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University students' memories of their secondary science education experiences

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Students' attitudes and perceptions about a course of study and their career choices are influenced by their prior educational experiences. These experiences also apply to physics education, which is not exempt from this process. University students' attitudes toward physics classes during their high school years, the teaching methods used in the course, and their opinions about studying physics are investigated in this study. Students majoring in education, engineering, and health sciences at a university in northern Iraq participated in the survey. The survey collected data from 243 students. The researchers designed a survey that was used to collect data. Descriptive statistics, cluster analysis, and the Mann–Whitney and Kruskal–Wallis tests were used to answer the research questions. The results show that students' opinions about high school physics classes can be positive. Students' attitudes and thoughts do not change according to gender, school status, grade level, or departments. The use of technology and supporting course materials were effective in all dimensions.

KEYWORDS

physics education, science education, university students, memorize, experience

Introduction

Their prior educational experiences significantly impact their attitudes and thoughts about a course of study and their decision about which career to pursue. According to Haught et al. (2015), school memories are linked to one's beliefs about education. Regardless of accuracy, memories of earlier years provide significant insight into what is remembered and what is important to the individual. They reflect a personal "truth" for that person that shapes current perceptions and behaviors (Miller and Shifflet, 2016). This information also applies to physics classes and the physics teacher that high school students experience. This study focused on university students' experiences in physics during high school. The study examined students' attitudes toward physics instruction, perceptions of physics teachers, thoughts on the instructional activities used, and generally, their opinions of physics instruction.

Students often view physics as one of science's most difficult and confusing subjects. They view physics as challenging in high school and become more evasive in university (Guido, 2013). It is also noted that physics needs to be taught as a stand-alone subject because it provides students with the necessary information (Kurniawan et al., 2019). Numerous elements contribute to student achievement and the formation of positive attitudes in a physics course that is perceived as challenging. The instructional activities (Bakaç et al., 2011; Tomara et al., 2017), alternative course materials (Bakri et al., 2020; Wati and Widiansyah, 2020), laboratory activities (Snětinová and Kácovský, 2019; Holmes and Lewandowski, 2020), teacher attitudes (Thibaut et al., 2018; Head et al., 2020; Mami, 2021), and the use of technological opportunities (Civelek et al., 2014; Maulidah and Prima, 2018; Abdusselam and Karal, 2020; Aragaw et al., 2022) are the first of these.

An attitude is a psychological state that is characterized by a positive or negative evaluation of a particular entity (Eagly and Chaiken, 1993). Attitude toward physics can be described as a collection of emotions or an evaluative judgment created by someone who knows physics and can make decisions (Barmby and Defty, 2006; Testa et al., 2021). Numerous researchers (Civelek et al., 2014; Kotluk and Kocakaya, 2017; Aragaw et al., 2022) studying the art of teaching physics courses have investigated the impact of teaching methods on academic performance and the effect of students' attitudes toward physics. In other words, it is an important factor in the research on teaching physics. Teaching activities, such as blogging (Duda and Garrett, 2008), active learning (Gao, 2019), and web-based applications (Balta and Tzafilkou, 2019), have a direct impact on students' attitudes toward physics education (Kurniawan et al., 2019).

Teaching methods are key factors that influence teaching–learning outcomes (Hudson et al., 2010). To improve student success in or understanding of high school physics courses, many teaching strategies or methods, such as computer-assisted instruction (Bakaç et al., 2011; Rosali, 2020; Ugwuanyi and Okeke, 2020), simulations (Kiv et al., 2019; Wati and Widiansyah, 2020; Banda and Nzabahimana, 2021), project-based learning (Retno et al., 2019; Widyaningsih and Yusuf, 2019; Samsudin et al., 2020), brain-based instruction (Saleh and Subramaniam, 2019; Achor and Gbadamosi, 2020), and online multiple intelligence learning approach (Ahamad et al., 2021), have been introduced by scholars. Students' perceptions of teaching methods increase when evaluating the learning experience, even if they do not directly correlate with the outcome (Ramaila and Reddy, 2018). It is not enough to simply use the method, students must also have a positive impression of how the procedures will affect their performance.

