Unraveling Force and Weight Misconceptions: A Study among Medicine-Enrolled Honors High School Graduates

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Abstract

Throughout the years, scientific research has increasingly focused on identifying alternative ideas, or ideas that students have, about fundamental concepts and principles of physics. A significant amount of valuable and essential international bibliographic information has been produced by this process, including details on mechanics, thermodynamics, and other science fields. Specifically, we focus on classical mechanics in the present paper. The primary objectives of this study were to investigate alternative ideas about the concept of force and weight and determine the personal interest of the honours graduate students of the 3rd Lyceum for the Physics course who attend medical school. Moreover, the gender parameter of participants was examined. Two multiple-choice questionnaires were given to students, one for investigating personal interest in Physics, using C.L.A.S.S. and, subsequently, a questionnaire related to the basic concepts of weight and force. Furthermore, we analyzed the percentage of correct and incorrect responses of the participants to determine whether the answers were related to gender or representative of statistical fluctuations. In particular, the statistical analysis of the data collected shows that many honours students of our educational system retain a large percentage of the alternative ideas about the concepts of Physics. Additionally, the misconceptions recorded in the questions did not correlate with parameters such as grades in the Panhellenic exams, gender, and students' interest in the Physics course. Our study's results can be used in science teaching, curricula design, and teachers' professional development.

Keywords: Alternative Ideas, Physics, Mechanics, C.L.A.S.S., Force, Weight.

INTRODUCTION

Through interactions with each other, social and cultural contacts, and books, students begin to build a wide range of interpretations, ideas, and perceptions about how the world works (Hollins, 2015). They use these perceptions to interpret and explain many phenomena they perceive to exist or occur around them. These perceptions "accompany" children in classrooms and usually differ from scientific views. Therefore, when students come to school, they have already formed their own rules and theories about many phenomena they perceive (Panagou et al., 2022; Soh et al., 2010).

These pre-existing ideas are essential for further learning activities because how students observe and interpret the various events and phenomena and communicate or accept new information is primarily related to their ideas. For this reason, many researchers believe that teachers should modify these perceptions and not treat them as errors that must be eliminated (Rubie-Davies, 2010).

Many cognitive psychologists, including Piaget and Ausubel, have emphasized the importance of students' prior knowledge of what they can learn. Piaget was the first to investigate children's conceptions of science in the early 1930s, and he argued that children construct their knowledge differently from adults (Jovchelovitch, 2019). Students learn when new knowledge "fits" into their existing cognitive structure. The systematic study of children's ideas about the concepts and phenomena of natural sciences was initiated by Driver & Easley (Driver & Easley, 1978), who linked the learning of the cognitive object of natural sciences with their mental development.

These ideas of children are not simple misconceptions due to lousy information. They are perceptions, opinions, and mental constructions due to how they observe and perceive what is happening around them (Alwan, 2011; Kotsis & Panagou, 2022). Studies show that these ideas can remain not only after teaching but also after they become adults. As mentioned above, students come to school already possessing established knowledge, opinions, and ideas, which affect the learning processes and should be considered in the educational methods (Kotsis, 2023). According to Bertrand, "the problem is not for students to acquire an experimental knowledge, but to change knowledge, overturning the obstacles that everyday life has accumulated for them" (Nowotny, 2015).

Student interest in physics is another factor to consider when determining alternative ideas. Studying the international bibliography, students' interest in physics and general attitude toward science is heavily influenced by curricula, school textbooks, teachers, and teaching practices (Keller et al., 2017; Maison et al., 2020). The teaching techniques applied by Science teachers significantly impact students' attitudes toward teaching and their interest in cognitive subjects (Bal-Taştan et al., 2018; Jiang & McComas, 2015).

In general, it can be said that many studies have been conducted exploring students' alternative ideas in all aspects of science and their interest in physics concepts (Kotsis & Panagou, 2022; Stylos & Kotsis, 2023). Nonetheless, this study investigates how honours students internalized alternative ideas about force and weight and their personal interests in Physics.

LITERATURE REVIEW

A large part of research regarding the teaching of Science deals with the detection of alternative ideas/conceptions of students about concepts and phenomena of Science by constantly adding new research data to this field. Investigating the existence of students' alternative ideas in physics concepts is of particular interest as they greatly influence the learning process and the design of appropriate teaching approaches and interventions (DiSessa, 2014; Kotluk & Kocakaya, 2017).

