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Demographic Factors Associated with Students' Belief and Attitude towards Physics and Learning: A Cross-Sectional Study from Indonesia

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Students' Belief and Attitude (BA) towards physics and learning are believed to influence student performance in learning. Identification and exploration of students' BA are crucial aspects in supporting the quality of physics learning. The Colorado Learning Attitudes about Sciences Survey (CLASS) is an instrument that is widely used to identify and explore students' beliefs and attitudes towards physics and learning. However, few studies have investigated the relationship between each categories of CLASS and the impact of demographic characteristics (gender, study program, school origin, interest in becoming a teacher, and length of study) on student beliefs. This study aims to fill in this gap. Using CLASS to measure these beliefs and attitudes among 439 physics students and prospective physics teachers from 11 universities. The survey data was analyzed with the Pearson Correlation, Mann-Whitney U, and Kruskal-Wallis tests. Overall, the results obtained show that all belief and attitude categories are significantly interconnected. Apart from that, there is also a positive and significant relationship between categories. This indicates that the three categories have demonstrated to be capable of constructing BA as a whole. However, no significant differences were discovered in the association between students' belief and attitudes towards physics and their learning based on demographic characteristics.

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Introduction

Researchers in physics education have been interested in students' epistemological beliefs about physics for the past two decades. Epistemological beliefs are a person's perspectives or understanding of the nature of knowledge and how one learns it. In this context, students' epistemological beliefs about physics include their perspectives on the nature of physics knowledge and how they engage in the physics learning process (Adams et al., 2006; Hammer, 1994). In many Physics Education Research (PER), students' learning approaches are discussed using various terms, such as attitudes, beliefs, values, expectations, views, personal interests, learning orientation, motivation, and epistemological beliefs. Our use of the terms "Belief and Attitude" is intended to cover a broad scope of terminology (Docktor & Mestre, 2014). Furthermore, the combination of these terms reflects the way students view physics knowledge and learning as a whole (Lising & Elby, 2005; Zhang & Ding, 2013).

It has been identified that when students study physics topic, they bring a variety of epistemological beliefs to physics and learning. Some have developed expert opinions, while others remain novices. One of the beliefs of novices (ordinary people) is that physics knowledge is a collection of fragmented concepts, which differs significantly from the beliefs of experts, who regard the field as a matrix of coherent and interconnected themes (Hammer, 1994). However, novice students' beliefs and attitude are more likely to alter and be open to new information (Sahin, 2010). Except when students have studied more sophisticated or complex physics subjects and their epistemological beliefs are deeply ingrained, their beliefs and attitudes are more difficult to modify since they have become an essential component of their understanding framework. As commonly observed, students' epistemological beliefs frequently diverge from those of experts (Gray et al., 2008; Perkins et al., 2005). So, preliminary study into the description of students' beliefs and attitude towards physics and their learning in a broad context is required, one of which is the cross-sectional approach, which allows researchers to obtain samples from the population with good generalizability.

The Colorado Learning Attitudes about Sciences Survey (CLASS), developed by Adams et al. (2006), refined by Douglas et al. (2014), and revalidated in the context of the Finnish population by Kontro & Buschhüter (2020), is a widely used instrument for measuring beliefs and attitudes towards physics and its learning. CLASS initially consisted of eight categories: real word connection, personal interest, sense-making/effort, conceptual connection, applied conceptual understanding, general problem solving, problem solving confidence, and problem solving sophistication (Adams et al., 2006). Then, using the psychometric test Confirmatory Factor Analysis (CFA), Douglas et al. (2014) reduced these eight categories to three primary dimensions: Personal Interest and Relation to the Real World (students internalize physics concepts and relate them to the world around them), Problem Solving and Learning (students' attitudes towards problem solving and learning physics), and Effort and Sense Making (the level of student effort in understanding physics concepts and their relationships). Kontro & Buschhüter (2020) then performed revalidation using the same dimensions. In this study, we used the instrument by Adams et al. (2006) and Douglas et al. (2014) with slight modifications.

To make it easier to talk about dimensions, we simplify Douglas et al. (2014)'s three dimensions in this work. Effort and sense-making become effort (EF), personal interest and relationship to the real world become conceptual understanding (CU), and problem solving and learning become problem solving (PS). In meaning, both are the same and contain identical statements. Furthermore, when an instrument is utilized with different respondents and varying coverage, it must be revalidated. This is because respondents' cultural backgrounds and characteristics will influence the outcomes. CLASS was revalidated and modified using the RASCH process (explained in the techniques section). The RASCH technique is employed in revalidation because the analytical results can provide item and person reliability, item and person separation, and the Wright map to explain the meaning of survey scores and generate alternative survey forms (Boone, 2016). Furthermore, RASCH can evaluate the model's applicability of items, detect problematic items, and identify unique respondents (Planinic et al., 2019).

