JIPF (JURNAL ILMU PENDIDIKAN FISIKA)
p-ISSN: 2477-5959 | e-ISSN: 2477-8451 *Vol. 9 No. 3, September 2024, Page 368-376*

Analysis of Student Attitudes and Beliefs in Physics Education

Wandi [1*)], Irma Rahma Suwarma [2], Winny Liliawati [3], Fani Mardianti [4], Riski Amelia [5]
Universitas Pendidikan Indonesia, Indonesia[1,2,3,4,5]
[*)]Corresponding E-mail: wandi@upi.edu

Received: April 7th, 2024. Revised: July 26th, 2024. Accepted: July 29th, 2024

Keywords :
Attitude; Belief; Physics Education

ABSTRACT
Understanding the attitudes and beliefs of physics students is a critical step in overcoming obstacles and creating a more positive and conducive learning environment. To achieve that aim, the study is strategically designed to achieve the following objectives: 1. to compare student attitudes and beliefs about learning physics to the perspectives of experts in the field; and 2. to investigate disparities in student attitudes and beliefs about gender, with the goal of identifying potential gender-based variations that could impact problem-solving performance in the field. We used a quantitative descriptive study approach to comprehensively explore high school students' attitudes and beliefs about physics, as well as to compare their viewpoints with those of professionals in the area. We're using the Colorado Learning Attitudes about Science Survey (CLASS). The findings show that the majority of pupils had scores between 50 and 60, suggesting a modest level of conformity to the expert. In terms of gender, female pupils clearly surpass their male counterparts. While both male and female students excel in courses that correlate with their own interests, they experience similar obstacles in learning applied conceptual knowledge. These findings emphasize the necessity of targeted treatments and educational techniques for addressing inequities and promoting overall academic success in children of both genders.

INTRODUCTION

Physics education is a part of scientific literacy, nurturing critical thinking, problem-solving skills, and a profound comprehension of the physical universe [1]. Within the realm of effective physics instruction, student attitudes and beliefs hold significant importance for increasing overall achievement in the subject [2] [3]. A student's disposition toward a subject profoundly shapes their learning experience and the dedication they invest in mastering it. Furthermore, these beliefs, whether constructive or negative, intricately mold the strategies and approaches students employ when grappling with intricate problems, particularly in the context of physics education.

Attitudes refer to the emotional and cognitive dispositions that students hold towards physics as a subject. These attitudes can be positive, negative, or somewhere in between, and they play a pivotal role in shaping the overall learning experience [4]. One of the most significant roles of attitudes is their effect on student motivation [5] [6]. Students who possess positive attitudes towards physics tend to be more motivated, exhibit higher levels of engagement with the subject matter, and are more likely to invest time and effort into their studies. This intrinsic motivation often leads to better academic performance [7]. Conversely, students with negative attitudes may find themselves demotivated, leading to reduced effort and lower achievement. Research has explored gender differences in attitudes towards physics. Historically, physics has been associated with a male-dominated stereotype [8], which can influence the attitudes of female students. While significant strides have been made in reducing this gender gap, it is essential to continue addressing these disparities to create an inclusive and equitable learning environment.

Beliefs, in the context of learning physics, encompass students' perceptions, expectations, and confidence in their ability to comprehend and excel in physics. These beliefs profoundly impact their problem-solving strategies and learning outcomes. One of the central aspects of beliefs in physics education is self-efficacy, which refers to a student's belief in their own capacity to achieve specific goals or tasks in physics. High self-efficacy in physics is associated with perseverance in the face of challenging problems, effective problem-solving strategies, and superior academic performance [9]. Conversely, low self-efficacy can lead to self-doubt and difficulties in overcoming obstacles [10]. Students often hold beliefs about the nature of physics itself, whether they perceive it as an abstract, theoretical field or as a practical, real-world discipline. These beliefs can significantly impact students' motivation and engagement with physics content, as well as their problem-solving approaches.