Extensive studies by Greek and foreign researchers have been carried out in Science Teaching with the ultimate aim of recording and categorizing the alternative ideas and perceptions of pupils, students, and teachers in a multitude of concepts of Physics (Kotsis & Panagou, 2022). These concepts include energy, gravity, and force and detecting their distance from established scientific understandings (Daud et al., 2015; Kotsis & Panagou, 2023; Panagou et al., 2022; Stylos et al., 2008).

The word "force", for instance, for children, has many meanings. As mentioned above, students' perceptions of forces come from the family and broader social environment where they live and grow up, from the daily experience of movement, conflicts, and efforts to move bodies. These perceptions are stabilized - consolidated as their experiences grow and are difficult to modify with teaching interventions (Abdurrahman et al., 2017).

Students need help understanding that rest is a particular case of motion in which the body's velocity is constant and equal to zero. Driver et al., (2014) report that students are unwilling to accept the presence of forces without movement. They have associated the presence of force only when there is motion, which they consider keeping the body in motion. When a book is stationary, students assume that air pressure or gravity keeps the book stationary or that the table intervenes and prevents the book from falling. On the other hand, when there is motion, students believe that there is a force acting, or more specifically, a force acting in the direction of the object's motion.

Many studies have confirmed that students believe that force is a property of a single object and that the existence of a reaction is generally not accepted (Abell, 2013). From a scientific point of view, forces in nature always appear in pairs. For every force, there is an equal and opposite reaction. For example, a bottle on a bench exerts a force, and the bench exerts an equal and opposite force on the bottle. Sjoberg and Lie's study of 1000 Norwegian students confirms this notion (Garcia et al., 2016).

Furthermore, a person's interest and attitudes toward a cognitive domain are the totals of their opinions and feelings based on their experiences and beliefs about that cognitive domain. The person's attitudes include the person's knowledge, feelings, and behaviour, in the sense that the person's knowledge and ideas about a subject create in the person a set of emotions and influence his behaviour towards this subject (Kind et al., 2007). Undoubtedly, the cognitive skills students acquire during lessons are essential but fleeting. On the contrary, their interest and attitudes towards the cognitive objects and the behaviours they cause seem longer (Lachman et al., 2015; Osborne et al., 2003).

Moreover, several studies have been conducted to determine students' personal interest in different physics concepts, as mentioned above (Adams et al., 2006; Perkins et al., 2005). Specifically, the researchers wanted to determine how students view the physics course, its importance, and how this will affect their future academic and personal lives (Lin-Siegler, 2016).

An essential part of the research in Science Teaching concerns how the quality of teaching can be improved (Biesta, 2015). One of the main factors affecting the courses' effectiveness is the student's interest and attitudes toward the subjects and the teaching techniques (Keller, 2017). The development of positive attitudes and great interest in science courses can motivate students to study the subjects, possibly improving their science performance and encouraging them to make future science-related study and career choices (George, 2006; Tytler, 2012).

Purpose of the Study

This study examines alternative ideas about force and weight (the cognitive object of physics), along with the personal interests of honours students in the 3rd Lyceum Physics course and if these interests correlated to gender.

The research was prepared to investigate the following fundamental questions:

1) How consistent are the honours students of the 3rd Lyceum in their scientific and non-scientific (alternative) understandings of force and weight for the physics course?
2) How interested are the honours students of the 3rd Lyceum in the physics course?
3) Is there a statistically significant difference in students' performance for their answers depending on gender?

METHODOLOGY

The Study Population

Study participants were 316 honours students from the 3rd Lyceum, specifically first-year students from the Department of Medicine at the University of Ioannina (54% of the population were boys, and 46% were girls). Greek medical students are among the highest achievers in the educational system. Meanwhile, medical schools are in high demand and only accept a limited number of students. Consequently, students must perform very well on the university entrance examinations to be able to access them. Physics is one of the subjects students will be tested on, which means they need to study hard to succeed.

Additionally, Greek students must choose between natural sciences and technology and social sciences and humanities as their education orientation. Usually, students who follow the scientific education direction score high in science subjects such as physics, mathematics, biology, and chemistry. The 313 respondents followed a scientific education in the 3rd Lyceum, while 3 followed a technological one. The research was carried out in the first semester of their academic studies.

