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Students' Attitudes Toward Physics and Its Influencing Factors: A Literature Review

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Abstract: *This literature study aims to address factors that influence students' attitudes towards physics and variations in learning methods that can be a reference for teachers to enhance students' attitudes towards physics. This study used systematic literature review method. Literature review was conducted using the keyword "attitudes towards physics". These keywords are searched through the Scopus search engine. We found 38 articles relevant to keywords with publication time constraints being the previous ten years. By using literature as a review, it was found that students' attitudes towards physics are influenced by a positive school environment, learning methods applied in the learning process, gender, type of school and age. We did not find that personality and grade level influenced students' attitudes towards physics as previous research concluded. In addition, we found more variety of learning methods to enhance students' attitude towards physics. Variations of learning methods that are proven to significantly enhance students' attitudes towards physics are problem based learning model, jigsaw cooperative learning model, inquiry learning model, STEM approach, peer instruction method, cognitively guided instruction method, multiple intelligences based instruction method, concept mapping, flipped classroom method, dialogical practical work, active learning, blended learning, augmented reality, game-based learning module, computer simulations, virtual laboratory, creating digital storytelling, and haptic augmented simulation.*

Keywords: *attitudes towards physics, learning methods, physics learning*

Sikap Siswa terhadap Fisika dan Faktor-faktor yang Mempengaruhinya: Sebuah Tinjauan Literatur

Abstrak: Studi literatur ini bertujuan untuk membahas faktor-faktor yang memengaruhi sikap siswa terhadap fisika serta variasi metode pembelajaran yang dapat menjadi referensi bagi guru untuk meningkatkan sikap siswa terhadap fisika. Studi ini menggunakan metode tinjauan literatur sistematis. Tinjauan literatur dilakukan dengan menggunakan kata kunci "*attitudes towards physics*". Kata kunci ini dicari melalui mesin pencari Scopus. Kami menemukan 38 artikel yang relevan dengan kata kunci tersebut dengan batasan waktu publikasi dalam sepuluh tahun terakhir. Berdasarkan literatur yang ditinjau, ditemukan bahwa sikap siswa terhadap fisika dipengaruhi oleh lingkungan sekolah yang positif, metode pembelajaran yang diterapkan dalam proses belajar, jenis kelamin, jenis sekolah, dan usia. Kami tidak menemukan bahwa kepribadian dan tingkat kelas memengaruhi sikap siswa terhadap fisika sebagaimana disimpulkan dalam penelitian sebelumnya. Selain itu, kami menemukan lebih banyak variasi metode pembelajaran yang dapat meningkatkan sikap siswa terhadap fisika. Variasi metode pembelajaran yang terbukti secara signifikan dapat meningkatkan sikap siswa terhadap fisika antara lain model pembelajaran berbasis masalah, model pembelajaran kooperatif tipe jigsaw, model pembelajaran inkuiri, pendekatan STEM, metode pembelajaran teman sebaya (*peer instruction*), metode pembelajaran berbasis panduan kognitif, metode pembelajaran berbasis kecerdasan majemuk, pemetaan konsep, metode kelas terbalik (*flipped classroom*), praktik dialogis, pembelajaran aktif, pembelajaran campuran (*blended learning*), *augmented reality*, modul pembelajaran berbasis permainan, simulasi komputer, laboratorium virtual, pembuatan cerita digital (*digital storytelling*), dan simulasi haptic augmented.

Kata kunci: metode pembelajaran, pembelajaran fisika, sikap siswa terhadap fisika

INTRODUCTION

Physics is one of the branches of natural science that deals with scientific concepts. As part of natural science, physics has an important role in explaining various phenomena and events that occur in the universe (Kaya & Büyük, 2011). Through physics, all events, symptoms and phenomena that occur in the universe can be studied in depth. Physics is a basic science that is useful for being able to understand, study, and develop other sciences from various fields. Thus, it can be said that physics contributes greatly to the development of science and technology (Astalini et al., 2019). Modern technological advancements prevalent in daily life stem from fundamental physics principles, as evidenced in electrical devices, computing systems, telecommunications equipment, medical technology, and numerous other applications.