Kaur & Zhao [11] defined Physics Attitude Scale consists of five dimensions: Enthusiasm toward Physics, Physics Learning, Physics as a Process, Physics Teacher, and Physics as a Future Vocation. The first dimension, "Enthusiasm toward Physics," gauges the level of passion and interest a person has for the subject, reflecting their eagerness to explore its concepts. "Physics Learning" assesses how a person views their own ability to grasp and understand physics concepts, indicating their self-perceived competence and confidence in learning the subject. "Physics as a Process" delves into how individuals perceive the methods and approaches involved in the study of physics, shedding light on their appreciation for the scientific process itself. "Physics Teacher" evaluates the role of educators in shaping students' attitudes, highlighting the impact of teaching methods and interactions with physics instructors. Lastly, "Physics as a Future Vocation" examines whether individuals see physics as a potential career path or a field of study that might play a significant role in their future, offering insights into their long-term aspirations within the realm of physics. This multi-dimensional scale provides valuable insights into the complex and multifaceted nature of attitudes toward physics, enabling educators and researchers to better understand and address the diverse perspectives of students and individuals in this field.

Dimension Attitude and belief based on Adams et al. [12] are Real world connections, Personal interest, Sense making/effort, Conceptual connections, Applied conceptual understanding, Problem solving general, Problem solving confidence, Problem solving sophistication. Attitude and belief toward physics encompass a spectrum of dimensions that collectively shape how individuals perceive and engage with the subject. These dimensions provide valuable insights into the cognitive and affective aspects of learning and engaging with physics.

Understanding the attitudes and beliefs of learning physics is a pivotal step in alleviating challenges and cultivating a more favorable and conducive learning environment. However, amidst the extensive body of research concerning teaching methodologies and curriculum development in the domain of physics education, there exists a notable dearth of comprehensive studies addressing the roles of student attitudes and beliefs within the educational framework. This research undertakes to bridge this knowledge gap by offering valuable insights into this uncharted territory.

To this end, the study is strategically crafted to fulfill the following objectives:

1. To compare student attitudes and beliefs in learning physics with the perspectives of experts in the field. This comparative analysis will illuminate the congruence or disparity between student perceptions and the professional vantage point.
2. To explore disparities in student attitudes and beliefs related to gender, with the aim of identifying potential gender-based variations that could impact problem-solving performance in the field of physics.

METHOD

For this study, we have adopted a quantitative descriptive research design to systematically investigate high school students' attitudes toward physics and conduct a comparative analysis with the perspectives of experts in the field. This design allows us to collect and analyze numerical data, providing a clear and comprehensive snapshot of student attitudes and beliefs. We are utilizing the Colorado Learning Attitudes about Science Survey (CLASS) developed by Adams et al. [12], specifically focusing on the "Attitude toward Physics" questions. The CLASS survey, widely recognized and validated in educational research, offers a structured and standardized instrument for assessing student perceptions in physics education. The "Attitude toward Physics" questions within the survey are designed to capture a range of cognitive and affective aspects of student attitudes, encompassing factors such as Real World Connections, Personal Interest, Sense Making/Effort, Conceptual Connections, Applied Conceptual Understanding, Problem Solving General, Problem Solving Confidence, and Problem Solving Sophistication.

The total number of respondents in this study is 121 students in West Java, Indonesia, divided based on grade levels as follows: 24 students in Grade X, 57 students in Grade XI, and 40 students in Grade XII. Out of the total respondents, there are 86 female students and 35 male students. The data analysis process follows the method developed by Adams et al. [12], which involved several important steps with partial modification. Firstly , in order to assess the reliability of both the individual items (questions or indicators) and the respondents themselves, we employed a statistical measurement method called the Rasch model. This statistical model is particularly useful for evaluating the quality and consistency of responses in educational assessments, surveys, and psychological measurements. The Rasch model helps us understand the reliability of each item in our survey or assessment tool, as well as the reliability of each person's responses. In this way, we can ensure that the data we collect and analyze are robust, providing a more accurate and comprehensive insight into the attitudes of high school students toward physic.

Secondly, we utilized Microsoft Excel as a primary tool to compare and contrast the responses provided by the students for each specific indicator. This involved examining how students answered various questions or statements related to their attitudes toward physics. We also compared these student responses with the expert opinions or responses, which served as a benchmark. By making these comparisons, we aimed to determine the degree of alignment or disparity between the students' perceptions and the viewpoints of professionals in the field.

