Attitudes and beliefs toward physics: A mini review

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A mini review of attitudes and beliefs toward physics has been carried out. The purpose of this study was to address aspects that influence attitudes and beliefs toward physics and various learning models that can increase attitudes and beliefs toward physics. The method used in this study was literature review. Literature review was done by searching for keywords, *i.e.*: attitudes towards physics and beliefs towards physics. This keyword search was done through Google Scholar, Base, and Core search engines. We have obtained 25 articles that matched the keywords and have been screened with the limitation of the year of publication, namely the last 10 years. Through this literature review it can be obtained that physics attitudes and beliefs were influenced by gender and personality, grade level, type of school, and age. Contradictions regarding aspects that influence attitudes and beliefs about physics occur in the gender aspect. Various learning methods to improve attitudes and beliefs about physics were cooperative learning models with jigsaw, Science Technology Engineering and Mathematics (STEM), concept maps, peer instruction methods, open inquiry methods, learning integrated with music, and learning using a computer simulation model.

Keywords: Attitudes towards physics; beliefs about physics; learning methods.

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1. Introduction

Physics is one of the subjects related to the application of various scientific concepts that can be found in everyday life. Physics is considered a tough subject because it requires perseverance, thoroughness, and lots of practice to master it [1]. Studying physics is important as a means for enhancing thinking skills. The findings from the application of physics can be learned by students through the learning process in class. However, there are obstacles that can hinder the learning process of physics. Attitudes and beliefs are one of the factors that influence the learning process that originates in students. There are positive and negative attitudes and beliefs of students. Students who show positive attitudes and beliefs about physics tend to enjoy learning effectively when they understand physics well, and have high learning attitudes and beliefs [2, 3]. Attitudes and beliefs towards physics are influenced by the learning environment. The implementation of the curriculum and application of technology used by teachers affect the attitudes and beliefs of students [4]. Thus, teachers need to design learning in such a way as to enable students to have positive attitudes and beliefs about physics.

Attitudes can affect problem solving abilities and students' learning motivation towards physics [5]. Measuring attitudes and beliefs about physics can be conduced using the Colorado Learning Attitudes about Science Survey (CLASS) and Meryland Physics Expectations (MPEX) instruments [6, 7]. Therefore it is necessary to conduct a literature review on attitudes and beliefs about physics, as well as learning methods that can improve attitudes and beliefs about physics. Thus the purpose of this literature review is to discuss various aspects that influence attitudes and beliefs toward physics and determine appropriate learning methods to improve attitudes and beliefs about physics.

2. Research method

The research design used was literature review. A literature review study is a method used to collect data sources on a particular topic. Literature review is a systematic, explicit, and reproducible method. The use of the literature review method is to identify, evaluate, and synthesize the research results and thoughts of previous researchers [8]. The writing of the review results in this study went through four stages, namely (1) selecting topics to be reviewed, (2) tracing and selecting relevant articles, (3) analyzing and synthesizing articles, and (4) organizing review writing. The collection of literature sources was obtained from various sources through National and International journals by utilizing the Google Scholar, Base, and Core search engines. The search results were obtained through the aforementioned search engines with keywords including: attitudes towards physics, beliefs about physics, as well as attitudes and beliefs towards physics. 25 articles were found that matched the keywords. These articles have been screened with a range on the year of publication, namely the last 10 years. The articles used were selected and synthesized with high relevance for review. The article synthesis technique used a synthesis matrix. The synthesis matrix was used to organize literature sources and interpret them with a unique integration of research findings. Examples of articles with high relevance are given in Table I.

TABLE I. Examples of High Relevance Articles in a Synthesis Matrix.

Title	Methods	Findings	Years
Student attitude description toward physics on secondary school.	The method used in this study is the mixed method by combining quantitative and qualitative methods. Measuring attitudes towards physics used a Likert scale questionnaire and semistructured interviews.	Based on this research, there are several findings, namely, indicators that have good criteria are indicators of the social implications of physics. The rest for indicators of normality of scientists and career interest in physics obtain sufficient criteria.	2018
Development of Physics Attitude Scale (PAS): An instrument to measure students' attitudes toward physics	This study focused on a detailed description of the Physics Attitude Scale (PAS) to measure students' attitudes towards physics. The development of this new instrument involved extensive interviews	This finding shows that the Physical Attitude Scale (PAS) has strong psychometric properties. It was further found that there was a positive correlation between enthusiasm for (a) learning physics; (b) physics as a process; (c) physics as a calling of the future; and (d) physics teachers and physics learning.	2017

TABLE II. The synthesis results.