According to Wayne and Youngs (2003), there is a relationship between teacher characteristics and student success. Teachers' perceptions also influence students' opinions of instruction. Teachers' interactions with their students in the classroom influence students' enthusiasm for teaching (Mami, 2021). The reverse is also true. Negative teacher behaviors in the classroom can contribute to students' dislike of the lesson. Students' opinions of whether physics classes are difficult or easy affect their attitudes toward the course and, therefore, their success. According to a study conducted at different educational levels and eras, students perceive physics as difficult and boring (Williams et al., 2003; Ekici, 2016; Barikhlana et al., 2019; Mufit, 2019; Mbonyiryivuze et al., 2021).

Students' present behaviors can be traced back to the experiences they had in the past. Examining students' experiences and memories throughout their school years provides critical data for curriculum development, teacher development, and education policymakers (Miller and Shifflet, 2016). Miller (2015) discussed the importance of an individual's prior experiences in his study. According to Turunen (2012), individuals carry both happy and bad memories of their school years throughout their adult lives. They have an emotional impact on students' school or academic memories (Hudson et al., 2010; Haught et al., 2015), as well as an effect on students' physical identity (Wang et al., 2018), and they influence students' achievement levels (Wayne and Youngs, 2003). From this perspective, this study will contribute to the research on school memories. This study will contribute to the existing body of knowledge by focusing not only on students from one area but also on students from other areas.

This study aimed to investigate university students' attitudes and thoughts about the physics course they took in high school. In this context, the research questions were set as follows:

1. What are the students' attitudes toward physics classes, the teaching methods used, their perceptions toward physics teachers, and their opinions about learning physics?
2. What are the characteristics of students with high attitudes toward physics teaching, teaching methods used, perceptions of physics teachers, and opinions about learning physics?
3. Do students' attitudes toward physics teaching, the teaching methods used, their perceptions of physics teachers, and their opinions about learning physics change according to gender, the status of the high school they graduated from, the subject areas they attend, the presence of a laboratory in high school, the use of technology in teaching, and the use of supporting course materials?

Method

This study is a descriptive one that is based on a quantitative approach. Descriptive studies attempt to capture a particular fact as accurately and completely as possible (Fraenkel and Wallen, 2008). This study is classified as descriptive research because it investigates university students' attitudes toward teaching physics in high schools, their perceptions of their teachers, and their views on the teaching methods used.

Population and sample

Students of education, engineering, and health sciences at a university in northern Iraq participated in the study. The survey was completely voluntary. The survey collected data from 243 students. Female participants made up 47.7% of the sample, while male participants made up 52.3%. Thirty-nine percent of the participants were first-year students, 17.35% were second-year students, 18.15% were third-year students, and 25.55% were fourth-year students. In addition, 56% of the participants attended engineering departments, 19.8% attended education faculty departments, and 24.3% were studying in health sciences faculty departments. While 49% of individuals attended public high schools, 51% attended private high schools. Students (37.4%) graduated from a high school that had a laboratory. Students (31.7%) in high school physics classes used alternative course materials. On the other hand, 39.5% of high school physics students used technological tools in their classes.

Data collection instrument

The survey developed by the researchers used a data collection instrument. Primarily, relevant literature (e.g., Williams et al., 2003; Hudson et al., 2010; Miller and Shifflet, 2016) was reviewed for the survey items. To develop the survey items, the researchers then asked students at the university an open-ended question in which they could write down what they thought about their high school physics course. Seventeen items were constructed using literature and the students' written responses. All items were forwarded to science educators for checking content validity in the following phase. The wording of some items was changed. Some of them were moved from the main survey to an independent variable section. For example, "We had a physics lab in our high school," "There were digital technologies such as computers and data shows in my high school, and our teachers were allowed to use these technologies," and "There were enough materials/documents such as practice books, activity books, problem-solving books to study and understand high school physics" were moved to the independent variable section. The final version of the survey includes 14 items and four dimensions, including attitudes, teaching methods, perceptions about teachers, and opinions about physics education. The final version is available online. Cronbach's alpha and McDonald's alpha were calculated for reliability of the survey (Table 1).

Each dimension's reliability is satisfactory (0.58–0.97). The complete survey is at a reliable level (0.84–0.90) (Taber, 2018). Composite reliability coefficients are between 0.59 and 0.88. According to Shrestha (2021), combined reliability levels of 0.6–0.7 are considered satisfactory. So, the survey is accepted as reliable.

TABLE 1 Reliability of survey.