There has been a lot of research that examines how students' beliefs and attitudes towards physics and their learning are described, both in the form of surveys (Perkins et al., 2005; Zhang & Ding, 2013) and by providing learning treatments to change students' belief and attitude perspectives from novices to experts (Balady & Taylor, 2022; Bodin & Winberg, 2012; Lee et al., 2023; Sahin, 2010; Zhang et al., 2017). However, a few studies have investigated the relationship between the categories EF, CU, and PS. Examining the relationships between these three categories can lead to a more comprehensive and consistent knowledge of undergraduate physics students' beliefs and attitudes, as well as how these characteristics interact and influence one another. It is important to consider the instrument's internal consistency, namely if it can accurately and consistently measure each area. This study can provide a better and more complete knowledge of the factors that influence students' beliefs and attitudes towards physics and their learning by bridging the gap between these three groups.

In this study, we examined how demographic factors such as gender, study the program, school origin, interest in becoming a teacher, and length of study affected students' belief and attitudes among all categories (EF, CU, PS). These demographic characteristics were chosen based on a variety of factors from previous literature reviews. Kim & Hamdan Alghamdi (2023), Robinson et al. (2021), and Zhang et al. (2017) found that gender effects students' attitudes towards physics and the learning process. This suggests the need to consider gender factors in designing appropriate learning strategies. In addition, Chen et al. (2019) suggested research on how students' epistemological beliefs change over time. This shows the importance of understanding the development of students' epistemological beliefs from the initial level to higher levels in the physics curriculum. Chen also noted differences in students' epistemological beliefs between Education and non-education students in China. Similar studies in Indonesia can provide insight into how the local educational context influences students' epistemological beliefs. Furthermore, studies of school origin factors (urban and rural areas) and factors of interest to become teachers have not been carried out much. This study can provide a better understanding of students' motivation to study physics and pursue a career as a teacher. This comparative approach to demographic factors in each category and among full-equivalent BAs reveals a willingness to examine the impact of these variables holistically. Thus, this study can provide a more comprehensive understanding of how these various components affect and correlate with students' epistemological beliefs about physics in the Indonesian context.

As a result, the aim of this study is to explore this field by answering two research questions. First, consider the extent of the relationship between the three categories of the belief and attitude instruments: effort, conceptual understanding, and problem solving. Is there a strong relationship between these three categories enabling them to describe students' beliefs and attitudes in general? Second, examine how demographic characteristics influence students' belief and attitudes about physics and their learning. Gender, study program, year of university study, school of origin, and desire to become a teacher are among the demographic aspects investigated in this study. This study provides insights into how demographic factors influence students' beliefs and attitudes towards physics and learning. This understanding is crucial for educators and policymakers to tailor interventions that can improve engagement and performance in physics education.

Methodology

Research Design

This research adopted a cross-sectional survey design (Creswell, 2012). Cross-sectional is a research method that allows researchers to carry out analysis with the same variables for all subjects in the sample population at a certain period. This method can also be used to understand the relationship between variables. The cross-sectional survey aims to measure students' beliefs and attitudes towards physics and their learning. A cross-sectional design was chosen because researchers can take samples from the population with good generalization, and survey results can be obtained quickly (Wang & Cheng, 2020). Cross-sectional designs are commonly used to find relationships between demographic factors and cognitive factors (Berry et al., 2010; Parmenter et al., 2021).

Participants

This survey included 439 students from 11 Indonesian institutions enrolled in the Physics Education and Physics study program. Participants were recruited using a convenience sample method, which selects respondents based on their willingness to complete the survey and open up information. Convenience sampling allows for greater flexibility in data collection, particularly when the population being studied is easily accessible (McMillan & Schumacher, 2010). Although convenience sampling has the potential for bias, caution in interpreting the findings is paramount. Most participants were female (75.6%), and 61.5% had finished upper secondary education in urban areas. Table 1 has a detailed list of demographic factors.

Table 1. Analysis of demographic variables

Demographic Aspects	Group	Number of People	Percentage (%)
Gender	Male	107	24.4
	Female	332	75.6
Study Program	Bachelor of Physics Education	325	74.0
	Bachelor of Physics	114	26.0
Study Year	First year	189	43.0
	Second year	61	13.9
	Third year	135	30.8
	Fourth year	54	12.3
School Background	Urban Area	270	61.5
	Rural Area	169	38.5
Interested in Becoming a Physics Teacher	Yes	298	67.9
	No	141	32.1

Instruments and Data Collection

August 2023 was the survey's one-month duration. The instrument utilized in this study was a modified version of The Colorado Learning Attitudes about Sciences Survey (CLASS), a questionnaire created by Adams et al. (2006) and revalidated by Douglas et al.