RESULTS AND DISCUSSIONS

To evaluate the reliability of both respondents (person) and the questions (item) in the tested questionnaire, the data collected from the research is subjected to analysis utilizing the Rasch Model. This analysis is conducted through the utilization of the Winstep 5.4.1 software application. The process involves assessing the consistency and dependability of responses from individuals (persons) as well as the effectiveness and quality of the questions (items) included in the test. The results of this analysis are presented and illustrated in Figure 1.

```
 Calculating JMLE Fit Statistics
>=========================================================================<
Time for estimation: 0:0:0.938
Output to E:\nulis nulis nulis\## Project Jurnal\Penelitian fisika\Data\ZOU015WS.TXT
E:\nulis nulis nulis\## Project Jurnal\Penelitian fisika\Data\datarasch.prn
-------------------------------------------------------------------------------
| Person      121 INPUT      121 MEASURED              INFIT         OUTFIT    |
|             TOTAL       COUNT      MEASURE  REALSE    IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN        149.6        42.0        .62     .21      1.05    -.2   1.08    -.1|
| P.SD         16.8          .0        .76     .10       .58    2.1    .61    2.1|
| REAL RMSE     .23 TRUE SD     .72  SEPARATION  3.19  Person RELIABILITY  .91|
|-------------------------------------------------------------------------------|
| Item        42 INPUT       42 MEASURED               INFIT         OUTFIT    |
|             TOTAL       COUNT      MEASURE  REALSE    IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN        430.9       121.0        .00     .11      1.02     .0   1.08     .4|
| P.SD         57.0          .0        .55     .02       .29    1.6    .28    1.4|
| REAL RMSE     .11 TRUE SD     .54  SEPARATION  4.75  Item   RELIABILITY  .96|
-------------------------------------------------------------------------------
Output written to E:\nulis nulis nulis\## Project Jurnal\Penelitian fisika\Data\ZOU015WS.TXT
CODES= 1245
Measures constructed: use "Diagnosis" and "Output Tables" menus
```

Fig 1. *The results of the analysis of Person and Item Reliability using the Rasch Model*

From Figure 1, it can be observed that the reliability level for persons is 0.91 and the item reliability is 0.96, which according to Fisher [13] falls into the categories of Very Good and Excellent respectively.

In Figure 2, the distribution of percentages comparing students' answers relative to expert answers is displayed. In this figure, the x-axis represents the level of agreement scores between student and expert answers. The higher the number of statements that match with the expert, the higher the agreement score, indicating that the students' answers are closer to the expert perspective. Meanwhile, the y-axis represents the percentage of students according to the score categories obtained. From the data, it can be seen that the majority of students (45.5%) have scores between 50-60, indicating a moderate level of conformity with the expert. The highest percentage is approximately 1.7% with scores between 80 to 90, while the lowest is 3.3% with scores between 30 to 40.