Dimension	Cronbach's α	McDonald's ω
Attitudes toward physics	0.75	0.76
Teaching Method	0.80	0.81
Perceptions about teacher	0.59	0.59
Opinion leaning physics	0.58	0.62
Total	0.87	0.88

Data analyses

Before the analysis, it was verified that all data had been input correctly. Tableau was used to generate descriptive statistics and visualize data for each theme. Cluster analysis was performed using the total scores obtained on each dimension. Cluster analysis was performed using the k-means algorithm. Lloyd's approach was used to construct the k-means clustering for each k using squared Euclidean distances. The cluster analysis revealed the demographic features of the group classified as a high cluster. Before the advent of inferential statistics, it was established that variables had a normal distribution. Because the variables violated a normal distribution, non-parametric tests were preferred. The Mann–Whitney U test was employed for bivalent variables (gender, school status, and laboratory status), but the Kruskal–Wallis H test was utilized for other variables.

Findings

In presenting the findings, first of all, descriptive statistics were presented for each dimension item. Following that, cluster analysis findings, which are the results of classifying students in each dimension, were shared. Then, the profile of the student group, which was higher according to the result of cluster analysis, was determined. In the second part, the findings regarding whether there is a differentiation in each dimension according to the independent variables are included.

Attitudes toward physics

When the students' attitudes toward the physics lesson are examined in general (Figure 1), the rate of students who do not like the physics lesson is 23.4%, while the rate of students who like it is 46.1%. It is average (3.3), that is, at the agreed level. While the rate of students who think it is difficult to understand physical concepts is 24.5%, the rate of students who think it is not difficult is 49%. The average of questions is 3.4 and agrees on the level. While the rate of students who did not like the physics lesson at high school was 32.5%, the rate of students who stated

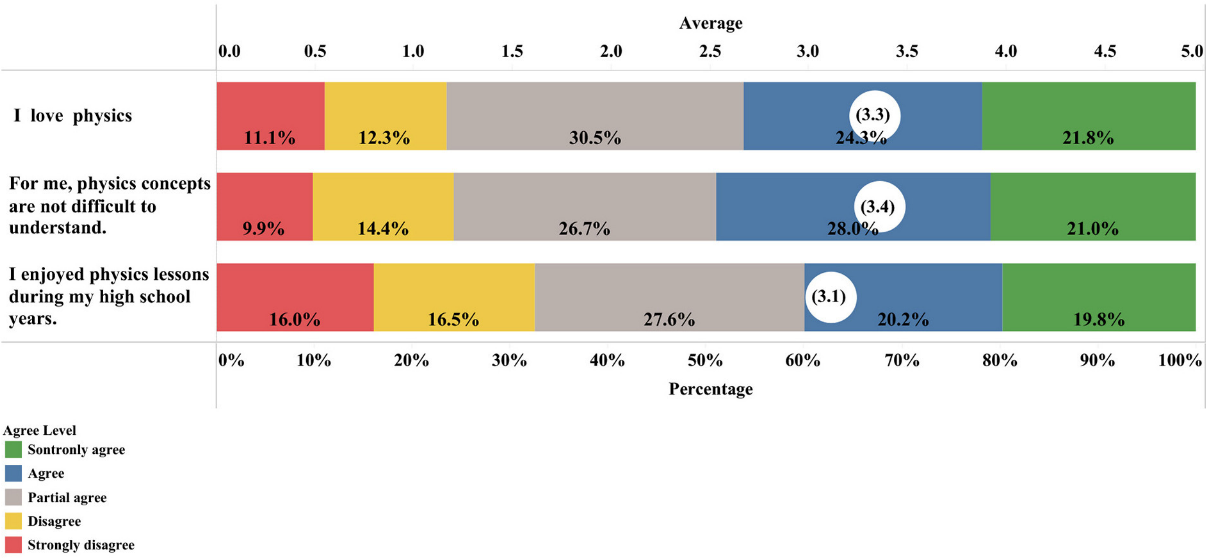

FIGURE 1
Distribution based on item related to attitude and agrees with level.

that they liked it was 40%. The average for this item is 3.1 and at a partially agreed level. The participants generally enjoyed the physics course, but there was not a high rate of liking for the physics course in high school.