Pilot Study

A necessary condition for collecting the research material is evaluating the content of the questionnaires with a trial application on people like the final sample. A pilot study was conducted for this purpose, which revealed the following:

a) What words, phrases, or concepts are misunderstood or lead the subjects to misinterpretations?
b) How interesting and valuable are the answers to each question?
c) What questions do subjects have difficulty with, or what additional information are they asking for?
d) How much time is required to complete the questionnaire?
e) What are the subjects' reactions, and how can they be overcome?

Instrument

The questionnaire consists of three parts. The first part (Part A) includes questions related to gender, the direction followed in the 3rd Lyceum, the interest in the Physics course on a five-grade scale, the score in the Physics course in the Panhellenic entrance exams for Higher Education, his classification as a High School student on a scale (1=Poor, 2=Average, 3=Good, 4=Excellent) and the reasons he does not like Physics.

Afterwards, the second part (Part B) included the questions from the (C.L.A.S.S.). CLASS is a tool that examines the beliefs and attitudes of students in Physics Sciences (Adams et al., 2006; Semsar et al., 2011) and is based on the following surveys: (a) the Maryland Physics Expectations Survey (Madsen et al., 2015) (b) the Views About Science Survey (Halloun & Hestenes, 1996), and (c) the Epistemological Beliefs Assessment about Physical Science (Sahin, 2010). These investigations aimed to study the attitudes, beliefs, and expectations of students taught introductory physics courses regarding the nature of knowledge and learning in the natural sciences and the relationship between the physical and real world. These studies showed a significant difference in the opinions of beginners and experts in Physics and how their initial beliefs and attitudes significantly affected their performance in the physics course.

The CLASS tool includes eight categories, including 42 participant statements about their beliefs and attitudes in Physics Sciences (Maison et al., 2019). Each category comprises from 4 to 8 statements, and the eight categories concern: 1) The connection with the real world, 2) Personal interest, 3) The effort to understand, 4) The conceptual connections, 5) The application of conceptual understanding, 6) Solving problems, 7) Confidence in solving problems and 8) The ability to solve problems.

In the present study, as mentioned above, we focused on the "Personal Interest" category and investigated whether the participants have a personal interest in Physics.

The questionnaire's third and last section (Part C) examined whether honours students had alternative ideas about force and weight. It consists of a closed-end questionnaire of 12 multiple-choice items. The questionnaire has also been used in previous research by the authors, and it contains examples from school textbooks and everyday life (Kotsis & Panagou, 2022; Panagou et al., 2022).

Main Study

Participating students responded to the items in their classrooms at the beginning of their first lecture at the university under the authors' supervision. The process was completed in two steps. First, the study was introduced to the students, and instructions for completing the instrument were given. Second, following a scripted, standard protocol for introducing the study, the research assistants obtained informed consent, explained associated assurances, gave instructions for responding to the test, and monitored the students throughout the process.

Statistical Analysis of the Data

The research data was processed with the statistical program IBM SPSS Statistics: 29.0 and Microsoft Office Excel spreadsheets. The internal consistency reliability for the second and third parts of the questionnaire was checked by Cronbach's alpha coefficient and Kuder-Richardson Formula 20 (KR-20), respectively. So, the items in the third part of the questionnaire were coded as binary items (incorrect - correct).

The overall performance in the "Personal Interest" category of the CLASS tool in physics was calculated. For the knowledge section, firstly, the 12 items were analyzed for item difficulty (values should range from 0.30 to 0.70) and item discrimination index (values should range from 0.20 and over) (Boopathiraj & Chellamani, 2013; Chu et al., 2012), and secondly, the overall performance was determined. Afterwards, the total performance of correct and false answers was estimated as the sum of the correct and wrong responses to the items.

Specific statistical indicators (average, frequency, percentages) were estimated, and the appropriate diagrams and tables were created for visual representation. Histograms were used to test the normality of the data. The statistical criterion χ^2 test was used, with which it is possible to establish whether there is a relationship between the two variables under consideration. The level of statistical significance was set to $\alpha = .05$ in all tests.

RESULTS

The participants' responses regarding their interest in the Physics course are shown in Table 1. A large percentage of the participants showed moderate or great interest in Physics, while the percentage of those who showed little interest was much smaller.

Table1. *Interest in the subject of Physics*

Interest in Physics	Frequency	Percentage %
Not at all	3	1.0
A little bit	10	3.2
Average	142	44.9
Very	116	36.7
Very much	42	13.3
Other answers	3	0.9
Total	**316**	**100.0**

Subsequently, the respondents were asked to mark on the questionnaire the grade they wrote in the course of Physics in the Hellenic Entrance Examinations. The results of the statistical analysis are presented in Table 2.