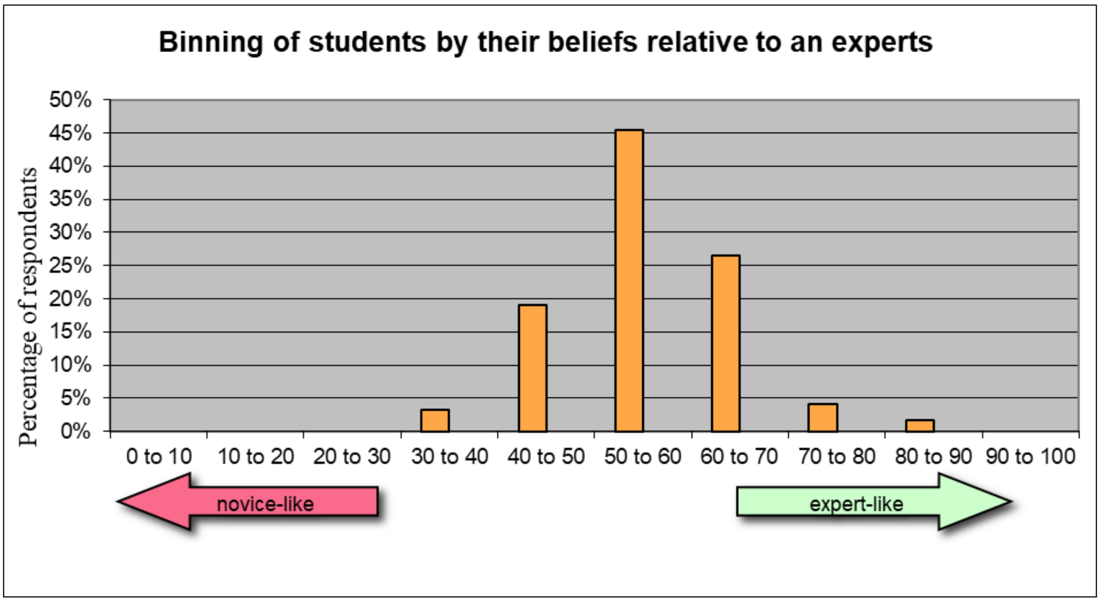

Fig 2. *Percentage of statements for which student agrees with experts response*

A moderate level of agreement between students and experts indicates that improvement and coaching is still needed. Several factors influencing these results include, first, the popularity of physics among students. Most students say that physics is “not for me” [14], indicating that physics is less popular among students. This statement shows that many students feel that physics is not a suitable field for them. This illustrates that physics is less popular among students. In this context, the popularity of physics refers to the level of student interest and engagement in the subject. If many students feel that physics is irrelevant or difficult to understand, this may result in a lack of interest and neglect of the subject. The impacts can vary, from lower participation in physics courses to a decline in the number of students choosing to continue studying physics at a higher level.

Second, the inadequate qualifications of physics teachers is a significant problem in the educational context. Many studies have been carried out to evaluate and improve the qualifications of physics teachers in various countries. For example, studies by Sanjar & Oghly [15] in Japan and by Sultanova et al. [16] in Ukraine highlight teacher training efforts to improve the quality of physics teaching. The research shows that despite efforts to improve the qualifications of physics teachers through training and professional development programs, there are still challenges to be overcome. Factors such as lack of resources, unsupportive educational policies, and lack of incentives for teachers can affect the effectiveness of such training.

Figure 3 displays the overall distribution of student responses where the statements are not the same or disagree with the expert. This indicates that the smaller the disagreement score, the closer the students are to the expert's ability. Based on the data, it is found that the majority of students (35.5%) have scores between 50 to 60, placing them at a moderate level. Students with the highest disagreement scores (scores 60 to 70) make up 3.3%, while those with the lowest disagreement scores (scores 10 to 20) are at 1.7%, indicating that these students' responses are similar to those of the expert.

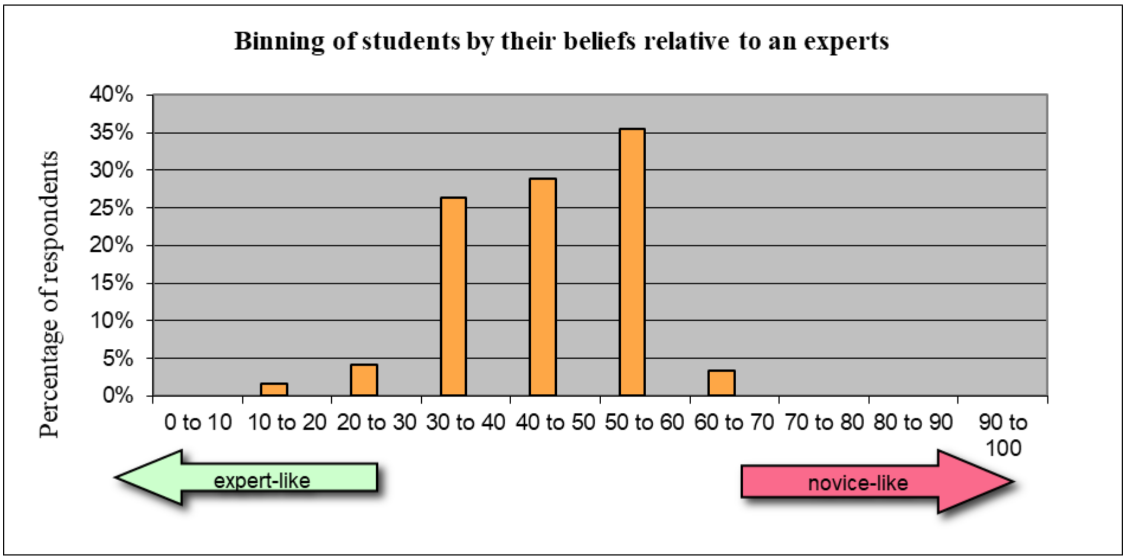

Fig 3. *Percentage of statements for which student disagrees with experts response*

Based on the obtained agree and disagree scores from all students, it can be said that the majority of students are at a moderate level with scores between 50 to 60 (45.5% agree and 35.5% disagree). For students with abilities closest to novice, 3.3% agree and 3.3% disagree, while students with abilities closest to expert level are 1.7% agree and 1.7% disagree.