Learning physics is important in education to improve thinking and problem-solving skills. Nonetheless, there are a number of problems that students may encounter when studying physics (Aprilia et al., 2023) and many factors influence physics learning outcomes, including instructional strategies employed during the learning process, student motivation levels, classroom environment, learners' epistemological beliefs, and their attitudinal dispositions toward the subject (Abaniel, 2021). An investigation of the influence of pedagogy on student learning attitudes in physics learning is indispensable. This is due to findings stating that learning attitudes towards physics are a significant predictor that determines students' academic success (Akpinar et al., 2009). In a study it was concluded that attitude is the best predictor of increasing student success and achievement (Dagnew, 2017). This is reinforced by other studies that state attitudes have been shown to influence the way students learn and grow their understanding of a subject (Şahin, 2009). In addition, attitudes towards physics learning are a very large factor influencing their study habits, relating to their conceptual development (Chu et al., 2008). Therefore, improving students' attitudes towards physics is important to achieve the success of a learning process.

Attitudes towards physics can be define as interest, perception, and values espoused towards physics, such as the application of the curriculum, the learning process, physics teachers, and physics as a career, expressed in the form of likes or dislikes; positive or negative reactions to physics (Kaur & Zhao, 2017). Simply, students' attitude in physics learning have two points of view, are positive view and negative view. A positive attitude towards physics can be seen from students' enthusiasm for learning, appearing interested and active during the learning process. Meanwhile, students' negative attitudes towards physics can be seen from their lack of enthusiasm for learning, disinterest and passivity during the learning process. Attitudes towards physics are influenced by many factors, among them an unsupportive learning environment (Aprilia et al., 2023) teaching practices carried out by teachers (Adams et al., 2006), and sharpened by unpleasant classroom experiences (Perkins et al., 2005), and teacher's likability (Monica et al., 2021). Therefore, this study recommends that teachers improve their competence, especially in professional aspects and pedagogy, to attract students' interest and attention, as well as increase their motivation to learn physics. Teachers should design learning that is innovative, creative, fun, and student-centered, so as to enable students to have a positive attitude in learning physics. Teachers should be friendly facilitators, who facilitate students to learn meaningfully, rather than being firm teachers who are feared by students.

The attitude of students to physics can be measured. Measurement of attitudes towards physics can use the CLASS (Colorado Learning Attitudes about Science Survey) instrument (Adams et al., 2006), MPEX (Meryland Physics Expectations) instrument (Redish et al., 1998), and Physics Attitudes Scale (PAS) (Kaur & Zhao, 2017). Therefore,

it is necessary to held a literature review on sstudents' attitudes towards physics to find out what factors can improve students' attitudes towards physics. A literature review of students' attitudes towards physics has been conducted before (Aprilia et al., 2023), but there are findings that experience contradictions, namely about students' attitudes towards physics influenced by gender. This is because the findings are only supported by two articles that state it. In addition, findings on learning methods and models that can improve students' attitudes towards physics are also less varied. This study reviewed literature with a larger number of articles and conference papers and limited them to sources only from the Scopus database. Accordingly, this study seeks to investigate physics attitude influencers and discover effective teaching method variations for positive attitude development. The findings of this literature study will provide information about students' attitudes towards physics and what factors influence it, making it easier for teachers to determine learning strategies to have a greater impact on educational practice.

METHOD

This study used a literature review research design. Literature review research is a research method used to collect various sources of data on certain topics to be studied in research. The literature review method is a systematic method for synthesizing various research articles. The literature review method is employed to assess, identify, and integrate findings from prior research studies (Okoli, 2015). In this study, the synthesis process follows four steps adapted from previous work (Aprilia et al., 2023): (1) selecting the topic for synthesis, (2) screening and choosing applicable research papers, (3) reviewing and synthesizing the selected research papers, and (4) organize the synthesized findings. The literature article as sources used in this study were collected and obtained from reputable international journals by utilizing the Scopus search engine. In the stage of collecting articles to be synthesized, the PRISMA model is adopted with four steps: identification, screening, eligibility, and included. First, the search for articles through the Scopus database was carried out using the keyword "attitudes towards physics" with the span of the research period being the last 10 years. Of the 67 articles obtained, the articles were then re-selected based on topics relevant to physics learning. Found 38 articles and conference papers that match keywords and are relevant to physics learning. The articles used in the study were synthesized using the synthesis matrix technique. The matrix synthesis technique is used to organize article sources and interpret the results of the sources with the integration of unique research findings.