Table 2. *Score in the Physics Major in the Panhellenic Examinations*

Grade in Physics	Frequency	Percentage %
19.5-20	107	33.9
19-19.5	104	32.9
18.5-19	39	12.3
18-18.5	34	10.8
<18	32	10.1
Total	**316**	**100.0**

Of interest are the participants' answers to the question, "What are the reasons you do not like Physics?" As can be seen in Figure 1, the reasons they do not like the Physics course are mainly the poor teaching of the course by the teachers (percentage 32%), the lack of connection with everyday life (rate 27.8%), and the high degree of difficulty of the course (rate 20.3%). To a lesser extent, as can be seen from the figure, the lack of interest (rate 14.9%) and understanding (rate 5.1%) contribute.

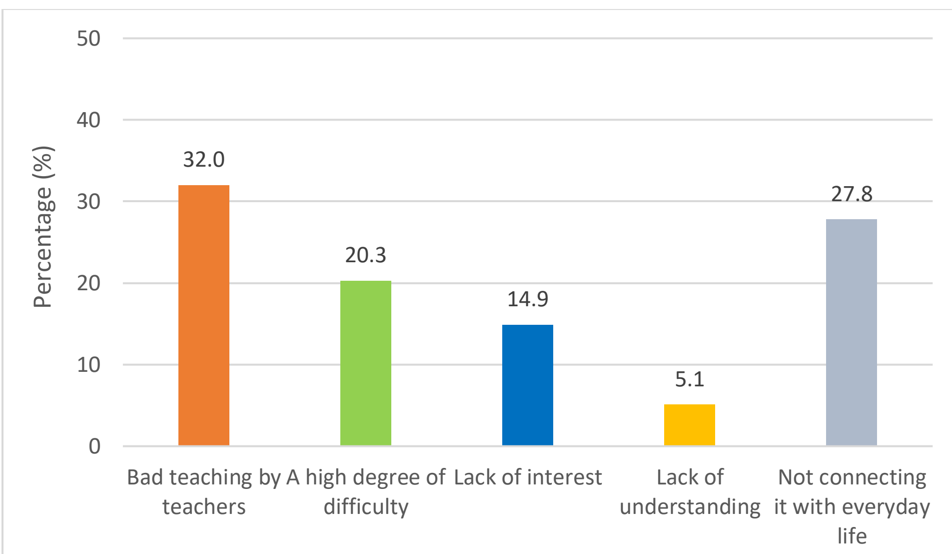

Figure 1: *Distribution of respondents' answers to the question "Reasons you do not like Physics?"*

Investigation of personal interest in the subject of Physics

In the second part of the questionnaire, the respondent's answers to the statements of C.L.A.S.S. are presented separately, which concerns their interest in Physics (Table 3). The a-

Cronbach reliability test verified the internal consistency. The reliability factor was α=.730, indicating valid responses. As can be seen, a large percentage of students (71.2%) recognize that physics is experienced in everyday practice and that the knowledge and skills they acquire change their ideas about how the world works and what they observe in everyday life. Nevertheless, it is noteworthy that only one in three students study physics, intending to acquire knowledge that will be useful outside of school requirements.

Accordingly, the "desired percentage" and "undesired percentage" of all respondents who participated in the study were investigated. The "desirable" percentage refers to the rate of "Agree" and "Strongly Agree" responses and corresponds to the opinions formed by an experienced teacher. In contrast, the "undesired" percentage refers to the rate of "Disagree" and "Strongly Disagree" responses and it does not correspond to the views held by an experienced teacher. Because the CLASS explores student beliefs about Physics and separates the beliefs of physics teachers from those of novices, the scale was incorporated to compare first-year students' responses with those formed by an experienced physics teacher.

Table 3: *Distribution of responses to the students' statements regarding personal interest in the Cognitive Object of Physics*

	Statements	Disagree/Strongly disagree (%)	Uncertain (%)	Agree/Strongly agree (%)
1	I think that Physics is experienced in everyday life.	17.41	11.39	71.2
2	I'm not satisfied until I understand why and how something works.	12.97	12.03	75.00
3	I am studying Physics to gain knowledge that will be useful in my life outside of school.	51.90	18.04	30.06
4	I like solving Physics problems.	30.07	13.92	56.01
5	Knowing Physics changes my ideas about how the world works.	27.85	14.87	57.28
6	Reasoning skills used in Physics can be useful for me in my daily life.	7.28	16.14	76.58

Figure 2 shows that 6 out of ten students offer desirable rates of personal interest in Physics, almost 3 out of ten show undesirable rates, and 1 out of ten show neutral interest.