1	[9]	The method used is an investigation to see changes in the attitude of first year physics students for two years at the University of Edinburgh.	Based on the findings, there are differences between physics majors and non-physics majors as well as gender differences with physics majors consistently getting higher scores both before and after teaching. The findings in this study have implications for the way physics is taught in universities.
2	[10]	The method used is the prepost test. The control sample consisted of students who used STEM and those who did not use STEM.	The results obtained showed that PGSD students experienced an increase in learning science and mathematics after STEM and those who did not use STEM. being treated in the form of curriculum. When compared to students who do not use STEM, PGSD students have higher beliefs about NoS and attitudes towards science and mathematics.
3	[11]	This study uses a quantitative method by comparing attitudes and beliefs about the physical sciences (physics and mathematics) and the sciences that study life (biochemistry and biology).	There was a significant difference in performance according to CLASS between students pursuing degrees in physics and those pursuing degrees in biology, with a large effect size.
4	[12]	This research focused on a detailed description of the Physics Attitude Scale (PAS) to measure students' attitudes toward physics. The development of this new instrument involved extensive interviews with both experts and students.	These findings indicate that the Physics Attitude Scale (PAS) has strong psychometric properties. It was further found that there was a positive correlation among (a) enthusiasm for learning physics; (b) enthusiasm for physics as a process; (c) enthusiasm for physics as a future vocation; and (d) physics teachers and physics learning. Improving students' attitudes stimulates students' interest in subjects and improves physics learning outcomes.

No	Authors	Methods	Findings
5	[13]	The method used in this research is quantitative using a Likert scale questionnaire.	The research findings show that mathematics learning integrated with music has a positive effect on pre-service teachers' attitudes and beliefs about mathematics learning.
6	[14]	This research method is pre - experimental. The subjects involved in the research were students from Romania.	The findings of this study indicate that physics is a subject that students like but they learn too little. Physics teachers need to select methods that will demonstrate students' physics relevance to life, make life experiences valuable, stimulate curiosity, and involve them in research and practical activities.
7	[15]	This research has been conducted at the University of Edinburgh. The method used is the comparison method. The instrument used is CLASS.	The findings show that students' attitudes and beliefs from time to time remain consistent and do not change. This shows that a cross -sectional or pseudo - longitudinal study is the right method to use in this study.
8	[16]	This research is a quantitative research with a survey research design that is strengthened by interview results to support quantitative data.	The results showed that the students' attitudes were in the good and quite good categories based on the indicators used to investigate attitudes. The indicators of the social implications of physics and the adoption of a scientific attitude have good results. Analysis of attitude indicator data on high school physics in Batanghari district shows that the dominant attitude of students is in the medium category with a percentage of 45%.
9	[2]	The research method used is contemporary literature by conducting a systematic review of more than seventy different findings.	There are positive and negative students' beliefs about physics. Students who display positive beliefs tend to enjoy and learn effectively when they understand physics well. Conversely, students with negative attitudes usually put less effort into their learning process. From the literature review, there are four factors that greatly influence students' beliefs in learning physics. These factors include the students themselves, teachers, and the environment and school culture.
10	[17]	This research is using experimental method. The respondents of this study were first semester students majoring in science at Beijing Normal University (BNU), China.	The results of the pretest -posttest findings using the Colorado Learning Attitudes about Science Survey (CLASS) for the three classes taught using the PI method increased students' attitudes and beliefs about physics and physics learning compared to those using conventional methods. Additionally, the gender results revealed that female science majors in PI classes achieved greater positive changes in attitudes and beliefs after instruction than male students
11	[18]	The target of this research is high school students in grade 10. The data analysis method used is quantitative which involves numerical data analysis.	Based on this research, it is found that there are several factors that influence students' attitudes towards physics, namely gender and personality. This study found no significant differences in students' attitudes in terms of connecting physics with everyday life, attitudes in the time and effort needed to learn physics, and students' attitudes towards understanding the laws and concepts of physics. Significant gender differences in terms of students' interest in learning physics and problem solving with male students show higher levels of women.