RESULTS AND DISCUSSION

Results

In this study, a total of 38 articles concerning students' attitudes towards physics were systematically synthesized. To illustrate the findings more comprehensively, selected examples of the synthesis results are presented in Table 1.

Table 1. The Example of the Results Synthesis in a Synthesis Matrix

No	Author	Research Methods	Findings of Research
1	(Alarabi et al., 2022)	To evaluate teacher and student attitudes regarding online physics instruction, the study modified an exploratory cross-sectional descriptive design technique.	The findings of the article indicate that public school students tend to have more positive attitudes towards online physics education than private school students.

No	Author	Research Methods	Findings of Research
2	(Belay et al., 2022)	This study employed a quasi-experimental between-groups design with pre- and post-tests on a sample of high school students in grade 11.	The result of the study showed that dialogic practical work can be used to enhance secondary school students' attitudes toward physics.
3	(Moro & Billote, 2023)	Quasi-experimental research design is the methodology employed, with an emphasis on the pedagogical intervention's impact. The Analysis-Design-Development-Implement-Evaluate (ADDIE) concept was specifically applied in the creation of the learning module based game.	Findings reveal that the game-based instructional module effectively boosted learners' motivation and physics-related attitudes, resulting in measurable gains in physics comprehension.
4	(Gao, 2019)	The method used in the study involved assessing the effectiveness of the Active Learning teaching method in an introductory physics course (Topics in Physical Sciences, SCP101) at LaGuardia Community College.	The results of this study show that, in comparison to the conventional lecture-based teaching approach, the Active Learning teaching technique is more effective in enhancing a variety of elements of students' learning attitudes toward physics. In particular, it was discovered that Active Learning was especially helpful in fostering students' enthusiasm in physics, assisting them in making connections with the outside world, and enhancing their problem-solving skills.
5	(Ayasrah et al., 2024)	This study employed a quasi-experimental design with a pre-test, post-test, and control group. This design aimed to compare the attitudes toward physics of eleventh-grade students in the UAE who learned in environments based on computer simulations (CSs) with those who learned through non-CSs environments.	The findings of the study indicate that the CSs-based learning environment positively impacts students' attitudes towards physics, making them more inclined towards scientific inquiry, enjoying science lessons more, and showing increased interest in pursuing careers in physics or science. Results also indicated a significant difference in the attitudes perceived in these scales, with male students showing a larger significant effect size in all three scales compared to female students.
6	(Zhang et al., 2017)	The method of this study involved studying first-year undergraduate science majors at Beijing Normal University (BNU), who were from four large classes of the same introductory physics course based on calculus	The investigation found that compared to traditional pedagogy, Peer Instruction produced more positive transformations in learners' physics attitudes and conceptual beliefs. A gender-disaggregated analysis uncovered that these benefits were particularly pronounced among female students, who exhibited substantial attitude and belief enhancements, while male