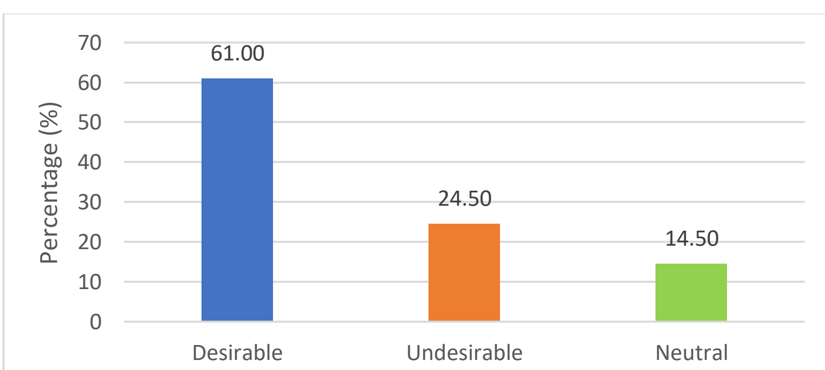

Figure 2: *The distribution of the "desirable" and "undesirable" percentages.*

Figure 3 shows the "desirable" and the "undesirable" percentages resulting from the above questions for the respondents who participated in the study concerning gender. It is noteworthy that no significant differences are observed between boys and girls.

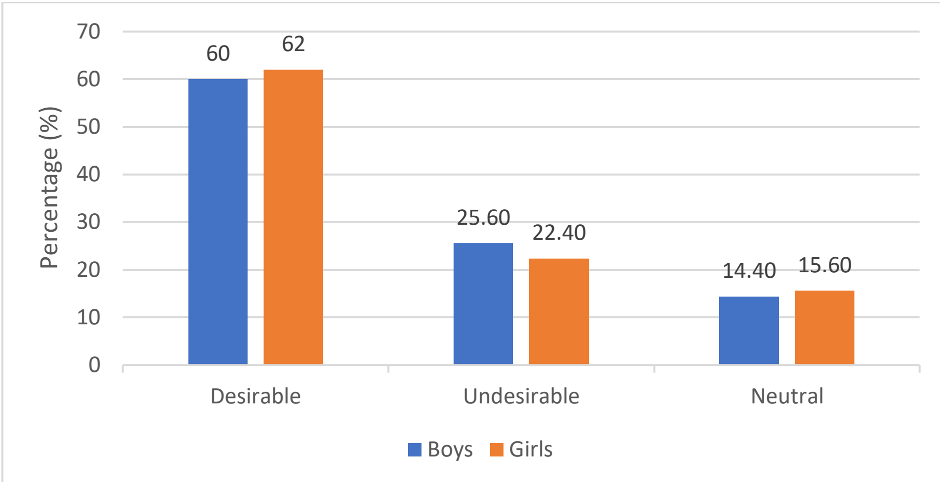

Figure 3: *The distribution of the "desirable" and "undesired" percentages by gender. The chart compares the percentages of boys/girls for the "desirable" and "undesirable" percentages and those with a neutral response.*

Respondent's Answers to the Knowledge Items

Respondent's answers to the questions asked are presented as bar graphs. To avoid listing many tables, a summary table was created with the total score (Table 6) of the correct answers for each question. In addition, the questionnaire questions on the concept of force and weight are listed in Tables 5 and 6.

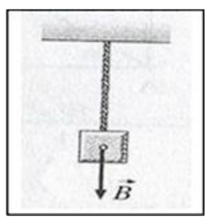

Figure 4: *Question five (5) about the force concept (Stylos et al., 2008)*

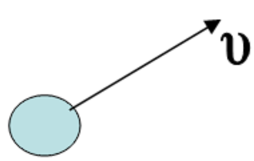

Figure 5: *Question six (6) about the force concept (Stylos et al., 2008)*

Calculation of the Total Performance (Score):

The discrimination indices for the 12 items of the knowledge section ranged from 0.02 to 0.51. Item 12 had low discrimination (0.02) and was removed. As shown in Table 6, the overall performance for the Physics Subject calculated by the 11 items is (64.56 ± 16.60). The Kuder-Richardson 20 test verified the internal consistency of the knowledge section. The KR20 coefficient was 0.65, considered reasonable (Glen, 2020).

