International Journal of Engineering Education Vol. 34, No. 4, pp. 1427–1435, 2018
Printed in Great Britain

0949-149X/91 $3.00+0.00

An Examination of the Beliefs About Physics and Learning Physics Among Engineering Students*

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It has been suggested that the attitudes, beliefs and expectations of students about learning physics can impact the way they perform in physics courses. Here, our aim is to understand the beliefs and attitudes of engineering students of an accredited Colombian university about physics and how physics should be taught in this context. Our research process includes the translation of a pre-existing survey, its subsequent validation in the Spanish language, and its application as a diagnostic test. This survey is based on CLASS, an instrument developed by researchers at the University of Colorado that consists of 42 Likert-type questions. The results of this instrument, which is based on the expert-novice comparison technique, can be distributed into eight categories relating to beliefs and attitudes about physics. We applied this survey to more than 700 first-year students of engineering programs. Based on the student responses, we discuss the overall results and specifically focus on the three categories that had the lowest student favorability values compared to expert opinions—Conceptual Connections (47.1%), Problem Solving Sophistication (44.6%), and Applied Conceptual Understanding (36%). Our overall results (56.5%) are comparable to those obtained by surveying students in other countries and cultures with the same test, such as USA (62%) and Saudi Arabia (55%). Furthermore, we highlight some of the answers of the students, and examine the effects that their beliefs have on their attitude. Therefore, physics courses should be oriented or prepared in such a way that students can strengthen their beliefs and attitudes. Strategies focused on developing high levels of confidence should be taken into account. Finally, we provide some recommendations of how physics teachers can promote a positive attitude among their students, such as classroom debates related to physics topics in order to help students to develop their different perspectives about a specific issue or phenomenon, enforcing the idea that there is not only one correct way to reach a solution or solve a problem.

Keywords: engineering education; physics; physics teaching; CLASS; attitudes; beliefs

1. Introduction

For over three years we have been evaluating the way in which physics is taught to and learned by engineering students at an accredited Colombian university. We hold many concerns with respect to how these courses should be developed within the university degree, how the topics should be prepared, which aspects should be prioritized and/or emphasized, and whether more focus should be put on strengthening the knowledge of the students or on developing the students' thinking skills.

Throughout our investigations, we have identified various factors that negatively affect the academic outcome of engineering students. For instance, a high number of students per class, a low student participation rate, the presence of difficulties in the classroom environment, and too many distractions such as the internet, all play a major role. In fact, with respect to the regular physics courses that make up part of the engineering degree, repetition rates (whether due to formal withdrawal or a student failure) of greater than 40% exist for both large (n > 100) and small (n = 24) classes.

With the goal of improving both teaching methods and student results, we have carried out a series of pedagogical exercises. The aim of these exercises was specifically to improve student motivation, boost student commitment, promote student self-confidence, and encourage student participation in the classroom [1]. Unfortunately, however, very few of these exercises have achieved positive results.

The persistent problems that engineering students suffer when learning physics raises the need for further development of teaching methods. As such, to determine novel ways to improve teaching and motivation processes, we have recently focused on exploring the expectations, beliefs and attitudes of first-year engineering students with respect to this subject. In 2015, a literature search was performed in order to identify valid instruments capable of evaluating these aspects. One instrument was a survey called CLASS (Colorado Learning Attitudes about Science Survey) that was developed by researchers at the University of Colorado. CLASS [2], which adequately matched our needs and concerns, is a widely validated and optimized version of a previous survey based on related topics [3].

* Accepted 23 March 2018.

2. Theoretical framework

A fairly recent review by Docktor and Mestre [4], which was commissioned by the National Research Council of the United States, examines research on physics education at the undergraduate level. The review highlights six topical areas within this line of investigation: conceptual understanding, problem solving, curriculum and instructions, assessment, cognitive psychology, and attitudes and beliefs about teaching and learning and of physics. We considered it of utmost importance to focus our research on the state of student attitudes and beliefs about learning physics.

In Colombia, various external tests are currently carried out in both public and private schools with the aim to assess the educational quality of the students. These tests are given to students in grades 3 and 5 of primary school, and to grades 7, 9 and 11 of secondary school. These tests mainly focus on the basic competences of the students in relation to fundamental standards established by the Ministry of Education for each grade. The test results from the last three years have shown a low student performance in the development of competences related to the subject of physics. Moreover, during the last four years the national average score has been less than 50%, especially in rural areas and the Caribbean costal region [5]. Since 2006, Colombia has begun to implement an external test as part of a worldwide effort called the Programme for International Student Assessment (PISA). This is a project developed by the Organization for Economic Co-operation and Development (OECD) that evaluates the combined skills of reading, mathematics and science. The last evaluation cycle in 2015 included 72 countries, among which Colombia was ranked 58th in the natural sciences category [6]. The score obtained by Colombia, which was 49% below the basic established level, was not that different from the scores obtained in the 2006, 2009 and 2012 cycles. This presents a rather worrying panorama regarding the current state of science education in Colombia.