No	Author	Research Methods	Findings of Research
		in the second semester. One class was traditionally taught, while the other three adopted Peer Instruction (PI) methods. The study aimed to examine the impact of PI on students' attitudes and beliefs about physics, with classes assigned based on major and year.	counterparts displayed minimal shifts. This suggests that PI instruction may particularly benefit female students in terms of their attitudes towards physics.
7	(Kanyesigye et al., 2022)	This study used a quasi-experimental design with a quantitative approach, more precisely a pre-test-post-test control group experimental design based on a randomized Solomon four group design. The experimental group received standard training, while the control group underwent problem-based learning (PBL) as an intervention.	The results of this study show that students' attitudes toward physics were positively impacted in a statistically meaningful way by both problem-based learning and conventional education. But when it comes to teaching physics, problem-based learning works better than conventional approaches.
8	(Aşiksoy & Islek, 2017)	A mixed-methods strategy was used in this study, combining quantitative and qualitative techniques. A physics lab attitude scale was used to gather quantitative data, and participant semi-structured interviews were used to get qualitative data. 42 students participated in this study, split into two groups (21 treatment, 21 control). Students were divided into the two groups at random.	The study's conclusions show that the students' perspectives were positively impacted by their virtual laboratory experiences. Furthermore, semi-structured interviews revealed that students felt positively about their experiences in the virtual physics lab. These results imply that virtual labs can be a useful instrument for improving students' perceptions of physics lab courses.
9	(Fidan & Tuncel, 2019)	The study used a quasi-experiment with a pre- and post-test control group design. Ninety-one students, ages twelve to fourteen, from three seventh-grade groups in a northern Turkish junior high school participated in this study. With 30 students in Experimental	According to this study, students who engaged in augmented reality (AR)-enhanced Problem-Based Learning (PBL) activities showed significantly greater learning accomplishment ratings in physics when compared to students who received standard teacher-based training. This shows that using AR into PBL can improve students' comprehension and memorization of physics ideas. Furthermore, students who integrated AR technology with PBL

No	Author	Research Methods	Findings of Research
		Group-1 (EG-1), 31 in Experimental Group-2 (EG-2), and 30 in the Control Group (CG), the participants were split into two experimental groups and one control group.	exercises expressed more favorable opinions on physics. Their positive perception of the subject was influenced by their finding that the AR encounters were interesting and useful for grasping difficult ideas. This suggests that AR has the potential to improve learning and spark students' enthusiasm in science classes.
10	(Akçayır et al., 2016)	Pre- and post-test control group designs were part of the quasi-experimental methodology employed in the study. While the control group utilized a conventional laboratory handbook, the experimental group used a manual with AR assistance.	The results of this study confirmed that augmented reality (AR) technology can improve students' laboratory skills and foster a favorable attitude toward physics laboratories.. The instructor observed that AR applications not only motivated students and increased their interest in the course but also saved time, allowing students to complete experiments more quickly and spend more time discussing the results. Additionally, it was found that students preferred materials like images and videos provided by AR over traditional text, indicating a shift in learning preferences towards more interactive and visual materials.
11	(Abdulkarim & Raburu, 2013)	This study used a factorial design with two treatments (Traditional Method and Concept Mapping) at two different gender levels (Female and Male), producing a 2x2 CRF design. 46 Dhofar University first-year students were included in the study sample; they were split into two groups, one for the experimental group and another for the control group, each with 23 students.	The study's findings revealed that the experimental group, which utilized idea mapping as a teaching tactic, and the control group, which used conventional teaching methods, had statistically significant differences in their attitudes about physics. Furthermore, the study discovered no evidence of a substantial gender difference in attitudes toward physics or a gender interaction with the concept mapping strategy. These results suggest that concept mapping can be an effective teaching strategy to enhance students' attitudes towards physics, irrespective of their gender.
12	(Hernánez-Suarez et al., 2021)	This study used a descriptive quantitative method to identify the attitudes of a group of junior high students toward physics.	The study's conclusions show that junior school student have a somewhat positive attitude toward physics. Overall, there were no discernible differences in the opinions of students in Grades 10 and 11. But there was a distinction observed in the degree of difficulty associated with studying physics., where Grade 10 students exhibited an unfavorable attitude, possibly due to their first exposure to the subject. This highlights the importance of considering student attitudes in the