If we look at the graph, it seems that the curve tends to be more inclined towards the expert view. This means that the moderate level of conformity obtained from the student's views matches the expert's views more closely. This shows that students' understanding of physics tends to be more in line with the views of experts or established standards. Although there was variation in students' scores, in general, this trend suggests that they had a better degree of agreement with expert views. This illustrates the positive results of teaching and learning efforts, which may be successful in helping students understand and accept physics concepts according to expected standards. However, further analysis needs to be carried out to understand the factors that contribute to this trend as well as whether there are certain areas that need special attention to increase the level of student conformity with expert views.

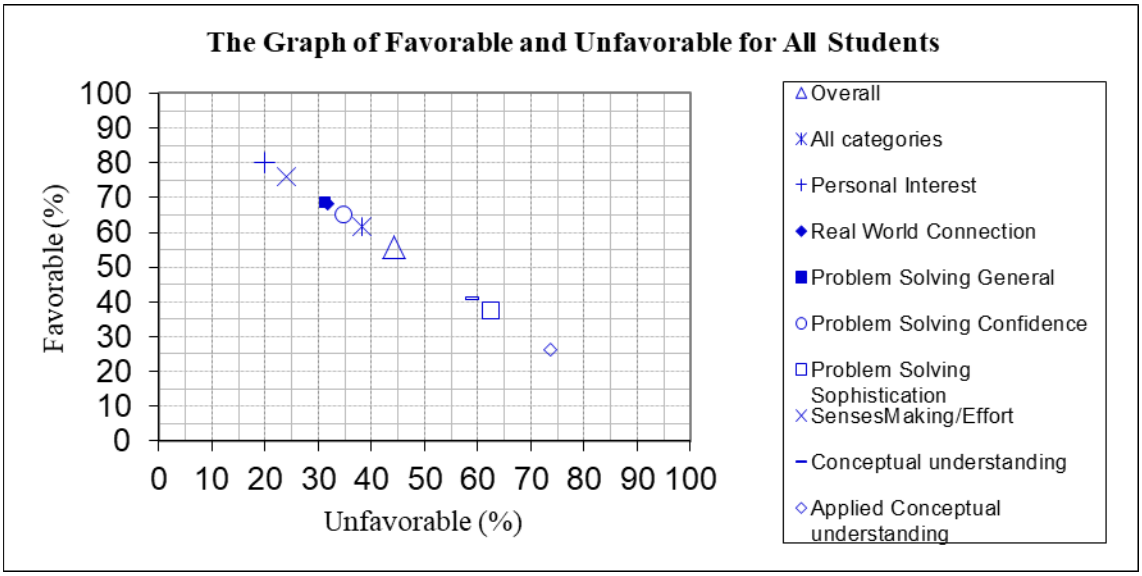

Fig 4. *The Graph of Favorable and Unfavorable for All Students for Each Indicator*

Figure 4 shows the favorable and unfavorable responses of all students for all attitude and belief indicators. In this context, "favorable" and "unfavorable" serve as metrics to gauge the alignment between students' responses and those of experts. When students' responses align closely with the expert's perspective, they are considered "favorable." Conversely, if there is a discrepancy between students' responses and the expert's, they are labeled as "unfavorable." Analyzing Figure 4, it becomes apparent that approximately 44.2% of all responses across indicators exhibit favorable alignment with the expert's viewpoint. However, upon closer examination of individual indicators, a notable trend emerges. For instance, within the personal interest indicator, a striking 80.0% of student responses demonstrate favorable alignment with the expert. This suggests a strong correlation between students' interests and the expert's assessment.

Personal interest plays a pivotal role in one's attitude and belief toward physics. It measures the inherent curiosity and fascination a person holds for the subject. Individuals with a high degree of personal interest are more likely to engage in physics-related activities, seek out additional information, and have a positive outlook on learning. The high level of student interest that is in line with expert views indicates that teaching and learning efforts may be successful in communicating and clarifying physics concepts effectively to students. This also indicates that students may feel connected to the course material and see relevance according to expert views.