Table 6. *The total score of correct answers by respondents.*

Cognitive Object of Physics	
Questions	Percentage of scientifically correct answers (%) (total n=316)
Q1	82.91
Q2	75.63
Q3	67.09
Q4	68.09
Q5	51.90
Q6	54.43
Q7	42.72
Q8	79.43
Q9	76.27
Q10	65.19
Q11	43.35
Q12	66.77

As one can see from the summary table 6, four of the twelve questions exceed 70% of the correct answers, and they are questions (1, 2, 8, and 9). Six of the twelve range from 50-70% correct answers. However, questions 7 and 11 are particularly interesting, where we observe percentages of correct answers below 50%. This means that one out of two honors students does not know the correct answer.

Subsequently, it was investigated whether there is an effect of the gender of the participants on the Total performance. No statistically significant difference was observed in the overall performance between the two sexes in the force and weight questions (table7).

Table 7. *Comparison of overall performance (Score) of boys and girls*

Parameter	Gender of the respondents		P value
	Boys (N=169)	Girls (N=147)	
ScorePhysics	7.25 ± 1.78	7.40 ± 1.90	0.48
ScorePhysics 100%	65.95 ± 16.15	67.29 ± 17.31	0.48

Finally, the Total performance for the "Personal Interest" category of the CLASS tool was calculated (Table 8), and its correlation with the grade in the Physics course at Panhellenic as well as with interest in the course was investigated, which was found to be statistically significant (Table 9).

Table 8. *Overall performance (Score) for the "personal interest" category of the CLASS*

<table>
<tr><th>Questions</th><th>ScoreCLASS</th></tr>
<tr><td>Q1. I think physics is experienced in everyday life</td><td rowspan="6">20.99 ± 4.03</td></tr>
<tr><td>Q2. I am not satisfied until I understand why and how it works</td></tr>
<tr><td>Q3. I am studying physics to gain knowledge that will be useful in my life outside of school</td></tr>
<tr><td>Q4. I like to solve physics problems</td></tr>
<tr><td>Q5. Knowing physics changes my ideas about how the world works</td></tr>
<tr><td>Q6. Logical skills used in physics can be useful to me in my everyday life</td></tr>
</table>

Table 9. *Correlation between overall performance (Score) for the "personal interest" category of the CLASS tool and study parameters*

	ScoreCLASS
Grade in the physics course in the Panhellenic exams	Chi-Square= 91.313, df=72, p=0.062
Interest in the physics lesson	Chi-Square=123.485, df=72, p<0.001

DISCUSSION

Until now, several works have been published concerning recording alternative ideas in mechanics concepts at various educational levels, students, university students, and teachers (Kotsis & Panagou, 2022; Kotsis & Panagou, 2023; Panagou et al., 2022). For instance, students have difficulty understanding that rest is a physical state where the body's velocity equals zero (Larkin, 2014). Driver reports that students are unwilling to accept the presence of forces where there is no movement. They have associated the presence of force only when there is motion, which they consider to keep the body in motion. When a book is stationary, students assume that air pressure or gravity keeps the book stationary or that the table intervenes and prevents the book from falling (Bloomfield, 2015). In our study, we observed that a considerable percentage of respondents (82.9%) answered correctly that the immobility of a book on a table is because the component of the forces exerted on the book is zero (question 1).

A dominant alternative idea that emerges in the present study is that the existence of the motion of an object presupposes the presence of a force acting on it or that the force acting on the object will have the direction of its motion. Three out of four honors students in our education system understand Newton's first law thoroughly, and only one out of two seems to have understood the second law. A significant percentage of participants, approximately 30%, believe that the resultant force will have the same direction as the direction of the car's movement. This conception is known as "Aristotelian", in which it is believed that the constant motion of a body is the result of a constant force having the direction of the velocity (question 2). This alternative idea recorded in the present research agrees with other studies published in the past (Clement, 2014; Kotsis, 2005).