Teaching method in high school physics course

When the participants' answers to the questions about teaching in high school physics courses were examined, 27.2% of the participants stated that the relationship between physics subjects and real life was not explained (Figure 2). In comparison, 51.2% said this relationship was explained. The average of this item is 3.4 and agrees on the level. While 22.6% of the students thought that a sufficient number of problems related to physics were not solved, the rate of those who thought positively was 47.7%. Its average is 3.4 and agrees on the level. While the rate of students who believed that all the experiments in their books were not done was 52.7%, the rate of students who stated that all the experiments were done was 23.8%. The average is 2.5 and disagreed. While the rate of participants who thought negatively about using digital technologies was 56.8%, the rate of those who expressed positive thoughts was only 23.4%. The average of the items was 2.5 and is at the level of disagreement. When the teachers' performance in activities such as demonstration was examined, the rate of students with negative thoughts was 51.4%, while the rate of participants with positive thoughts was 25.9%. It is calculated as an average of 2.5 and is at the level of disagreement. When the teachers' activities, such as drama and group work, were examined, 58.1% of the participants thought negatively, while the rate of those who thought positively was 18.5%. The mean is calculated as 2.3 and is in disagreement.

Perception about physics teacher

Participants' views related to their physics teachers were examined (Figure 3). First item was reversed so that, while 21% of participants had negative views, 56.4% of the participants had positive views related to their teachers. In the second item, 34.5% of the participants had a positive view, while 40.8% of the participants had a negative view of their teachers.

Opinion on learning physics

When the participants' opinions were examined (Figure 4), rate of students who did not agree with the idea that mathematics knowledge was required to learn physics was 13.2%. In comparison, the rate of those who expressed a positive opinion was 60%. The average is calculated as 3.7 and is at the agreed level. While 23.9% of the participants were negative about their difficulties with physics, the positive participation rate was 48.1%. The average is 3.7 and partially agrees on the level. On the other hand, while 43.3% of the participants thought negatively about the attractiveness of the books, the rate of participants stating positive thoughts was 25.5%. The average is 2.7 and partially agrees on the level.

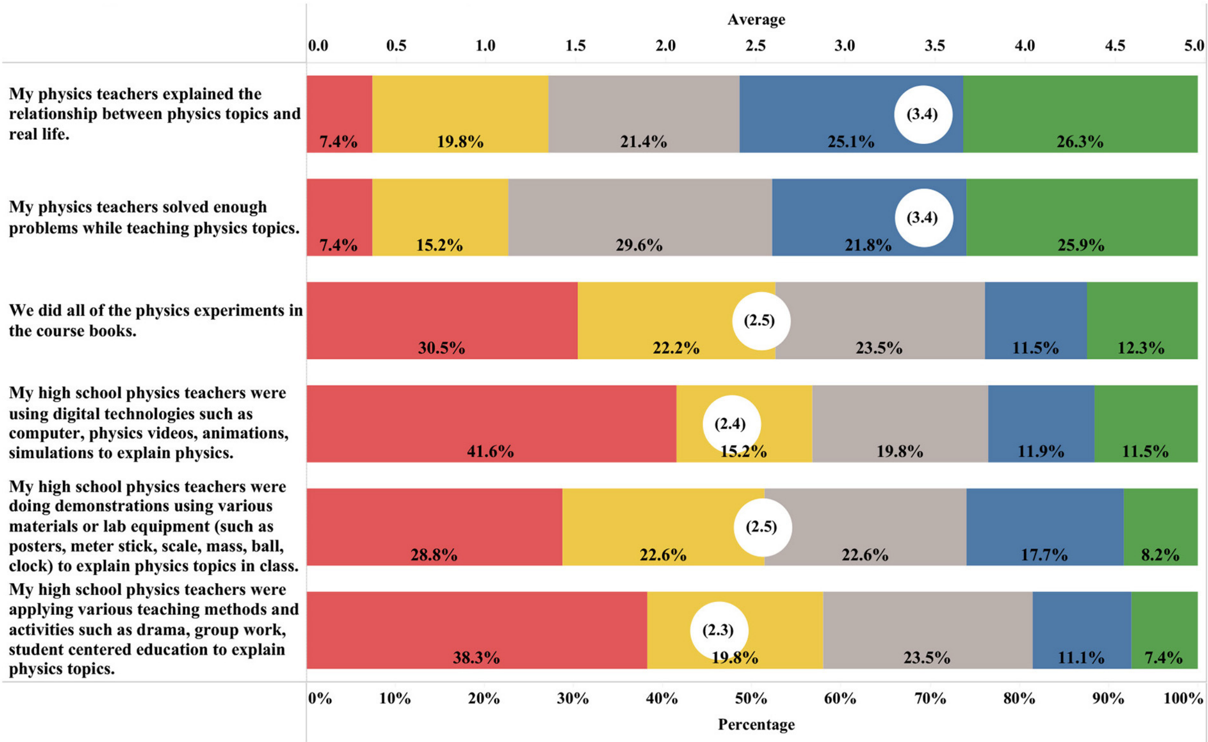

FIGURE 2
Distribution based on item related to physics course and agreed level.