(2014). The CLASS is an instrument designed to measure students' beliefs about physics and their learning. Initially CLASS had 42 items with 8 categories (Adams et al., 2006), but then we modified it to 44 items which were grouped into 3 main categories, namely effort (EF), conceptual understanding (CP), and problem solving (PS). The reorganization of 8 categories into 3 categories is based on the results of the CFA analysis by Douglas et al. (2014). The answer options for this instrument are on a 1-5 Likert scale, from strongly disagree to strongly agree.

The CLASS instrument was modified in four stages. First, translate into good, correct Indonesian. Next, a Focus Group Discussion (FGD) was undertaken with three final-year students in the physics education study program to ensure that the editorial lines for each item were appropriate and easy to comprehend. At this FGD stage, the emphasis is just about editorial changes, therefore the number of items remains constant. Third, the draft from the second step was handed to two professional lecturers for assessment to ensure its validity. These two experts were asked to provide qualitative evaluations on the content validity of each questionnaire item. Experts evaluate items to make sure that they are simple to grasp and that respondents will not face difficulty or provide unclear responses. During the expert validation stage, suggestions were received to add two items as a confrontation of existing items. Item number 7 "There may be more than one different explanation of a physical phenomenon if it is approached/explained in different ways" is a confrontation with item number 43. "It is possible that there is more than one correct answer to a mathematical physics problem if it is solved differently." This requires us to address two types of physics problems: quantitative (counting numbers) and qualitative (phenomena). Finally, the RACSH test was conducted to assess the instrument's validity and reliability.

This RASCH test was based on the responses of 100 prospective student responders. To assess the instrument's reliability, we looked at Pearson reliability, item reliability, and Cronbach alpha. According to the RASCH analysis, these three parameters are very good. The Mean Square (MNSQ) was used to evaluate how well the data fit the RASCH model. The average MNSQ person and outfit MNSQ infit values are good, with both person and item measures ranging from 0.61 to 1.40. The value is 0.85 for Pearson reliability with a separation of 2.40, 0.99 for item reliability with a separation of 10.81, and 0.85 for Cronbach alpha. To ensure that all items in this scale are a unified instrument for measuring BA, we use the dimensionality parameter. The results show that the total value of raw variance in observations is 54.9%. So, from these results it can be concluded that this instrument can be used to measure student beliefs and attitudes.

Displaying the Wright Map and item fit for each dimension demonstrates the validity of the response pattern as well as the internal structure. The MNSQ and Z-standardized (ZSTD) outfit values are often utilized. ZSTD is used to evaluate the significance of any deviation from the expected response based on the Rasch model. MNSQ scores considered fit by modelling range from 0.6 to 1.4 (Wright & Linacre, 1994), with ZSTD +-2 (Bond et al., 2020). Items with an Outfit MNSQ score outside of this range are ruled invalid. According to the data above, item 2 does not fit with Rasch modelling. In the prior analysis, items 35, 7, 32, 20, 27, 6, and 10 were excluded. These eight items are classified as underfit (noisy), which suggests that these three factors cannot explain all of the differences. As a result, 8 items were removed, leaving 36 fit items (see Appendix).

Table 2. Summary of CLASS revalidation results using RASCH analysis

Aspect	Parameter	Revalidated CLASS
Unidimensionality	More than 30%	Assumptions are fulfilled
Local independence	Maximum 0.30	Assumptions are fulfilled
Reliability item	More than 0.90	0.99
Reliability person	More than 0.90	0.85
Separation item	More than 2.0	10.81
Separation person	More than 2.0	2.40
Cronbach alpha	More than 0.6	0.85
Outfit dan infit MNSQ	0.60-1.50	Eight items do not fulfil the criteria above 1.40 and no item below 0.6
Wright map	The easiest and most difficult item to answer	Number 25 and number 27
Test Information Function (TIF)	-	Optimal for students with moderate ability

In terms of category grouping on the CLASS instrument, it was discovered that numerous items were included in the not scored category (4, 7, 9, 31, 33, 41), as well as several items were not included in certain categories, specifically item numbers (2, 10, 12, 17, 18, 19, 20, 27, 29, 38). So some of these items are assigned to the relevant groups. Aside from that, there are a few items that fit into two categories at once, thus one of them is removed. Table 3 shows item details and their classification into three categories.