On the other hand, the Applied Conceptual Understanding delves into the practical application of physics concepts. It reflects one's ability to use their theoretical knowledge to solve real-world problems. An individual with a high score here not only understands physics but can also apply it in practical situations. This indicator portrays a contrasting scenario, with merely 26.3% of student responses showing favorable alignment with the expert. This indicates a notable disparity between students' grasp of applied conceptual understanding and the expert's expectations. In summary, while the overall alignment between students' responses and expert perspectives stands at 44.2%, the varying percentages across different indicators underscore the nuanced nature of student comprehension and its correspondence with expert judgment.

Students' interest in physics is in the high category according to expert views, but the practical application of physics concepts in solving real world problems is very low. High interest in a subject, such as physics, can encourage students to be more enthusiastic in studying the material and mastering the concepts being taught. When students have a strong interest in physics, they tend to be more motivated to understand and apply those concepts in real-world contexts. When these two variables are in conflict, this may be due to the following factors: firstly, limited resources: Students may not have adequate access or the necessary resources to apply physics concepts in practical situations. This could include a lack of laboratory equipment or technology required for physics experiments, or limitations in access to relevant learning resources [17]. Secondly lack of Practical Experience: Even though students have a high interest in physics, they may not have enough experience in applying these concepts in a real-world context. Lack of opportunities to participate in practical activities or physics projects can hinder students' ability to apply what they have learned. Third, lack of Additional Motivation: Even though students' interest is high, they may be less motivated to apply physics concepts in real situations due to the lack of additional incentives or encouragement [18]. This may be due to a lack of appreciation or recognition for their efforts, or perhaps due to a lack of understanding of the direct relevance of physics concepts in everyday life. Fourth, Difficulty in Connecting Concepts with Practical Contexts [19]. Some students may experience difficulty in connecting physics concepts with practical applications in everyday life. This could be due to a lack of ability to transfer knowledge from learning situations to real situations, or due to a lack of understanding of how physics concepts can be applied in various contexts.

In Figure 5, a comparison of student responses based on gender is presented. Females are denoted by blue-colored symbols, whereas males are represented by red-colored symbols.