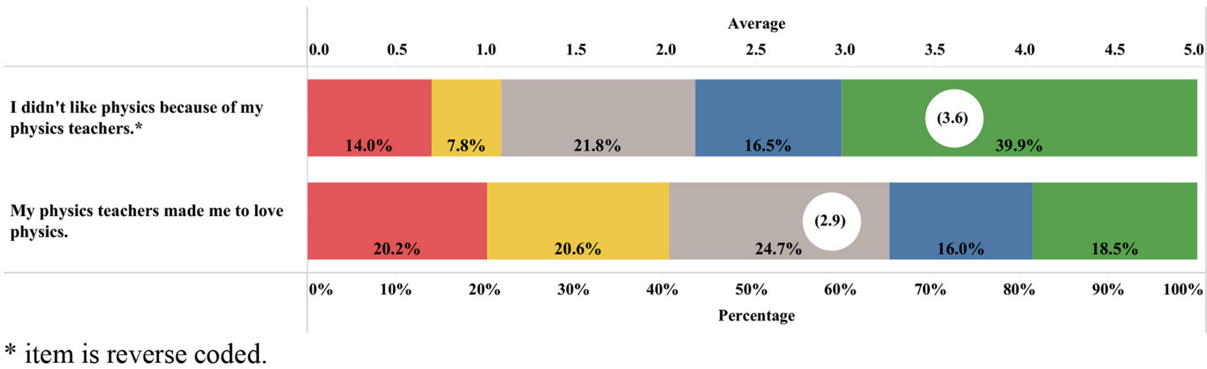

FIGURE 3
Distribution of students' views about teacher and agreed level.

Results of cluster analysis

According to cluster analysis based on the teaching method, five clusters were created (Table 2). The cluster model is significant because each p-value is smaller than 0.05. The second cluster has the highest center for each dimension. The second cluster's students have the highest positive views on learning physics. In this cluster, there are 56 students. According to other clusters, the fifth cluster has the lowest positive views on a teacher.

When the distribution of 56 individuals in this cluster is analyzed, it is discovered that 23 are female and 33 are male. While females are represented at a rate of 20%, males are

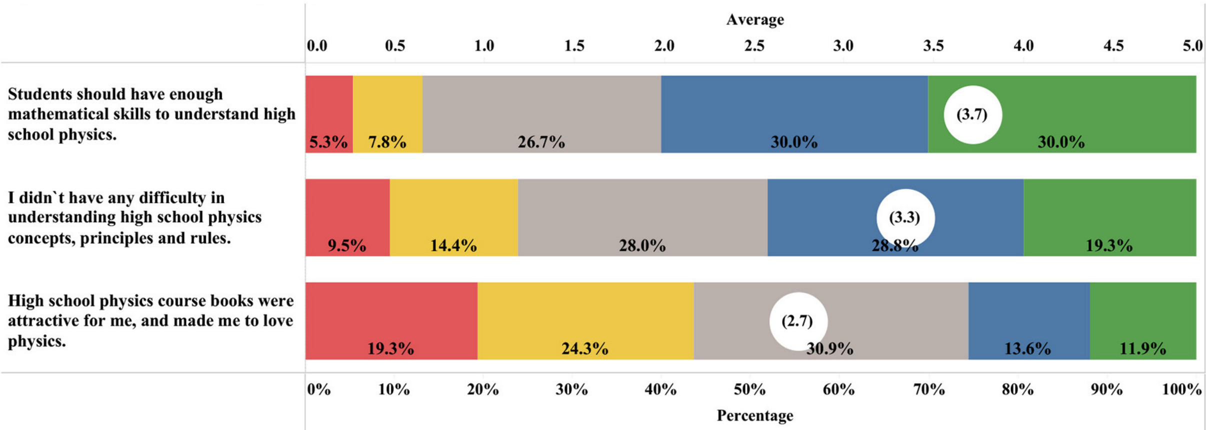

FIGURE 4
Distribution of students' opinions on learning physics and agreed level.