No	Authors	Methods	Findings
12	[19]	The method used is comparative research using a pretest -posttest design. Respondents in this study were 58 students from two grades 9.	The findings from this study showed that in the pretest there was no significant difference between the two experimental classes and the control class. Meanwhile, in the posttest there is a significant difference where the experimental class is consistently higher than the control class while the standard deviation is consistently lower.
13	[20]	Participants in this study were 301 high school students in Turkey. The method used is a quantitative method with linear regression analysis.	The findings from this study are that attitudes towards physics can significantly predict students' physics achievement on the understanding and requirements indicators. However, the interest and interest indicators cannot be explained. So that in this study the attitude of students towards physics could not strongly influence students' physics learning achievements.
14	[21]	This research method uses scanning studies. The population used consisted of grade 9, 10, and 11 high school students from schools in the central province of Kayseri. The research sample was 295 students selected from the population by random sampling.	The findings from this study on the results of a survey of students' attitudes towards physics subject scored the lowest student attitude 12, the highest 48 points. It can be concluded from these results that students are in an almost negative attitude towards physics lessons, and they have low levels of interest, expectations, and success in physics lessons. In addition, the lowest students' attitudes toward physics experiments score 8, the highest 42 points. From these statistical results it can be concluded that students have negative interests and attitudes towards physics experiments.
15	[22]	This study used a quasi - experimental design with pretest -posttest cluster sampling with a quantitative approach	The findings of this study were significant differences in pre -test and post -test scores in the Colorado Learning Attitude about Science Survey (CLASS) which identified an increase in students' physics learning attitudes.
16	[23]	The method used in this study is a combination research method by combining quantitative and qualitative methods.	Based on this research, there are several findings, namely, indicators that have good criteria are indicators of the social implications of physics. The rest for indicators of normality of scientists and career interest in physics obtain sufficient criteria.
17	[3]	This study uses a pseudolongitudinal method. The instrument used is the Colorado Learning Attitudes about Science Survey (CLASS). The sample in this study was 637 people consisting of class XII high school students in England and students majoring in Physics	Related to the aspect of thinking like an expert, the interesting results obtained from this study are that there is no significant change in beliefs and attitudes towards physics for undergraduate students at all semester levels.
18	[24]	This study used a mixed methods convergent parallel design to collect and analyze quantitative and qualitative data for each class. The primary data source is students from two schools namely, SMA 3 and SMA 8 in Jambi, Indonesia.	The findings show that students have positive attitudes towards physics, such as attitudes towards investigations in physics, pleasure in learning physics, adopting a scientific attitude, and increasing their time to study. This attitude can help students learn scientifically, structured, and independently.

No	Authors	Methods	Findings
19	[25]	This type of research is quantitative with survey research procedures where the instrument used is a questionnaire. The subjects of this study were 281 students consisting of 125 students from SMA Ferdy Ferry Putra Jambi City and 156 students from SMAN 6 Batang Hari. Quantitative data analysis techniques use descriptive and inferential statistics.	The findings of this study are influenced by three indicators, namely, the normality of scientists, the adoption of a scientific attitude, and the interest in a career in physics. Students who like physics will show a positive attitude towards physics, which is shown by never arriving late and always doing physics assignments on time. Another difference can be seen from the students' answers about the attitude statement, where many students do not repeat physics lessons at home. This causes the students' physics learning outcomes to be low due to factors from the students themselves.
20	[26]	The research identified 120 Malaysian students majoring in Physics who were randomly selected from several schools in Selangor who participated in this study by applying the STEM approach. This type of research is descriptive quantitative. The sample in this study were students at grade level form 4 and form 5.	The research findings show that students with the STEM approach have very good epistemological beliefs with an average score of 72.61 % and benefit in learning physics with an average score of 74.29 %. In this study, there were no gender differences in attitudes towards physics in male and female students. However, there were significant differences between the students at the form 4 and form 5 grade levels in epistemological beliefs and learning attitudes.
21	[27]	TThe method used is experimental. Participants in this study consisted of students in France, Italy, Lebanon, Norway, Portugal, Russian Federation, Slovenia, Sweden, and the United States grade 12.	The findings from this study are that positive attitudes towards physics in several countries can be influenced by several things, namely gender differences, interest in learning, and the culture of the school environment.
22	[28]	The respondents of this study were 460 students of class IX SMA in downtown Nizip, Gaziantep province. This study developed a Likert scale questionnaire with 30 questionnaire items.	From this research it was found that the type of high school affects attitudes towards physics subjects. Meanwhile, gender and parental education level did not have a significant effect on attitudes. Therefore, it was also found that students had an ambivalent attitude towards physics.
23	[29]	The method used is quasi-experimental pretest-posttest research. This research involved 152 students studying physics at the Ahmet Kelesoglu Faculty of Education, Selcuk University	The findings from this study are that there is a positive increase in the indicators of belief, understanding of concepts, the influence of physics in everyday life, and an interest in physics in the experimental class develops more attitudes compared to the control class which uses conventional learning models. This shows that students who use computer simulation models have a significant positive relationship.
24	[30]	The research method used is a quantitative design with survey research which is strengthened by interview results to support quantitative data. This research involved 926 students of Batanghari State Senior High School.	Researchers get good and quite good results with the following details: the adoption of a scientific attitude has a good result of 56 %, the enjoyment of learning physics has an adequate result of 55.5%, and an interest in spending time studying physics has a result of 57.9 %.

