j.tsc.2023.101387

Psaki, S. R., Mccarthy, K. J., & Mensch, B. S. (2018). *Measuring Gender Equality in Education: Lessons from Trends in 43 Countries*. *44*(1), 117–142. https://doi.org/10.1111/padr.12121

Rahmawati, I., Nisrina, N., & Abdani, M. R. (2022). Multi-representation-based interactive physics electronic module as teaching materials in online learning. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *11*(1), 47–55. https://doi.org/10.24042/jipfalbiruni.v11i1.10544

Reupert, A., Sullivan, A., Tippett, N., White, S., Woodcock, S., Chen, L., & Simons, M. (2023). An Exploration of the Experiences of Substitute Teachers: A Systematic Review. *Review of Educational Research*, *93*(6), 901–941. https://doi.org/10.3102/00346543221149418

Romansyah, T. A., & Taqwa, M. R. A. (2023). Are There Differences in Students' Ability to Solve Vector Problems in Mathematical and Visual Representations? *AIP Conference Proceedings*, *2569*. https://doi.org/10.1063/5.0112655

Sahara, L., Nafarudin, N., Fayanto, S., & Tairjanovna, B. A. (2020). Analysis of Improving Students' Physics Conceptual Understanding through Discovery Learning Models Supported by Multi-representation: Measurement Topic. *Indonesian Review of Physics*, *3*(2), 57–65. https://doi.org/10.12928/IRIP.V3I2.3064

Sakliressy, M. T., Sunarno, W., & Nurosyid, F. (2021). Students Scientific Attitude in Learning Physics Using Problem Based Learning Model with Experimental and Project Methods. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *10*(1), 59–70. https://doi.org/10.24042/jipfalbiruni.v10i1.8347

Santosa, I. E. (2022). Representation and content in student's exam note sheets. *Momentum: Physics Education Journal*, *6*(2), 139–149. https://doi.org/10.21067/mpej.v6i2.6320

Schiering, D., Sorge, S., Tröbst, S., & Neumann, K. (2023). Course quality in higher education teacher training: What matters for pre-service physics teachers' content knowledge development? *Studies in Educational Evaluation*, *78*, 101275. https://doi.org/10.1016/J.STUEDUC.2023.101275

Schürmann, L., & Quaiser-Pohl, C. (2022). Out-of-school learning levels prior achievement and gender differences in secondary school students' motivation. *International Journal of Educational Research Open*, *3*, 100158. https://doi.org/10.1016/J.IJEDRO.2022.100158

Silaban, Y. F. H., & Jumadi, J. (2022). Concept understanding profile of high school students on doppler effect and sound intensity levels. *Momentum: Physics Education Journal*, 51–58. https://doi.org/10.21067/mpej.v6i1.5664

Siregar, R. N., Suryadi, D., Prabawanto, S., & Mujib, A. (2023). Students' mathematics self-efficacy in learning social arithmetic topic. *International Journal of Evaluation and Research in Education*, *12*(4), 2176–2185. https://doi.org/10.11591/ijere.v12i4.25480

Soeharto, Csapó, B., Sarimanah, E., Dewi, F. I., & Sabri, T. (2019). A review of students' common misconceptions in science and their diagnostic assessment tools. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 247–266. https://doi.org/10.15294/jpii.v8i2.18649

Srivani, M., & Murugappan, A. (2023). Design of a Cognitive Knowledge Representation Model to Assess the Reasoning Levels of Primary School Children. *Expert Systems with Applications*, *231*, 120604. https://doi.org/10.1016/J.ESWA.2023.120604

Supratman, Zubaidah, S., Tarigan, M. R. M., & Azis, S. (2023). Contribution of critical thinking, science process skills towards learning outcomes based on gender. *International Journal of Evaluation and Research in Education*, *12*(4), 1985–1993. https://doi.org/10.11591/ijere.v12i4.24927

Tan, E., Ng, W. M., Soh, P. C., Tan, D., & Cleland, J. (2023). 'But what if you miss something …?': factors that influence medical student consideration of cost in decision making. *BMC Medical Education*, *23*(1). https://doi.org/10.1186/s12909-023-04349-3

Taylor, E. S. (2023). Teacher evaluation and training. In *Handbook of the Economics of Education*. https://doi.org/10.1016/bs.hesedu.2023.03.002

Wanwisa Wattanasin, Pinanta Chatwattana, & Pallop Piriyasurawong. (2021). Engineering project-based learning using a virtual laboratory and mixedreality to enhance engineering and innovation skills. *World Transactions on Engineering and Technology Education*, *19*(2).

Wilujeng, I., & Hidayatullah, Z. (2021). Alternative learning model in physics learning: Effect of the conceptual change model with cognitive conflict on critical thinking skill. *Momentum: Physics Education Journal*, *5*(2), 111–120. https://doi.org/10.21067/mpej.v5i2.5260

Yadav, D. K., & Lal, R. R. (2023). Analysis of Vedic Mathematics Ekadhikena Purvena Sutra in Squaring and Multiplication. *Proceedings of the 8th International Conference on Communication and Electronics Systems, ICCES 2023*, 12–19. https://doi.org/10.1109/ICCES57224.2023.10192851

Yanti, F. A., Kuswanto, H., Habibi, H., & Kinasih, A. (2020). Development of Analogy-Based Material Physics Module to Provide Analogy Ability of Physics Teachers Candidates. *Jurnal Pendidikan Fisika Indonesia*, *16*(1), 34–40. https://doi.org/10.15294/jpfi.v16i1.9122

Zambrano R., J., Kirschner, F., Sweller, J., & Kirschner, P. A. (2023). Effect of task-based group experience on collaborative learning: Exploring the transaction activities. *British Journal of Educational Psychology*, *93*(4), 879–902. https://doi.org/10.1111/bjep.12603

Zhan, Q., Wang, S., Li, C., Li, M., Liu, D., Peng, W., Song, F., Shi, T., & Li, Y. (2023). Revision and validation of the prosocialness scale for adults (PSA) among chinese college students. *BMC Psychology*, *11*(1). https://doi.org/10.1186/s40359-023-01124-3

Ziadat, A. H., & Sakarneh, M. A. (2022). Academic achievement and self-regulated learning from parent's perspective of student with learning difficulties. *International Journal of Evaluation and Research in Education*, *11*(3), 1028–1039. https://doi.org/10.11591/ijere.v11i3.22177