No	Author	Research Methods	Findings of Research
			teaching of physics, especially for those encountering physical concepts for the first time.
13	(Astalini et al., 2019)	The research adopted a quantitative survey methodology, administering standardized questionnaires to measure students' attitudes and motivation. Participants included 458 high school students recruited from educational institutions in Muaro Jambi.	The study's findings showed a strong correlation between students' motivation levels and their attitude towards physics. This implies that raising student motivation may have a favorable impact on how they view the subject and behave toward it. This study also discovered that pupils who did well in physics had a higher inclination to express interest in a career in the subject. This suggests that a more favorable attitude toward physics is likely to be fostered by scholastic success in the discipline.
14	(Kaur & Zhao, 2017)	In order to measure students' attitudes toward physics, the PAS was extensively described in this study. In-depth interviews with professionals and students were conducted during the creation of this new instrument.	These results indicate a strong psychometric features of the Physics Attitude Scale (PAS). Further research revealed a favorable association between (a) physics teachers and physics learning, (b) physics teachers and physics learning, (c) physics teachers and physics learning, and (d) physics as a process and future vocation. Enhancing students' attitudes raises their level of interest in the subject and enhances their learning physics outcomes.
15	(Hothi et al., 2019)	This study employed a flipped classroom instructional approach to enhance academic skills development, specifically targeting physics instruction for computer engineering undergraduates.	The findings of this study revealed that students who had a positive attitude towards Physics in high school carried that interest into their higher education. Students who enjoyed learning Physics during high school tended to develop a more favorable attitude toward the subject in higher education, emphasizing the importance of delivering engaging Physics instruction from an early stage. Additionally, this study found that female students showed more favorable responses in certain clusters compared to male students. This suggests gender-based differences in attitudes towards Physics, which could be important for tailoring educational approaches.

Based on the synthesis results, the articles were subsequently categorized according to two moderator variables: instructional methods and gender, in order to examine whether these moderators influence students' attitudes towards learning physics. The categorization results related to the influence of instructional methods as a moderator on students' attitudes towards physics are presented in Table 2.

Table 2. Effective Learning Methods to Enhance Students' Attitudes Towards Physics

No	Authors	Type of School	Learning Methods
1	(Alarabi et al., 2022)	Secondary School	Online Physics Education
2	(Belay et al., 2022)	Secondary School	Dialogic Practical Work
3	(Moro & Billote, 2023)	Senior High School	Game-Based Learning Module
4	(Abaniel, 2021)	University	Open Inquiry Learning Model
5	(Gao, 2019)	University	Active Learning
6	(Ayasrah et al., 2024)	Secondary School	Computer Simulations
7	(Çetin & Özdemir, 2018)	Junior High School	Blended Learning
8	(Zhang et al., 2017)	University	Peer Instruction
9	(Kanyesigye et al., 2022)	Secondary School	Problem Based Learning
10	(Erdoğan & Bozkurt, 2022)	University	Virtual Laboratory App
11	(Okeke et al., 2023)	Secondary School	Cognitively Guided Instruction
12	(Aşiksoy & Islek, 2017)	University	Virtual Laboratory
13	(Civelek et al., 2014)	Secondary School	Haptic Augmented Simulation
14	(Fidan & Tuncel, 2019)	Junior High School	Augmented Reality – PBL
15	(Kotluk & Kocakaya, 2017)	Secondary School	Creating Digital Storytelling
16	(Gurcay & Ferah, 2017)	Junior High School	Multiple Intelligences Based Instruction
17	(Ibrahim et al., 2022)	Secondary School	STEM
18	(Akçayır et al., 2016)	University	Augmented Reality
19	(Maison et al., 2021)	Senior High School	Inquiry – Jigsaw Cooperative Learning Models
20	(Senan et al., 2016)	Secondary School	Multimedia-Learning Package
21	(Abdulkarim & Raburu, 2013)	University	Concept Mapping
22	(Doucette et al., 2022)	University	A Conceptual Inquiry-Based Lab
23	(Good et al., 2019)	University	Evidence-Based Active Engagement (EBAE) (Flipped Classroom and Peer Instruction)
24	(Hothi et al., 2019)	University	Flipped Classroom

Furthermore, the categorization results concerning the influence of gender as a moderator are presented in Table 3.

Table 3. Students' Attitudes Towards Physics Based on Gender

No	Authors	Gender	Findings
1	(Ayasrah et al., 2024)	Male	The study's findings indicated that there was a substantial difference between the attitudes that students perceived on these scales, with male