A valid questionnaire is then generated in the form of a Google Form. The link is delivered to students directly or through physics teachers using the social media platform WhatsApp. WhatsApp was chosen because each student and lecturer has a WhatsApp group in each subject they teach, which makes distributing surveys easy. Students also have the option not to complete the questionnaire for ethical concerns. Filling out the questionnaire is based on student volunteerism. The information submitted is likewise kept confidential and anonymous.

Table 3. Category and Instrument Items Belief and Attitude towards Physics and Learning

Category	CLASS Categories	Items
Effort (EF)	Real Word Connection - RWC	28, 30, 37, 43, 17, 44
	Personal Interest - PI	3, 11, 14, 25, 9, 33
	Sense Making/Effort - SM	23, 24, 36, 39, 42, 12, 19
Conceptual Understanding (CU)	Conceptual Connection – CC	1, 5, 13, 21, 41
	Applied Conceptual Understanding – ACU	8, 22, 40, 4, 38, 31
Problem Solving (PS)	Problem Solving General (PSG)	15, 29, 16, 26, 18, 34
	Problem Solving Confidence (PSC)	
	Problem Solving Sophistication (PSS)	
Confirmatory Question	*To ensure that respondents are focused when filling out the survey*	31

Data Analysis

The collected data will be reviewed first, then sorted, and destroyed if there are two or more similar identities. Data were analyzed using descriptive and inferential statistics. Descriptive analysis highlights students' Belief and Attitude scores towards physics, as well as their learning outcomes for each category and demographic data. The Pearson correlation is applied to examine the link between Belief and Attitude in three areas: effort, conceptual understanding, and problem solving, as well as the relationship between these categories. The

Mann-Whitney test was then used to compare the mean Belief and Attitude analyses of the two groups (by gender, study program, school of origin, and interest in becoming a teacher). Finally, the Kruskal-Wallis test was used to compare mean evaluations of belief and attitude across two groups (years of study). The Mann-Whitney and Kruskal-Wallis tests were used because the data obtained were not normally distributed.

Results

Relationship Between Categories on Student Belief and Attitude Instruments

The Pearson correlation test was performed to determine the correlation between categories (EF, CU, and PS) on students' Belief and Attitude instruments towards physics and learning. The research found a positive and significant relationship between all categories ($p < 0.01$). This suggests that BA has a strong connection with EF (r =.815), CU (r =.777), and PS (r =.842). These data show that problem solving has the highest correlation between belief and attitude, whereas conceptual understanding has the lowest.

Additionally, there is a positive and significant correlation between categories ($p < 0.01$). These include EF-CP (r =.463), EF-PS (r =.554), and CU-PS (r =.450). The correlation between these categories revealed that the highest value was the correlation between EF and PS, while the lowest was the correlation between CU and PS. Table 4 summarizes the findings of correlation tests and descriptive statistics.

Table 4. Correlation matrix results and descriptive statistics

Category	BA	EF	CU	PS
BA	-			
EF	.815**	-		
CU	.777**	.463**	-	
PS	.842**	.554**	.450**	-
Minimum	1.79	1.74	2.30	1.33
Maximum	5.00	5.00	5.00	5.00
Mean	3.76	3.89	3.61	3.76
SD	.381	.435	.455	.517
Skewness	-.078	-.355	.241	-.310

Note. BA = Belief & Attitude; EF = Effort; CU = Conceptual Understanding; PS = Problem Solving

** *p < 0.01 (significant correlation)*

Relationship between Demographic Factors and Students' Belief and Attitude towards Physics and Learning

Gender

Men (M=3.96) had a higher perception of EF than women (M=3.87). Women, however, have higher perceptions of BA (M=3.76), CU (M=3.65), and PS (M=3.76) than males, specifically BA (M=3.73), CU (M=3.49), and PS (M=3.73). Analysis using the Mann-Whitney test (Table 4) revealed significant differences between men and women in the EF (Sig. 0.047) and CU (Sig. 0.001) categories. Meanwhile, no significant difference was found between the BA (Sig. 0.197) and PS (Sig. 0.339) groups.