No	Authors	Methods	Findings
25	[31]	The learning attitudes survey about science (CLASS) was administered to 308 students from two private high schools in Almaty, Kazakhstan grades 9, 10 and 11.	The findings of this study provide several items that differentiate students based on gender, class, and physics exam success. The scores obtained by each differ based on age, grade level, test scores, and gender. Age and grade level correlated the most with conceptual relationships, while test scores correlated best with students' understanding of the material. Differences by sex were most significant in self-application and relation to the real world, with men scoring significantly higher.

3. Results and analysis

In this study, we have synthesized 25 articles, which are the most relevant to the topic being discussed. The results of the synthesis may be observed in Table II.

Based on the literature review, there are several factors that influence students' beliefs in learning physics, namely, factors related to the students themselves, to the teacher, and to the school environment. Students' positive attitudes towards physics subjects will be integrated with the social implications of physics, adoption of scientific attitudes, normality of scientists, pleasure in learning physics, and career interest in physics [23, 25, 30]. Students who like physics will show a positive attitude which is shown by never being late and always doing assignments on time.

Assessment of attitudes in learning is very important to do to find out students' attitudes towards physics subjects, so that later the teacher can use them to determine appropriate learning strategies for students. Based on findings in Scotland, physics attitudes were measured repeatedly with the result that attitudes and beliefs about physics did not change and remained consistent [15]. Physics scale attitudes that can be developed into an instrument in measuring attitudes and beliefs about physics, namely: (a) enthusiasm for learning physics; (b) enthusiasm for physics as a process; (c) enthusiasm for physics as a future vocation; and (d) physics teacher and physics learning [12]. Improving student attitudes will stimulate student interest in subjects, achievements, and student learning outcomes, so that a positive attitude can help students make better career choices in physics and other related fields of science [12, 20, 26]. In addition to this, it is necessary to have the role of the teacher during the learning process by choosing the right method that can stimulate curiosity and involve students in research and practical activities [14].

The findings show that students' attitudes and beliefs about physics are influenced by differences in gender and personality [18, 27], class level [11, 28], type of school [9], and age [14, 31]. Several findings state that male students have higher attitudes and beliefs than female students. In addition, class level and age also affect the confidence level of students with the result that a high grade level has a high level of confidence [31]. However, there are findings that the attitudes and beliefs of students towards physics are not influenced by gender differences but rather the personality and class level of students [26]. This is supported by previous findings that gender does not affect attitudes and beliefs about physics [32]. In addition, the type of school that is treated is in the form of providing the right curriculum, so beliefs and attitudes towards learning are increasing [10].

Students in the good category have an active attitude in finding things that conflict with the results of the experiment, then students respond critically, have high curiosity, and never give up. In addition, there are also students who have a negative attitude. Explanation of the obstacles that occur in the attitude indicators of students, it can be seen that students have unfavorable attitudes because the teacher's teaching model or strategy cannot increase students' positive attitudes towards Physics [16]. Learning models that can improve students' attitudes and beliefs about physics, namely: cooperative learning models with a jigsaw approach [24], using the Science Technology Engineering and Mathematics (STEM) approach [10, 26], learning using concept maps [19], using peer instruction methods [17], using open inquiry methods [22], integrated learning with music [13], and learning using computer simulation models [29]. Using the right learning model can increase the positive attitude of students, where the teacher must also carry out learning using science skills. This can be done by implementing physics experimental activities or providing an integrated learning environment with laboratory measurements that can help students solve problems in physics and improve their attitudes to be more critical [21]. Students who have science skills will have a positive attitude towards science. Improving students' scientific attitudes can also increase students' positive attitudes towards learning physics [16].

4. Conclusion

Literature review about attitudes and beliefs towards physics has been done. Physics attitudes and beliefs are influenced by gender and personality, grade level, type of school, and age. However, there are findings on the gender aspect according to [26] does not affect attitudes and beliefs about physics, whereas according to [18, 27] gender influences attitudes and

beliefs about physics. Various learning methods to improve attitudes and beliefs about physics are cooperative learning models with a jigsaw approach, using the Science Technology Engineering and Mathematics (STEM) approach, learning using concept maps, using peer instruction methods, using open inquiry methods, learning integrated with music, and learning using a computer simulation model.

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