No	Authors	Gender	Findings
			students showing a larger impact size than female students on all three scales..
2	(Zhang et al., 2017)	Female	According to the study, there are gender differences in the effects of PI. While male students did not show any significant improvements, female students showed a significant overall favorable shift in attitudes and beliefs following training.
3	(Robinson et al., 2021)	Female	According to the study, women's CLASS post-scores correlate more closely with their FCI gains than do men's CLASS pre-scores, indicating that women's attitudes about studying physics may have a stronger impact on women's learning than men's learning.
4	(Sheldrake et al., 2019)	Male	The study identified that boys were more likely to have positive attitudes towards physics compared to girls.
5	(Hothi et al., 2019)	Female	This study found that female students showed more favorable responses in certain clusters compared to male students.
6	(Veloo et al., 2015)	Male	The findings indicated that there was a substantial gender difference in the attitudes that students had about physics, with male students exhibiting more positive attitudes..
7	(Doucette et al., 2022)	Male	According to the study, a statistically significant predictor of the students' post-E-CLASS score is their gender. Men outperformed women by 1.46 points on the post-E-CLASS..
8	(Good et al., 2019)	Female	According to the study, evidence-based active engagement (EBAE) strategies benefit male and female students equally, but they especially work successfully to improve the attitudes of female students toward problem solving.
9	(Mbonyiryivuze et al., 2021)	Female	The study discovered a statistically significant gap in gender that favored female students when it came to the application of physics knowledge to understanding real-world scenarios.
10	(Ibrahim et al., 2022)	No difference	The study did not find significant differences in beliefs or attitudes based on gender.
11	(Abdulkarim & Raburu, 2013)	No difference	The study did not find any evidence of a substantial gender difference in attitudes toward physics or of a gender interaction with the idea mapping strategy.
12	(Kanyesigye et al., 2022)	No difference	The results of the study revealed that promoting PBL or changing students' attitudes toward thinking like physics experts did not depend on gender or kind of school.

No	Authors	Gender	Findings
13	(Belay et al., 2022)	No difference	The research findings indicate a statistically significant difference in favor of the treatment group with no gender differential effects between the comparison and treatment groups..
14	(Çetin & Özdemir, 2018)	Female	According to the study, females attitudes toward physics appeared to improve more than males did with integrated training (Gürler & Baykara, 2020).
15	(Gürler & Baykara, 2020)	No difference	The study discovered that these attitude were not significantly impacted by the parents' gender or educational attainment.

Based on Table 3, the comparative percentages reflecting the influence of gender on students' attitudes towards physics between male and female students are illustrated in Figure 1.

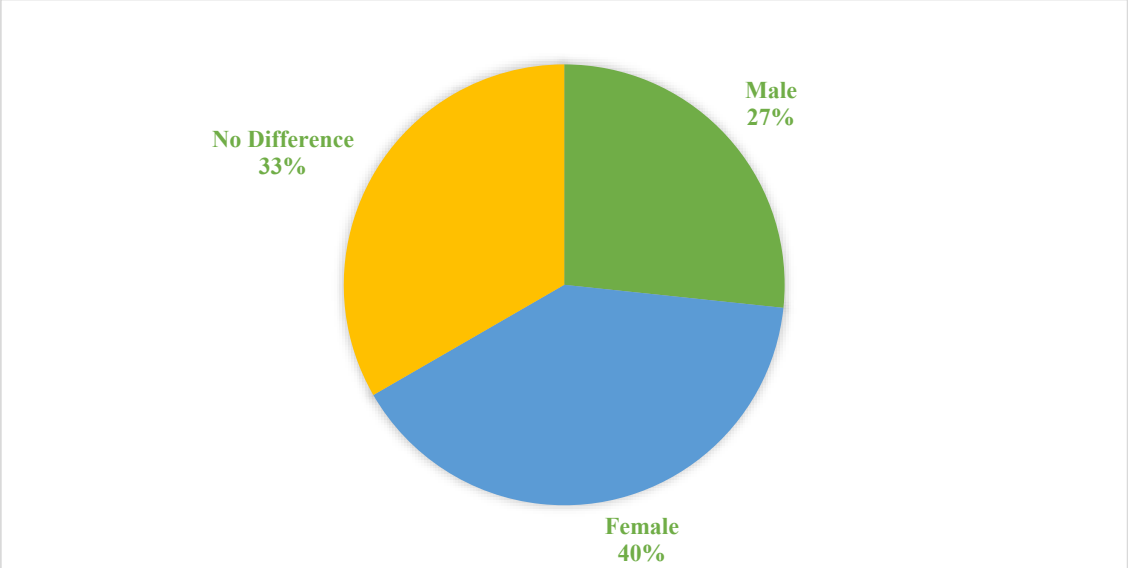

Figure 1. Percentage of the Articles Synthesized About Students' Attitudes Towards Physics Based on Gender