Table 5. Results of analysis of the influence of gender on students' beliefs and attitudes

Variable	BA		EF		CU		PS	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gender								
Men	3.73	.387	3.96	.479	3.49	.464	3.73	.516
Woman	3.76	.379	3.87	.417	3.65	.445	3.76	.517
Z-score	-12.89		-1.982		-3.253		-.957	
Sig.	.197		.047		.001		.339	

Study Program

The average result shows that undergraduate Physics Education students have higher perceptions of BA (M=3.76), EF (M=3.90), and CU (M=3.64) than undergraduate Physics students, specifically BA (M=3.72), EF (M=3.87), and CU (M=3.51). Meanwhile, undergraduate Physics students (M=3.79) reported higher PS perceptions than undergraduate Physics Education students (M=3.74). Furthermore, the Mann-Whitney test findings (Table 6) revealed a significant difference between undergraduate Physics Education students and undergraduate Physics students in the CU category (Sig. 0.013). Meanwhile, there were no significant differences between the BA (Sig. 0.408), EF (Sig. 0.825), and PS (Sig. 0.360) categories.

Table 6. Results of analysis of the influence of study programs on students' beliefs and attitudes

Variable	BA		EF		CU		PS	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Study Program								
Bachelor of Physics Education	3.76	.390	3.90	.427	3.64	.457	3.74	.517
Bachelor of Physics	3.72	.350	3.87	.457	3.51	.434	3.79	.515
Z-score	-.827		-.221		-2.492		-.916	
Sig.	.408		.825		.013		.360	

School Origin

Students from schools in urban areas have higher perceptions of BA (M=3.76), EF (M=3.90), and PS (M=3.77) compared to students from rural areas, namely BA (M=3.75), EF (M=3.87), and PS (M=3.74). Meanwhile at CU, students from urban areas (M=3.59) had a lower mean rating than those from rural areas (M=3.65). The results of analysis using the Mann U-Whitney test (Table 7) showed that no statistically significant differences between students from urban area schools and rural area schools in all categories, namely BA (Sig. 0.972), EF (Sig. 0.375), CU (Sig. 0.158), and PS (Sig. 0.564).

Table 7. Results of analysis of the influence of school origin on students' beliefs and attitudes

Variable	BA		EF		CU		PS	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
School Origin								
Urban Areas	3.76	.364	3.90	.421	3.59	.456	3.77	.509
Rural Areas	3.75	.406	3.87	.456	3.65	.450	3.74	.527
Z-score	-.035		-.887		-1.412		-.577	
Sig.	.972		.375		.158		.564	

Interest in Becoming a Teacher

Table 8 shows the variations in mean ratings for students interested in becoming teachers in terms of beliefs and attitudes towards physics and learning in each area. Students in physics and physics education program who want to be teachers have higher BA perceptions (M=3.76), EF (M=3.90), CU (M=3.63), and PS (M=3.76) than students who don't want to be teachers. The Mann U-Whitney test showed no statistical significant differences between students who desired and did not want to become teachers in all categories, including BA (Sig. 0.374), EF (Sig. 0.367), CU (Sig. 0.291), and PS (Sig. 0.927).

Table 8. Results of analysis of the influence of student's interest in becoming a teacher on students' beliefs and attitudes

Variable	BA		EF		CU		PS	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Interest in becoming a teacher								
Yes	3.76	.388	3.90	.420	3.63	.459	3.76	.521
No	3.73	.364	3.86	.464	3.58	.443	3.75	.506
Z-score	-.889		-.902		-1.057		-.092	
Sig.	.374		.367		.291		.927	

Length of Study

First year students (M=3.79) had a higher view of BA than second year students (M=3.70), third year students (M=3.73), and fourth year students (M=3.73). Similarly, first year students had the highest average PS rating (M=3.84). In the EF category, fourth-year students received the highest mean rating (M=3.94). Meanwhile, third year students had the highest CU ranking (M=3.67) compared to first year (M=3.59), second year (M=3.59), and fourth year (M=3.55). The Kruskal Wallis test (Table 9) revealed a significant difference in the length of study among students in tertiary institutions in the PS category (Sig.0.012). Meanwhile, no significant differences were detected between BA (Sig. 0.354), EF (Sig. 0.116), and CU (Sig. 0.309).

Table 9. Results of analysis of the length of study on students' beliefs and attitudes

Variable	BA		EF		CU		PS	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Study year								
First year	3.79	.383	3.93	.478	3.59	.460	3.84	.497
Second year	3.70	.414	3.80	.472	3.59	.449	3.72	.520
Third year	3.73	.357	3.85	.358	3.67	.448	3.67	.520
Fourth year	3.73	.388	3.94	.393	3.55	.452	3.71	.537
Kruskal-Wallis H	3.255		5.911		3.589		10.891	
Sig.	.354		.116		.309		.012	

Discussion

The fundamental purpose of this study is to investigate the correlation between categories on the CLASS instrument and demographic factors such as gender, study program, school of origin, interest in becoming a teacher, and length of study. By investigating these correlations, this study may provide insight on how demographic factors influence students' belief and attitudes towards physics and learning. The study's findings can have a direct impact on the development of learning programs that are better customized for the needs and characteristics of students based on their demographics. Understanding how demographic factors also influence students' beliefs and attitudes towards physics can help teachers adapt to their teaching strategies. For example, if certain demographic groups show less positive attitudes towards physics, educators can implement targeted interventions such as interactive teaching methods, real-world applications of physics concepts, or culturally relevant examples to enhance engagement.