TABLE 2 Average score of dimension in each cluster.

Clusters	Number of items	Avg. attitudes	Avg. teaching methods	Avg. teacher	Avg. opinion
Cluster 1	54	5.7593	12.185	4.3148	6.5741
Cluster 2	56	13.464	21.929	8.9821	12.679
Cluster 3	70	10.157	17.971	7.8714	9.6429
Cluster 4	19	10.474	19.368	3.8421	11.842
Cluster 5	44	9.25	11.864	5.1364	9.4773
F		41.74	41.56	38.89	30.98
***p*-value**		0.0	0.0	0.0	0.0

TABLE 3 Mann–Whitney U results according to gender.

Dimensions	Group	*N*	Mean	Median	SD	*U*	*p*
Attitudes	Female	116	9.43	9.50	3.12	6,323	0.056
	Male	127	10.14	11.00	3.11		
Teaching methods	Female	116	16.44	16.50	5.57	7,210	0.776
	Male	127	16.75	16.00	5.59		
Perception on teacher	Female	116	6.43	6.00	2.44	7,052	0.564
	Male	127	6.61	7.00	2.31		
Opinion	Female	116	9.72	10.00	2.62	7,049	0.560
	Male	127	9.88	10.00	2.69		

represented at a rate of 26%. When representations by class are studied, the third graders have the greatest percentage of representation at 32%, while the second graders have the lowest rate at 14%. First graders are represented at 23%, while fourth graders are represented at 19%. When departments are included, students of engineering and health sciences account for 24% of total enrollment, while education faculty students account for 19% of total enrollment. While those who graduated from public high school had a 20% representation rate, those who graduated from private high school had a 26% representation rate. While the representation rate of those with a laboratory in their school is 32%, the representation rate of those who do not is 18%. At the same time, those who used technology accounted for 38% of the population, and those who did not use any technology accounted for 14%. While those who utilized additional course resources are represented at 30%, those who did not use them remain at 8%. The use of technology in their education, the use of lab resources in their schools, and the use of alternative tools

TABLE 4 Mann–Whitney U results according to school status.

Dimensions	Group	N	Mean	Median	SD	*U*	*p*
Attitudes	Public	119	9.76	10.00	3.24	7,276	0.852
	Private	124	9.85	10.00	3.04		
Teaching Methods	Public	119	16.25	16.00	5.66	6,876	0.359
	Private	124	16.94	17.00	5.49		
Perception on Teacher	Public	119	6.49	6.00	2.40	7,297	0.882
	Private	124	6.56	6.00	2.35		
Opinion	Public	119	9.62	10.00	2.79	6,951	0.432
	Private	124	9.98	10.00	2.51		

TABLE 5 Kruskal–Wallis H results according to departments.

Dimensions	Area	N	Mean	Median	SD	χ^2	*df*	*p*
Attitudes	Engineering	136	9.71	10.00	3.25	1.207	2	0.547
	Education	48	9.58	10.00	3.13			
	Health Science	59	10.19	10	2.85			
Teaching Methods	Engineering	136	16.37	16.00	5.83	0.961	2	0.619
	Education	48	16.96	17.00	5.87			
	Health Science	59	16.85	17	4.71			
Perception on Teacher	Engineering	136	6.29	6.00	2.36	4.574	2	0.102
	Education	48	6.54	6.00	2.29			
	Health Science	59	7.05	7	2.41			
Opinion	Engineering	136	9.69	9.00	2.61	2.237	2	0.327
	Education	48	9.54	10.00	3.16			
	Health Science	59	10.27	10	2.26			

TABLE 6 Mann–Whitney U results according to presence of laboratory.

Dimensions	Group	*N*	Mean	Median	SD	*U*	*p*	Effect size
Attitudes	No	152	9.53	10.00	3.20	6,187	0.107	
	Yes	91	10.25	10.00	2.98			
Teaching Methods	No	152	15.21	15.00	5.16	4,282	0.01	0.381
	Yes	91	18.92	18.00	5.48			
Perception on Teacher	No	152	6.36	6.00	2.26	6,072	0.109	
	Yes	91	6.80	7.00	2.54			
Opinion	No	152	9.53	10.00	2.77	5,964	0.071	
	Yes	91	10.26	10.00	2.38			

all increase their chances of being included in the attitude and positive thinking group toward physics education.