Studies have shown that students believe that force is a property of a single object and that the existence of a reaction is generally not so accepted. From a scientific point of view, forces in nature always appear in pairs. Therefore, for every force, there is an equal and opposite reaction. For example, a bottle on a bench exerts a force, and the bench exerts an equal and opposite force on the bottle. Many honor students did not profoundly understand Newton's third law in the present study.

Additionally, research on weight and mass in school and university students has shown that the same alternative perceptions are observed in our study. Student's ideas about gravity and weight are of particular scientific interest as it seems rare among students that the weight of an object is the force of gravity on that object (Driver et al., 1998). Also, research has shown that not only students destined to become teachers in secondary education (Trumper, 2001) but also active primary education teachers need more clarification in this field (Kikas, 2004).

Our study shows that almost one in two honors students believe the heavier sphere will reach the ground first (question 7). Research has documented that children believe all bodies fall and that heavier objects fall faster (Osborne et al., 1983).

The first-year students' responses are considered truly impressive when asked about the weight of the bucket and cube that have equal masses and are balanced at different heights above the floor (question 11). According to the laws of Physics, the above case is a state of "asymmetrical" equilibrium, for which the constitutive force is zero. The students consider that a non-zero constitutive force acts in the same "orientation" as the observed result, which justifies it.

Also of interest are the answers to comparing the mass of the two stones with the same weight on the Earth's surface and the Moon's surface (question 12). Although they know that the acceleration of gravity is less on the Moon than on Earth, it is striking that 66.77% of the respondents incorrectly answered that the rock would have less mass on the surface of the Moon. Notably, about 15% of the respondents answered that the stone would have a smaller mass on the surface of the Earth, while about 18% that both stones would have the same mass. Based on the answers to this question, the respondents have difficulty distinguishing the difference between the concepts of mass and weight at the level of definition.

Concerning the attitudes of honor students in our educational system, students' attitudes and beliefs may affect their educational processes, learning processes, and learning due to the initial understanding of Physics concepts and phenomena (Holmes & Wieman, 2018). Their attitude towards the Physics course probably derives from how the subject is taught in middle and high school, which is usually carried out through memorizing theories and rules rather than through educational approaches where reflection and thinking will help to acquire knowledge and the essential understanding of concepts and phenomena (Mullet et al., 2018).

Bibliographic data have shown that students' attitudes and beliefs are also related to their performance. Research conducted on secondary education students revealed that beliefs regarding the structure and stability of knowledge of physics are good predictors of understanding physics (Stathopoulou & Vosniadou, 2007). Also, students with favourable beliefs about the Physics course achieve higher learning outcomes (Perkins et al., 2006). The motivation to engage in an activity is often driven by interest (Krapp, 2002).

The results obtained from the present study are of particular interest as the honours students of our educational system show a great interest in the course of Physics without significant differences between boys and girls. Seven out of ten respondents recognize that Physics is experienced in everyday practice and that the knowledge and skills they acquire change their ideas about how the world works and what they observe in everyday life. Nevertheless, it is worth noting that one in three students study the Physics course only for the school requirements rather than for acquiring knowledge that will be useful when the student finishes his course or for further deepening.

The results of the present study agree with those obtained from research by the authors concerning the investigation of the personal interest of the Department of Primary Education of the University of Ioannina students in the subject of Physics using the (C.L.A.S.S.). According to research, some students view Physics as loosely connected information that must be learned individually, while others view Physics as a set of ideas that must be known (Panagou et al., 2022). Some students perceive learning Physics as memorizing formulas and solving problems, while others believe learning involves developing a deeper conceptual understanding (Kotsis & Panagou, 2022).

In the present study, six out of ten students show desirable percentages of personal interest in Physics (the "desired" percentage refers to the percentage of "Agree" and "Strongly Agree" answers and corresponds to the opinions formed by an experienced teacher). In contrast, only 3 out of 10 show undesirable percentages (the "undesirable" percentage refers to the percentage of "Disagree" and "Strongly Disagree" responses and does not correspond to the opinions of an experienced teacher), and 1 in 10 shows neutral interest. These percentages did not show significant differences between boys and girls. Research has shown that most students have attitudes and beliefs about Physics that differ from those of an experienced Physicist (Sahin, 2010). Additionally, studies have shown that students may engage in scientific learning activities when interested in the subjects to be taught (Bryan et al., 2011; Osborne & Dillon, 2008).