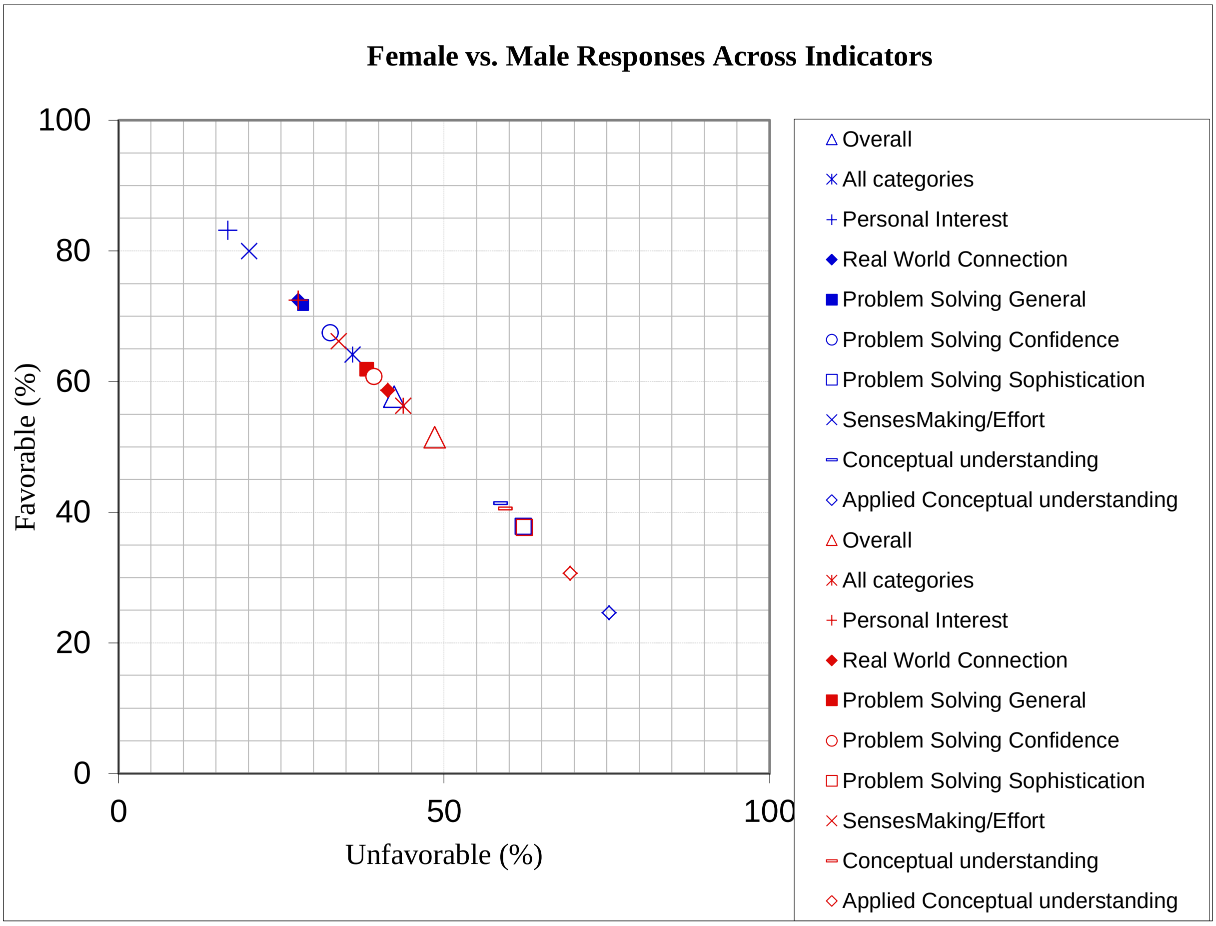

Fig 5. *The favorable and unfavorable responses of female and male students for each indicator*

The analysis presented in Figure 5 provides valuable insights into the differential performance of male and female students across various indicators. Upon examining the overall favorable rates, it is apparent that female students outperform their male counterparts. Female students exhibit a favorable rate of 57.6%, surpassing the 51.4% favorable rate among male students. This discrepancy raises questions regarding the underlying factors contributing to the differential performance based on gender.

The breakdown of performance by indicator provides valuable insights into the gender-based differences observed in the dataset. Notably, when examining female students' performance, a striking trend emerges. They exhibit a notably high favorable rate of 83.1% in the personal interest category. This suggests a strong inclination or engagement among female students in subjects that pique their personal interests. This is contrary to prior quantitative studies show that women often report a lower level of physics-perceived recognition, self-efficacy, and interest [20] [21]. However, the scenario contrasts starkly when considering Applied Conceptual Understanding, where female students achieve a significantly lower favorable rate of 24.6%. This finding implies a potential area of challenge or difficulty for female students in grasping and applying conceptual understanding within the studied domain.

Conversely, male students also display distinct patterns in their performance across indicators. Similar to their female counterparts, males exhibit the highest favorable rate in the personal interest category, albeit slightly lower at 72.4%. This suggests a shared inclination among both genders towards subjects aligned with their personal interests. However, akin to female students, males also struggle with Applied Conceptual Understanding, mirroring the same low favorable rate of 30.6%. This indicates a shared challenge among students of both genders in comprehending and applying conceptual understanding within the academic context studied.

Overall, the analysis underscores nuanced gender-based disparities in performance across different indicators. While both female and male students demonstrate strengths in subjects aligned with personal interest, they face common challenges in mastering Applied Conceptual Understanding. These findings highlight the importance of tailored interventions and educational strategies to address these disparities and foster holistic academic growth among students of all genders

CONCLUSION AND SUGGESTION

Students' views on physics are very important in improving learning outcomes. Based on the findings, the views of students in West Java, Indonesia in the context of physics are at a medium level according to the views of experts. This medium level has a tendency to agree that is close to the expert's view. Students' personal interest in physics is at the highest level, however, applied conceptual understanding is at the lowest level. If viewed based on gender, female's personal interest is higher than male's, but female's applied conceptual understanding is lower than male's. Further factor review needs to be carried out so that students' views of physics become better, which can ultimately improve learning outcomes.

ACKNOWLEDGMENTS

The authors would like to thank the Lembaga Pengelola Dana Pendidikan (LPDP) and the Ministry of Education, Culture, Research, and Technology of Indonesia for their support.

REFERENCES

[1] Napitupulu, N. D. (2022). The urgency of the multi-model approach in learning environmental physics to achieve learning goals. *World Journal of Advanced Research and Reviews*, *13*(3), 431-437.

[2] Chala, A. A., Kedir, I., & Wami, S. (2020). Secondary school students’ beliefs towards learning

physics and its influencing factors. *Research on Humanities and Social Sciences*, *10*(7), 37-49.