Discussion

The study has synthesized 38 articles that are most pertinent to the subject under discussion. Table 1 displays the synthesis findings. Numerous factors affect students' attitudes toward learning physics, according to the literature review. These elements have to do with the teachers, the learning environment, and the students themselves. Positive attitudes that students have about physics courses will be combined with their interest in physics as a career, the societal ramifications of physics, adopting a scientific mindset, and the fact that scientists are normal people (Astalini et al., 2018, Maison et al., 2019, Astalini et al., 2019). Students who enjoy physics will have positive attitudes. This positive attitude may display as a greater interest, participation in class, or a feeling of enjoyment during the learning process.

Apart from assessing knowledge and skills, assessing students' attitudes towards learning is very important. The results of assessing students' attitudes towards physics can

be used to help teachers determine appropriate learning strategies. If teachers are able to facilitate students' learning with appropriate learning strategies, then students' attitudes towards physics will gradually improve. Improving students' attitudes towards physics will increase physics learning achievement (Kapucu, 2017, Veloo et al., 2015). Studies conducted in India show that students who have a positive attitude towards physics in high school bring such interest to their higher education (Hothi et al., 2019). This case shows that it is necessary to apply physics education from an early age. Studies at SMA Batanghari, Jambi, identified several obstacles students face in improving their attitudes towards physics, they are lack of interest in a career in physics, lack of pleasure in studying physics, and reluctance to increase study time dedicated to physics. Therefore, the role of physics teachers in schools is very important in arousing students' interest in students (Riskawati et al., 2021). Teachers need to improve their personal qualities and pedagogy to attract the attention of their students. Teachers need to design interesting and fun learning, so as to enable students to have a positive attitude towards physics. The teacher should also conduct periodic assessments of students' attitudes towards physics, in order to monitor the development of their attitudes.

The Physics Attitude Scale (PAS) serves as a measurement tool for assessing students' attitudes toward physics, encompassing four dimensions: (a) enthusiasm for learning physics, (b) interest in physics as a career, (c) perception of physics as a process, and (d) views on physics instruction (Kaur & Zhao, 2017). Research indicates that enhanced positive attitudes foster greater interest and motivation in physics (Maison et al., 2019), which subsequently leads to improved academic performance and learning outcomes (Karyadi et al., 2018). Furthermore, such favorable attitudes empower students to make more informed decisions regarding future pursuits in physics and related disciplines (Kaur & Zhao, 2017, Kapucu, 2017, Ibrahim et al., 2022).

The results of this study show a number of factors affect students' attitude towards physics., among them the learning methods used, type of school (Alarabi et al., 2022, Gürler & Baykara, 2020, Çetin & Özdemir, 2018, and age (Wahyuni et al., 2022). Research indicates that when it comes to physics, female students are more positive attidues than male students. Six of the 38 synthesized articles found that female students are more positive than male students (Zhang et al., 2017, Robinson et al., 2021, Hothi et al., 2019, Good et al., 2019, Mbonyiryivuze et al., 2021, Çetin & Özdemir, 2018). This is in opposition to the results of the other study, which indicates that there is no discernible difference in how male and female students approach learning physics (Abdulkarim & Raburu, 2013, Gürler & Baykara, 2020, Ibrahim et al., 2022, Belay et al., 2022, Kanyesigye et al., 2022). Table 3 and Figure 1 show the synthesis results and the percentage of the 38 articles that were synthesized about the attitudes of students toward physics based on gender.

Students' attitudes toward physics are also influenced by their age and the type of school they attend. Compared to students in lower schools, high school students display a more positive attitude (Gürler & Baykara, 2020). Compared to students in private schools, students at public schools indicate a more positive attitude (Alarabi et al., 2022). Additionally, statistics show that there are statistically significant disparities between student in urban and rural schools with regard to the categories and connections used in problem-solving as well as the comprehension of physics concepts (Mbonyiryivuze et al., 2021). Meanwhile, students are not much affected by changes in grade level or type of class (Hernánez-Suarez et al., 2021).