Relationship Between Categories on Student Belief and Attitude Instruments

The study's findings indicate that each category has a strong correlation to BA. Similarly, each category has a positive and significant correlation. This demonstrates that all questions and categories in CLASS can help students get a comprehensive grasp of their beliefs and attitudes about physics and learning. As Douglas et al. (2014) and Kontro & Buschhüter (2020) evaluated and validated CLASS, the results were grouped into three main categories (personal application and relation to the real world, problem solving and learning, effort and sense making). This study demonstrates the existence of a relationship between these three categories. However, in this study, the phrases personal application and link to the real world are defined as conceptual understanding. Both have similar meanings: the process of internalizing students physics concepts and the ability to connect them with the world around them, as well as the ability to use them to solve problems (Docktor & Mestre, 2014; Kustusch, 2016; Sutopo & Waldrip, 2014). Another reason for using the term conceptual understanding is to include two of the eight elements in CLASS: conceptual connection and applied conceptual understanding (Adams et al., 2006).

Among the three categories, the category that has the highest correlation with belief and attitude is problem solving, while the one with the lowest is conceptual understanding. This problem solving category accommodates three categories proposed by Adams et al. (2006), namely problem solving general (PSG), problem solving consistency (PSC) and problem solving sophistication (PSS). Sherin (2001) defines problem solving as the ability to understand problems in terms of a specific scheme and then solve them using that scheme's approaches and equations. Several studies reveal a positive relationship between beliefs and problem solving and the learning design designed (Good et al., 2019; Mbaka et al., 2023). On the other hand, Reddy (2020) in his case study research revealed that students have personal epistemological beliefs that differ from each other and with respect to each problem they solve.

The Effect of Gender on Students' Belief and Attitude towards Physics and Learning

Good et al. (2019) in their study, found that female students in introductory physics had average attitudes and a more expert problem-solving approach than their male counterparts, especially towards the end of the course. Apart from that, Kim & Hamdan Alghamdi (2023) also found that the average Nature of Science (NOS) score for female students was much higher than male students. Male students displayed more naive epistemological beliefs than female students. This is in accordance with the findings in this study that the average value of female students' beliefs and attitudes towards physics and learning is higher than male students. However, even though the number of female students is higher, when a correlation test is carried out, the difference between the two is not significant. These results are also supported by the findings of Chen et al. (2019) that students' epistemological beliefs regarding physics learning do not depend on gender, because they do not have a main influence on gender patterns. This means that the gender variable makes a small contribution to students' epistemological beliefs.

The study's findings also indicate that men had higher views of EF than women. But, there is no significant correlation between men and woman in this category. These findings are consistent with those of Li & Singh (2021), who discovered that the learning environment reduced female students' self-efficacy and interest in physics at the start of the course, but the gender gap in motivational constructs (effort) increased by the end. The study discovered that the decrease in students' self-efficacy and interest in physics was mediated by the learning environment, which predicted students' physics identity. Although these findings differ from Yeung (2011) findings that males make little effort to study at school in general. Many prior research in the physics education literature found that female students had lower averages of motivational characteristics and perspectives of physics (e.g., motivation, interest, identity, etc.) than male students in physics classrooms (Marshman et al., 2018; Nissen & Shemwell, 2016; Sawtelle et al., 2012).

Furthermore, it is higher among CU and PS women. The results show that men and women have a significant correlation in conceptual understanding but no significant correlation in problem solving. These findings are consistent with Robinson et al. (2021) which found that both men and women had significant improvements in problem solving and conceptual understanding, with women outperforming males. Gender-based attitude differences must be addressed as part of a strategy to promote women's involvement, retention, and learning success (Kalender et al., 2022).

Effect of Study Program on Students' Belief and Attitude towards Physics and Their Learning

The findings of this study reveal a considerable disparity between undergraduate Physics Education students and undergraduate Physics students in the CU category. Meanwhile, there were no significant variations among the BA, EF, and PS groups. However, Physics Education undergraduate students have a higher average BA perception score than Physics undergraduate students. This is congruent with the findings of Chen et al. (2019), who discovered that students majoring in education have better score in attitudes towards learning physics than students majoring in non-education, independent of gender or university level. In addition to physics knowledge, students in education classes are taught how to teach physics to students and about pedagogy. This demonstrates that varied material content and learning strategies will influence students' attitudes towards science (Myers & Fouts, 1992). As a result, education students have a higher average BA score than non-education students.