In conclusion, looking at the general rate of correct answers, we notice that while the respondents are honours students with admission to the best university departments in the country, in our case, in medical school, they also have alternative ideas in the Physics course. This is consistent with many studies that study students' alternative ideas at all levels of education (Kotsis & Panagou, 2022; Panagou et al., 2022), even in surveys of teachers (Kotsis & Panagou, 2022).

CONCLUSIONS

The objective of this study was to examine the alternative viewpoints and personal interests of honours students in Physics and their alternative views of concepts within physics, precisely force and weight (a cognitive subject within physics), and whether gender influences the respondents' responses. We chose as the research population the honours educational system students as high scores in the Panhellenic Entrance Examinations characterize them.

Therefore, there would be no misunderstandings in Physics subjects, or if there were, they would be to a limited extent. One of the present study's main conclusions is that high performances in the Panhellenic exams are only sometimes consistent with in-depth knowledge of physics. The statistical analysis of the data collected shows that many honours students of the Greek educational system retain a large percentage of the alternative ideas about the Mechanics concepts. In addition, the misconceptions recorded in the questions did not show a correlation with parameters such as grades in the Panhellenic exams, gender, and student interest in the Physics course.

To summarize, the answers of the honours students of our educational system display the two familiar characteristics that can be distinguished in the perceptions of students of all levels of education of Physics Sciences. They rely, on the one hand, on their mental schemes that are intuitive or experiential and, on the other hand, on scientific knowledge gained from teaching, which has created confusion about these experiences. However, since we are referring to students who have passed through all levels of education, the prevailing characteristic is the second, i.e. their perceptions have been formed during the years of their education with knowledge from the scientific model (Kotsis, 2005).

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Table 4. *Questions about Force concept.*

Questions	Available Answers				
	A	B	C	D	E
Q1."A book lying motionless on the table owes its motionlessness to the fact that..."	Air pressure keeps the book stationary	Gravity keeps the book stationary	The component of the forces acting on the book is zero	The table "interferes" and prevents the book from falling	-
Q2."A car is moving along a straight road at a constant speed. The component of the forces acting on the body..."	Has the direction of velocity	Depends on the measure of speed	Is zero	Equal to body weight	Depends on body mass
Q3."When a car moves at a constant speed to the right, then the resultant force on it..."	Is zero	It has the direction to the right	It has the direction to the left	-	-
Q4. "A man exerts a force F on the floor. The reaction of this force is..."	The force from earth to man	The force from man to earth	The inactivity of man	The force from the floor to the man	-
Q5."The reaction of the body's weight shown in figure 4 below is the force exerted by..."	The body on the rope	The ceiling on the rope	The rope to the body	The body on earth	-
Q6."A golf ball moves through the air, as shown in figure 5. A student argues that three forces act on the ball. The weight B, the air resistance T, and the force F from the strike of the golf club. In fact, the forces are:"	Only the weight B	Only the weight B and force F from the strike of the golf club	Only weight B and air resistance T	Only weight B and force F from the strike of the golf club and air resistance T	Only force F from the strike of the golf club and air resistance T

__Table 5.__ Questions about the Weight concept

Questions	Available Answers		
	A	B	C
Q7. "When Galileo released the two spheres from the top of the Leaning Tower of Pisa, air resistance was not really negligible. Assuming the balls were the same size, but one was much heavier than the other, which hit the ground first…"	The heaviest	The lightest	Both at the same time
Q8. "A stone is weighed on the surface of the Earth, and the same stone is weighed on the surface of the Moon. Which one has the heaviest weight?	They will have the same weight on both surfaces	On the surface of the Earth	On the surface of the Moon
Q9. "At the upper end of an air-vacuum tube, we leave a sphere. Which of the following statements is correct? "	There is no gravity inside the vacuum tube, so the sphere does not fall	Only its weight acts on the sphere, which accelerates it	Air resistance prevents the sphere from falling freely
Q10. "Two people A and C of equal masses climb a ladder. A climb the ladder at a faster speed than C. The work done by A's weight when they both reach the top of the ladder is…"	Greater than the work of C	Smaller than the work of C	Equal to the work of C
Q11. "The bucket and the cube have equal masses, but they are suspended (balanced) at different heights above the floor. Which of the two has more weight? "	Both have the same weight	The bucket	The cube
Q12. "A stone on the surface of the Earth and another on the surface of the Moon are weighed and the same weight is obtained for both. Which of the two stones has the smaller mass? "	The stone on the surface of the Earth	Both stones have the same mass	The rock on the surface of the Moon