The results of internal and external tests in science assessment, in addition to the high percentage of physics course repetition at the local university level, really highlights the need to uncover the causes of poor competence in physics. As such, a diagnosis about the beliefs and attitudes of students would represent an important reference point for professors teaching physics. Regardless of the subject, if a professor wants to develop a well-planned curriculum, he (or she) should not only have a solid knowledge about what needs to be taught to the students, but also have a good picture of their beliefs and attitudes towards the specific subject. Perkins [7] claims that students who enter a course with more favorable beliefs are more likely to learn and grasp the key concepts. As mentioned above, an important benchmark for international evaluation is the PISA exam. In the natural sciences category, the test is oriented towards evaluating the attitudes of students towards science [6]. This innovative assessment is obtained through a series of questions contextualized within the cognitive section of the test. The close proximity between the attitude questions and the cognitive exercises allows questions to be addressed in specific areas that focus on student interest in science, and on student support for scientific research. The results obtained by the students in the cognitive evaluation are later associated to these contextual factors.

Docktor and Mestre [4] state that the attitudes and beliefs that students manifest about learning physics significantly affect their academic performance in physics courses. Students often think that physics is composed of an excessive amount of unconnected or unrelated information that has no relevance with the real word. Furthermore, students frequently have the idea that a physics course is principally based on memorizing a set of formulas that are later applied to solve problems without needing to fully understand the concepts, principles and laws behind the phenomenon in question [3].

The terms belief and attitude are widely used in various studies to describe the ideas that students have with respect to learning physics, the knowledge of physics, and solving physics problems. In psychology, the term attitude is described as a psychological tendency that is expressed by evaluating a particular entity or object with some degree of favor or disfavor [8]. Similarly, the term belief is used to describe a psychological state in which a person is convinced about the truth of a proposition [9]. The CLASS survey does not make a distinction between these terms (attitude and belief), but rather considers them throughout the entire survey to be interchangeable. For example, question 13 of the survey states: "I do not expect physics equations to help my understanding of the ideas; they are just for doing calculations". This question is used to inquire about the attitude of the students towards the solution of problems, as well as about their belief in whether these problems are useful for conceptually understanding a phenomenon or not.

The fact that professors have their own beliefs about the way students learn affects their decisions regarding how to teach and how to interact in the classroom. More often than not, teaching practices are incompatible with the beliefs of students. Redish [10] stated:

> "Student understanding of what science is about and how it is done, and their expectations as to what goes on in a science course play a powerful role in what they can get out of an introductory university physics course. This is particularly true when there is a large gap between what the students expect to do and what the professor expects them to do" (p 1).

Here, our diagnostic study is centered on identifying the most relevant beliefs that students of an accredited university in Colombia have about learning physics. Those beliefs which influence academic performance in physics courses in either a negative or a positive way are of particular importance. Our fundamental question is thus: What attitudes and beliefs do students have regarding learning physics? The classical way to study these attitudes and beliefs is to compare the form of reasoning between experts and novices in relation to the most relevant aspects of learning physics [11]. Such relevant aspects include: how to deal with studying physics, how is physics related to the real world, how is physics relevant to the student's intended career, how to deal with problem solving, how to find meaning in the results, and how much effort does a student need to exert to learn physics.

Recognizing the mental patterns of students and finding the differences between these and the patterns of experts (professors), facilitates the design of teaching techniques that are more consistent and specific to the expectations of the students. Research on physics education has primarily focused on the difficulties that students encounter, and on identifying the conceptual errors that they hold [12]. This type of research is important because it gives us feedback about the way, and extent to which students receive and adapt to the lessons given by a professor. However, we also consider it extremely important to study the attitudes and beliefs that students develop during their first physics course. From this, it is possible to perform a complementary study that relates these ideas to student progression in terms of conceptual learning.

During the last decade, researchers of science education have identified a variety of student attitudes and beliefs that are formed by experiences in the classroom. Studies by House [13–14] and Sadler [15] indicate that student expectations act as a better predictor of performance in university science courses than the amount of science and mathematics completed in high school. House found that student expectations of achievement as well as academic self-perception are the best predictors of performance in chemistry. In fact, these are better predictors than student achievement in previous institutions. Moreover, Gungor [16] concluded that developing favorable student attitudes towards physics increases their motivation for physics and aspirations to achieve higher grades, thereby having a statistically significant effect on the performance in the course.