Apart from the statement that there are differences in perceived beliefs between education and non-education majors, Chen et al. (2019) also stated that in more detail the major did not have a significant effect on the categories of problem solving confidence, problem solving sophistication, and applied conceptual understanding. These results are slightly different from this study, in the CU category, there were significant differences between Physics Education undergraduate students and Physics undergraduate students.

The Effect of School Origin on Students' Belief and Attitude towards Physics and Their Learning

Every student in higher education comes from a different school, whether it's public or private, urban or rural. Delgado-Viñas & Gómez-Moreno (2022) and Paniagua (2014) employ terms like "rural" and "urban" to distinguish between different geographic locations. In Indonesia, a few studies compare the abilities of urban and rural students (Kusairi et al., 2020; Tanti et al., 2020). For example, Zhao et al. (2022) found a digital outcomes gap between rural and urban students, with rural students reporting lower levels of behavioral engagement in e-learning courses than their urban counterparts. The findings of this study show that students from urban schools have higher BA perceptions than students from rural schools. Similarly, in the EF and PS categories, urban students have a higher average perception. However, statistically, there is no significant difference across all categories.

The Effect of Interest in Becoming a Teacher on Students' Belief and Attitude towards Physics and Their Learning

According to the study's findings, 67.9% of all respondents, including those with education and non-education degrees, want to be teachers. Career expectations are realistic and accessible options for students considering their future careers (Arbona & Novy, 1991). These expectations are frequently formed in childhood, becoming more concentrated and reduced during adolescence and young adulthood (Gottfredson, 1981). Job expectations have a significant impact on adolescents' future educational and professional achievement, as well as their earning potential and social position in adulthood, particularly for those from disadvantaged families. Adolescents' teaching aspirations are influenced by a variety of external and individual factors (Purwaningsih et al., 2020), including attitudes towards the scientific subject they are pursuing (Fray & Gore, 2018). Furthermore, teaching is valued for a variety of reasons, including altruistic, intrinsic, and extrinsic motivations, as proven by current research. These diverse reasons may drive the determination of teacher candidates and help them keep to their commitment (Ölmez-Çağlar, 2022).

According to the study's findings, students who are interested in to be teachers have a higher average sense of belief attitude towards physics and learning in each area than students who don't. However, the mean difference is insignificant. According to evidence, a teacher's complex mix of personal views about teaching and science influences their willingness and capacity to teach science as inquiry (Crawford, 2007). Students who want to be physics instructors should have a comprehensive understanding of physics and how it is taught so that they can later teach effectively and have views that are consistent with experts.

Effect of Study Length on Students' Belief and Attitude towards Physics and Learning

Chen et al. (2019) suggested investigating how students' epistemological beliefs towards physics learning are influenced by year-level variables. In his research, the results of one-way ANOVA showed that students at different year levels did not show significant differences in ($F = 0.684$, $p = 0.505$). These findings are consistent with those reported in this study, which indicated no significant BA differences between first and final year students using the correlation test. The EF and CU categories show no significant difference. This means that students at all levels have similar perspectives on physics and their understanding of EF and CU. However, there are substantial changes between generations when it comes to problem solving.

In particular, the findings of this study indicate that first-year students had a higher perception of BA than second-, third-, and fourth-year students. Similarly, to the image of PS, first-year students get the highest average rating. This is related to first-year students' great drive and passion for studying. Meanwhile, in the EF category, fourth-year students had the greatest average ranking. Students in their fourth or final year of college struggled to complete all lecture tasks after receiving all of the content. This reinforces the fact that final students had the highest perception of effort.

Conclusions

This research provides an overview of demographic factors related to students' beliefs and attitudes towards physics and their learning in Indonesia. We used the CLASS instrument which had been translated into Indonesian which was then modified and revalidated. We identified and looked for the relationship between student performance on BA and the relationship between categories on factors such as gender, study program, school of origin, interest in becoming a teacher and length of study. This study showed 6 main results. First, that each category (EF, CU and PS) is significantly related to BA. Likewise, between categories, all of them have a positive and significant relationship. Second, the average value of female students' beliefs and attitudes towards physics and learning is higher than male students. However, even though the score of female students is higher, when a correlation test is carried out, the difference between the two is not significant. Third, undergraduate Physics Education students have a higher BA perception than undergraduate Physics students. Fourth, students from schools in urban areas have a higher BA perception than students from rural areas, although statistically there is no significant difference. Fifth, students who are interested in becoming teachers have a higher average perception of belief attitude towards physics and learning in each category than students who are not interested in becoming teachers. However, the mean difference is not significant. Finally, in terms of length of study, first-year students had a higher perception of BA than second-, third-, and fourth-year students.