The application of the curriculum in schools, the use of innovative learning methods or strategies carried out by teachers can also improve students' attitudes towards physics.

Teachers' beliefs about teaching and learning and their teaching practices are found to have a substantial impact on students' attitudes towards physics (Chala, 2020). Positive and engaging teaching practices can improve students' attitudes and performance towards physics. Research demonstrates that a supportive school environment enhances students' attitudes towards physics, including their approach to investigations, enjoyment of physics lessons, adoption of scientific thinking, and study time commitment (Chala, 2020; Maison et al., 2021). However, selecting appropriate classroom learning strategies should be preceded by thorough attitude assessments to ensure suitability. Implementing mismatched instructional approaches may inadvertently foster negative attitudes toward physics (Ng & Chua, 2023).

Among various factors influencing students' attitudes toward physics, the implementation of innovative pedagogical approaches - including instructional models, teaching methods, and learning strategies - emerges as the most significant determinant in enhancing student disposition toward the subject. Models, methods or learning strategies that can improve students' attitudes towards physics are: inquiry learning model (Abaniel, 2021, (Doucette et al., 2022), using jigsaw cooperative learning model, using problem based learning model (Kanyesigye et al., 2022), using a STEM approach (Ibrahim et al., 2022), using the peer instruction method (Zhang et al., 2017, Good et al., 2019), using the cognitively guided instruction method (Okeke et al., 2023), using multiple intelligences based instruction method (Gurcay & Ferah, 2017), learning using concept mapping (Abdulkarim & Raburu, 2013), flipped classroom method (Hothi et al., 2019, Good et al., 2019), dialogical practical work (Belay et al., 2022), implementing active learning (Gao, 2019), and using blended learning (Çetin & Özdemir, 2018), as well as mobile learning-based learning methods or strategies, such as learning using augmented reality (Fidan & Tuncel, 2019), using the game-based learning module (Moro & Billote, 2023), learning using computer simulations (Ayasrah et al., 2024), using virtual laboratory (Erdoğan & Bozkurt, 2022, Aşiksoy & Islek, 2017), learning by creating digital storytelling (Kotluk & Kocakaya, 2017), and learning using haptic augmented simulation (Civelek et al., 2014), integration of haptic technology in education can support interactive and inclusive learning environments. The use of appropriate learning models, methods or strategies can increase students' positive attitudes. In addition, teachers must also facilitate learner-centered learning, where the teacher's role is only as a facilitator. Teachers should try to improve the motivation and attitude of learners towards physics. This is because, Students' motivation and attitudes toward learning physics are positively correlated., suggesting that more positive attitudes can enhance motivation to learn physics, and both of them can influencing students' learning styles and approaches to studying physics (Maison et al., 2019). Students generally exhibit a good attitude towards learning physics through investigation and experimentation. Learning through investigation and experimentation will improve students' attitudes towards physics. and train students' abilities in creative, critical thinking and problem solving. Improving these skills will have a positive impact on interests, students' educational experiences, student's achievement and outcomes in physics.

CONCLUSION AND SUGGESTIONS

Based on the analysis of 38 articles, it can be claimed that positive school environments and teaching strategies—especially when those strategies involve technology—have an impact on students' attitude about physics. Teachers' attitudes about teaching and learning, their methods of teaching. age, gender, and the kind of school they attend also have an impact on students' attitudes toward physics. We did not find that personality and grade

level influenced students' attitudes towards physics. Various learning models and methods that can be a reference for teachers to significantly improve students' positive attitudes towards physics include implementing inquiry learning model, using jigsaw cooperative learning model, using problem based learning model, using a STEM approach, using the peer instruction method, using the cognitively guided instruction method, using multiple intelligences based instruction method, learning using concept mapping, flipped classroom method, dialogical practical work, implementing active learning, and using blended learning, as well as mobile learning-based learning methods or strategies, such as learning using augmented reality, using the game-based learning module, learning using computer simulations, using virtual laboratory, learning by creating digital storytelling, and learning implementing haptic augmented simulation.

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