Differentiation according to variables

To determine whether gender affects the views and attitudes of students, the Mann–Whitney U test is applied (Table 3). Test results show that the difference between female and male students is not statistically significant ($p > 0.05$). It means that female and male students have similar views and attitudes.

To determine whether high school status (public or private) affects the views and attitudes of students, the Mann–Whitney U test is applied (Table 4). According to test results, the difference between public and private school graduation is not statistically significant ($p > 0.05$). It means that the school type does not affect students' views.

Kruskal–Wallis test is applied to determine whether departments affect students' views and attitudes (Table 5). According to test results, the differentiations among students' departments are statistically insignificant ($p > 0.05$). It means that departments do not have any effect on the view of students.

The Mann–Whitney U test is applied to determine whether a laboratory of high school status affects students' views and attitudes (Table 6). According to test results, the differentiations in attitudes, teachers, and opinions between public schools were statistically significant ($p > 0.05$). It means that school status does not affect students' views. But in the teaching method dimension of $p < 0.05$, students who graduated from high school with a laboratory positively affected the teaching method. The effect size is 0.381 and is at medium level.

To determine whether the usage of technology affects the views and attitudes of students, the Mann–Whitney U test is applied (Table 7). According to the test result, the differentiations between attitudes, teachers, and opinions were statistically significant ($p < 0.05$). It means that the usage of technology affects the views of students. Students having experience with technology have positive attitudes and views on learning physics in high schools. The effect sizes are between 0.257 and 0.445. They are of medium effect size.

The Mann–Whitney U test is applied to determine whether the usage of supporting course materials affects students' views and attitudes (Table 8). According to the test result, the differentiations between attitudes, teachers, and opinions were significant statistically ($p < 0.05$). It means that the usage of supporting course materials affects students' views. Students with experience of using such supporting course materials have positive attitudes and views on learning physics in high schools. The effect sizes are between 0.337 and 0.495. They are of medium effect size.

Discussion

Participants generally liked the physics course, but the proportion of those who liked the high school physics course was not very high. According to Barmby and Defty (2006), physics is not as popular as the other science courses, because students' expectations for success in physics are lower than in biology or chemistry. Students view physics as a difficult subject, which may explain why students' interest in physics wanes as they progress through secondary school (Williams et al., 2003; Erinosho, 2013; Patil et al., 2019). However, those who chose physics as an elective and those who chose a physics-related department at their university indicated that physics was less difficult (Oon and Subramaniam, 2013). Considering that in this study, most of the participants were educated in departments that were closely related to physics, the fact that students had partially positive attitudes could explain this result.

Although students' opinions about the teaching method varied depending on the item, they were partially

TABLE 7 Mann–Whitney U results according to usage of technology.

Dimensions	Group	*N*	Mean	Median	SD	*U*	*p*	Effect size
Attitudes	No	147	9.25	9.00	2.95	5,245	< 0.001	0.257
	Yes	96	10.65	11.00	3.22			
Teaching Methods	No	147	14.86	14.00	4.66	3,915	< 0.001	0.445
	Yes	96	19.27	19.00	5.80			
Perception on Teacher	No	147	6.08	6.00	2.26	5,083	< 0.001	0.280
	Yes	96	7.21	8.00	2.38			
Opinion	No	147	9.38	9.00	2.50	5,220	< 0.001	0.260
	Yes	96	10.45	10.50	2.75			

TABLE 8 Mann–Whitney U results according to usage of supporting course materials.

Dimensions	Group	N	Mean	Median	SD	U	P	Effect size
Attitudes	No	77	8.21	8.00	3.03	3,732	< 0.001	0.416
	Yes	166	10.54	11.00	2.90			
Teaching Methods	No	77	13.35	13.00	4.33	3,265	< 0.001	0.489
	Yes	166	18.11	18.00	5.44			
Perceptions on Teacher	No	77	5.61	6.00	1.96	4,239	< 0.001	0.337
	Yes	166	6.95	7.00	2.43			
Opinion	No	77	8.21	8.00	2.65	3,228	< 0.001	0.495
	Yes	166	10.54	10.00	2.31			

positive. According to Ramaila and Reddy's research (Ramaila and Reddy, 2018), students prefer teaching methods that encourage active participation in the learning process. Specifically, teaching techniques that offer technology and active participation impact learning outcomes and allow students to enjoy course procedures. In Balta and Tzafilkou's (2019) study, students were allowed to interact with the Socrative application in physics class.