Findings from the research can guide the development of targeted interventions aimed at fostering positive attitudes towards physics among students in Indonesia. This could involve curriculum adjustments, teacher training programs, or outreach initiatives designed to enhance interest and engagement in physics education, also reinforcing learning media (Diyana et al., 2020). And also, by employing a cross-sectional study design, the research captures a snapshot of beliefs and attitudes at a specific point in time among Indonesian students. This allows for comparisons across different demographic groups and provides a foundation for future longitudinal studies to track changes over time (Ibrohim et al., 2022).

Convenience sampling, as often used in cross-sectional studies, may lead to sampling bias. For instance, if the study recruits students from specific schools or regions that are easily accessible, the sample may not represent the diversity of all Indonesian students. This limits the generalizability of the findings to the broader population of students in Indonesia. Then, the vast number of participants in this study will contribute to institutions or departments and lecturers being able to design learning that is able to lead students to have confidence in physics and its learning as experienced by experts. However, the results of this research must be reconfirmed on a wider research scale with more respondents from several universities, both state and private universities, as well as educational and general universities. This will increase the external validity of the findings, ensuring that the research results can be more generally applied to the population of physics students in Indonesia. In addition, further research is needed to investigate predictors of differences in students' beliefs and attitudes towards physics and their learning using qualitative measures to support and interpret numerical findings more clearly. Combining numerical findings with qualitative interpretations can enrich our understanding of the dynamics of students' beliefs and attitudes toward physics. This can provide context and deepen the interpretation of the findings.

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Appendix

The CLASS statements for three categories: effort, problem solving and conceptual understanding according to Ref. (Adams, 2006).

Number	Items
Effort (EF)	
28	Learning physics changes my ideas about how the world works
30	Reasoning skills used to understand physics can be helpful to me in my everyday life
35	The subject of physics has little relation to what I experience in the real world
43	I enjoy solving physics problems in the form of explaining phenomena
17	Understanding physics basically means being able to recall something you've read or been shown
44	There may be more than one explanation for a physical phenomenon if it is approached/explained in several ways.
3	I think about the physics I experience in everyday life
11	I am not satisfied until I understand why something works the way it does
14	I study physics to learn knowledge that will be useful in my life outside of school
25	I enjoy solving physics problems in the form of calculation problems
9	I find that reading the text in detail is a good way for me to learn physics
33	I find carefully analyzing only a few problems in detail is a good way for me to learn physics
23	In doing a physics problem, if my calculation gives a result very different from what I'd expect, I'd trust the calculation rather than going back through the problem
24	In physics, it is important for me to make sense out of formulas before I can use them correctly
36	There are times I solve a physics problem more than one way to help my understanding
39	When I solve a physics problem, I explicitly think about which physics ideas apply to the problem
42	When studying physics, I relate the important information to what I already know rather than just memorizing it the way it is presented
12	I cannot learn physics if the teacher does not explain things well in class
19	To understand physics I discuss it with friends and other students
Conceptual Understanding (CU)	
1	A significant problem in learning physics is being able to memorize all the information I need to know
5	After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.
13	I do not expect physics equations to help my understanding of the ideas; they are just for doing calculations
21	If I don't remember a particular equation needed to solve a problem on an exam, there's nothing much I can do (legally!) to come up with it
41	It is possible for physicists to carefully perform the same experiment and get two very different results that are both correct
8	When I solve a physics problem, I locate an equation that uses the variables given in the problem and plug in the values.
22	If I want to apply a method used for solving one physics problem to another problem, the problems must involve very similar situations

40	If I get stuck on a physics problem, there is no chance I'll figure it out on my own
4	Practicing calculation problems helps me understand and apply physics principles more effectively
38	It is possible to explain physics ideas without mathematical formulas
Problem Solving (PS)	
15	If I get stuck on a physics problem on my first try, I usually try to figure out a different way that works
29	To learn physics, I only need to memorize solutions to sample problems
16	Nearly everyone is capable of understanding physics if they work at it
26	In physics, mathematical formulas express meaningful relationships among measurable quantities
18	There could be two different correct values to a physics problem if I use two different approaches
34	I can usually figure out a way to solve physics problems
Confirmatory Question	
31	We use this question to discard the survey of people who are not reading the statements. Please select agree—option 4 (not strongly agree) to preserve your answers