[3] Fazio, C., Carpineti, M., Faletič, S., Giliberti, M., Jones, G., Mcloughlin, E., ... & Battaglia, O. R. (2021). Strategies for active learning to improve student learning and attitudes towards physics. In *Teaching-learning contemporary physics: From research to practice* (pp. 213-233). Cham: Springer International Publishing.

[4] Du, H., Xiao, Y., & Zhao, L. (2021). Education and gender role attitudes. *Journal of Population Economics*, *34*(2), 475-513.

[5] Ferrer, J., Ringer, A., Saville, K., A Parris, M., & Kashi, K. (2022). Students' motivation and engagement in higher education: The importance of attitude to online learning. *Higher Education*, *83*(2), 317-338.

[6] Filgona, J., Sakiyo, J., Gwany, D. M., & Okoronka, A. U. (2020). Motivation in learning. *Asian Journal of Education and social studies*, *10*(4), 16-37.

[7] Wu, H., Li, S., Zheng, J., & Guo, J. (2020). Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement. *Medical education online*, *25*(1), 1742964.

[8] Santana, L. M., & Singh, C. (2023). Effects of male-dominated physics culture on undergraduate women. *Physical Review Physics Education Research*, *19*(2), 020134.

[9] Putri, R. K., & Hariyanti, F. (2022). Problem Solving Profile of Students with High Self-Efficacy Levels in terms of Gender. *JME (Journal of Mathematics Education)*, *7*(2), 19-30.

[10] Oleson, K. C., Poehlmann, K. M., Yost, J. H., Lynch, M. E., & Arkin, R. M. (2000). Subjective overachievement: Individual differences in self-doubt and concern with performance. *Journal of personality*, *68*(3), 491-524.

[11] Kaur, D., & Zhao, Y. (2017). Development of physics attitude scale (PAS): An instrument to measure students' attitudes toward physics. *The Asia-Pacific Education Researcher*, *26*, 291-304.

[12] Adams, W. K., Perkins, K. K., Podolefsky, N. S., Dubson, M., Finkelstein, N. D., & Wieman, C. E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. *Physical Review Special Topics—Physics Education Research*, *2*(1), 010101.

[13] Fisher, W. P. (2007). Rating scale instrument quality criteria. *Rasch measurement transactions*, *21*(1), 1095.

[14] Archer, L., Moote, J., & MacLeod, E. (2020). Learning that physics is 'not for me': Pedagogic work and the cultivation of habitus among advanced level physics students. *Journal of the Learning Sciences*, *29*(3), 347-384.

[15] Sanjar, J., & Oghly, Z. (2023). A Japanese approach to in-service training and professional development of science and physics teachers in Japan. *American Journal of Public Diplomacy and International Studies (2993-2157)*, *1*(9), 167-173.

[16] Sultanova, L., Hordiienko, V., Romanova, G., & Tsytsiura, K. (2021, March). Development of soft skills of teachers of Physics and Mathematics. In *Journal of Physics: Conference Series* (Vol. 1840, No. 1, p. 012038). IOP Publishing.

[17] Ntinda, M. N., Haiduwa, T., & Kamati, W. (2021). Development and Analysis of Virtual Laboratory as an Assistive Tool for Teaching Grade 8 Physical Science Classes. In *Intelligent Analytics With Advanced Multi-Industry Applications* (pp. 326-349). IGI Global.

[18] Chao, M. A., Kulkarni, C., Goebel, K., & Fink, O. (2022). Fusing physics-based and deep learning models for prognostics. *Reliability Engineering & System Safety*, *217*, 107961.

[19] Marshel, J., & Ratnawulan. (2020, March). Analysis of Students Worksheet (LKPD) integrated science with the theme of the motion in life using integrated connected type 21st century learning. In *Journal of Physics: Conference Series* (Vol. 1481, No. 1, p. 012046). IOP Publishing.

[20] Whitcomb, K. M., Kalender, Z. Y., Nokes-Malach, T. J., Schunn, C. D., & Singh, C. (2020). Comparison of self-efficacy and performance of engineering undergraduate women and men. *International Journal of Engineering Education*, *36*(6), 1996-2014.

[21] Li, Y., & Singh, C. (2021). Effect of gender, self-efficacy, and interest on perception of the learning environment and outcomes in calculus-based introductory physics courses. *Physical Review Physics Education Research*, *17*(1), 010143.