The result of the study was that students were satisfied with the course flow.

The study found that students perceived their teachers positively to some extent. High school physics teachers play an important role in forming students' physics identities (Hazari et al., 2017). The results of this study confirm this conclusion. When high school students describe the physics teacher positively in terms of all individual characteristics, it indicates that even an "imperfect" teacher is viewed as productive by students. It has been observed that students have a positive opinion of their professors, even if they have some undesirable characteristics (Koutsoulis and Avraamidou, 2010). In this regard, teachers may have acted effectively in planning lessons by considering students' needs and adopting approaches in which students can actively participate in class.

Whether the statement that physics education is perceived as difficult, boring, and irrelevant is a myth or based on reality is debated in the literature. Numerous researchers (Williams et al., 2003; Ekici, 2016; Barikhlana et al., 2019; Mufit, 2019; Mbonyiryivuze et al., 2021) have collected supporting evidence from students, but other statistics contradict this (Patil et al., 2019). This goal differs depending on the target population. Participants who are more excited about science subjects have a more optimistic outlook (Paul et al., 2020). In addition, students' opinions of high school physics classes can be viewed as positive. The fact that the subject areas to which students are admitted are those in which students maintain an interest in physics education may have influenced this conclusion.

According to the result of cluster analysis, which considered students' attitudes, teaching methods, teachers, and opinions, five clusters were formed. When examining the characteristics of learners in the higher group, males, engineering and health science students, graduates of private high schools, students who graduated from high schools with laboratories, and students who use technology in teaching and use supporting course materials are more represented. Further research will determine how the upper group's characteristics influence students' perspectives and ideas. The results of studies with larger samples have the potential to be generalizable. In addition, students' attitudes and thoughts do not change according to gender, school status, grade level, or subject area. The literature (Barmby and Defty, 2006; Saleh and Subramaniam, 2019) states that female students generally like physics courses less. However, many studies (Achor and Gbadamosi, 2020; de Barros Vidor et al., 2020) found no statistically significant difference in students' attitudes and thoughts according to gender when an effective instruction was provided.

The presence of a laboratory was effective only in the teaching method dimension. The use of technology and supporting course materials were effective in all dimensions. They enrich the teaching process and use teaching approaches and techniques that encourage student engagement in the course and positively impact student thinking (Samsudin et al., 2020; Nuñez et al., 2021). The use of technology has a particularly successful impact on students' attitudes and perceptions of the physics course (Hochberg et al., 2018; Maulidah and Prima, 2018; Bakri et al., 2020).

Conclusion

Participants generally liked the physics course, but there was not a high rate of liking for the physics course in high school. Although students' opinions about the teaching method vary by item, some are positive. Students' opinions of their teachers are partially positive. Students' opinions about physics teaching in high school can be considered positive. According to the result of cluster analysis considering students' attitudes, teaching methods, teachers, and opinions, five clusters were formed. When examining the characteristics of learners in the higher group, males, third-grade students, engineering and health science students, graduates of private high schools, students who graduated from high schools with laboratories, students who use technology in teaching, and students who use supporting course materials are more represented. Student attitudes and thoughts do not change by gender, school status, grade level, or subject area. The presence of a laboratory was only effective in the teaching method dimension. The use of technology and the use of supporting course materials were effective in all dimensions.

Analyzing the study results in a more general sense, we find that "memories," defined as students' experiences in their schools or academic environments, impact students' decisions regarding their future careers and relationships with the relevant course. The value-added facts are useful to educational policymakers and course planners. In addition, the importance of the role of educators, i.e., those who work in education and teach physics, is again emphasized.

According to the research findings, physics education in high school influences the development of a student's physics identity. As practitioners of educational science, teachers have a great responsibility in this regard. Instruction that includes active learning activities and technological opportunities benefits students. One limitation of the study is that the subject areas of the study participants are all related to physics education. Future researchers may work with larger samples and cross-disciplinary teams.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study involving human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants in accordance with the national legislation and the institutional requirements.

Author contributions

Questionnaire were prepared by all authors. Data collected by SA. Data were analyzed by OK. The draft paper were written by all authors. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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