The CLASS questionnaire [2] formed part of a study on physics education conducted by the Physics Education Technology (PhET) project and the Physics Education Research Group at Colorado. This questionnaire is a widely-used instrument that was designed to measure the attitudes of students towards learning physics. The authors ensure that the survey takes less than 10 minutes to complete. Its design included the participation of experts with a high level of experience in teaching physics, such as Carl. E. Wieman, who won the Nobel Prize for Physics in 2001. These experts complete the survey and their answers act as a reference for comparison with those given by students. When a student agrees with the teachers' answers, it means that this particular item or answer is granted a favorability point. In the same way, when a student's answer is different from those of the teachers, its means that this answer is unfavorable. The Likert-like survey consists of 42 questions that are classified into eight major categories of beliefs and attitudes about physics. These categories are determined and defined by the authors [2, 7] in the following way:

- Personal Interest (PI): I think about physics in my life.
- Real World Connections (RWC): physics describes the world.
- Sense Making and Effort (SM/E): I put in the effort to make sense of physics ideas.
- Conceptual Understanding (CU): physics based on a conceptual framework.
- Math Physics Connection/Problem Solving (PSX): equations represent concepts. Sherin [17] defines problem solving as the ability to understand the problem in relation to a particular schema, and then solve the problem using that schema's techniques and equations.

The CLASS study classifies this Math Physics Connection into three problem-solving categories: (i) Problem Solving General (PSG), (ii) Problem Solving Confidence (PSC), (iii) Problem Solving Sophistication (PSS).

This study included a data collection phase at the beginning of several academic periods in order to determine if the students' beliefs were closer to, or further from the beliefs of experts. A more favorable qualification is given to the students whose results are closer to those obtained by the physicist consulted in the CLASS study. Studies employing the same test at both the beginning and end of a course have shown that students become more novice-like over the course of a semester [10]. Actually, success has only been achieved in those courses that have been specifically designed to address the attitudes and beliefs of students [11]. In our study, we initially concentrated on using the CLASS survey to collect information about the beliefs and attitudes that students of engineering programs at an accredited Colombian university have when taking their first physics course. In the future, these results will be useful for devising strategies to improve conceptual learning in physics. We will not focus on analyzing the Personal Interest (PI) or the Real World Connection (RWC) categories (>70% favorability in both) because engineering students in general and physics teachers had a good perception of the importance of physics in their careers [18]. This is related to the interest that students show in physics and how the knowledge studied in this subject brings them closer to the world that surrounds them [2, 7]. According to Perkins [7] and Gire [19] engineering students generally believe that the connection between physics and mathematics is a fundamental aspect of their career.

Our analysis included all eight categories, but in particular, we focused on the following three: Conceptual Connections (CC), Problem Solving Sophistication (PSS), and Applied Conceptual Understanding (ACU). Hammer [3] found three dimensions to the beliefs of students: the content of physics knowledge (formulas versus concepts), the structure of physics knowledge (isolated pieces versus a coherent individual structure), and the learning of physics (the reception of information versus the active reconstruction of one's own understanding). Furthermore, he found that students who believed physics to be composed of interconnected concepts in a coherent manner were capable of learning physics in a self-sufficient way, without depending on the professor. In contrast, the ability of students who believed that physics consisted of discrete and disconnected facts were directly dependent on how the professor presented the subject.

3. Design

The sample population, which included students who took the General Physics course between 2014 and 2016, was composed of 719 students between the ages of 15 and 18 from six engineering programs. A web-based survey was conducted in which the students received an invitation by e-mail. The e-mail contained a synopsis explaining the objectives of the survey as well as the 42 questions (see annex) from the instrument, 36 of which enabled us to evaluate the general category.

The data collection process employed the CLASS survey from the University of Colorado, which unfortunately can only be found in English, Arabic, and Finnish. As such, before sending the survey to the students, it was necessary to translate it from English to Spanish and to have the translated version revised by four physics experts. In addition, students were subsequently interviewed to determine the validity of the translation. In order to evaluate the internal consistency of the translated CLASS instrument, a Cronbach's alpha test was performed. This test is an internal consistency model based on the average inter-element correlation, and essentially estimates the reliability of a psychometric test. The resultant coefficients range from –1.0 and 1.0, for which values falling between 0.70 and 0.90 are considered to represent a high internal consistency. On the other hand, values below 0.70 indicate a low internal consistency, and values superior than 0.90 suggest that the scale has various items measuring exactly the same. According to the Cronbach's alpha coefficient obtained in this study—a value of 0.814—the CLASS instrument has a high internal consistency (Table 1).

Table 1. Results of Cronbach's alpha

Scale	Number of Items	Alpha Coefficient
CLASS	36	0.814

The questionnaire was adapted to an online form, which also asks for information regarding the student's age, sex, and engineering program. This information was subsequently organized for statistical analysis of the data. We calculated the percentage of students that had a favorable opinion, a neutral opinion, or an unfavorable opinion with respect to the answers given by the experts for each of the aforementioned categories.

All the experts consulted for the validation of the CLASS survey were physicists, and some of them even had considerable experience in teaching introductory physics courses [2]. We find that our results are consistent with previous studies—that engineering students have less-expert views than physics students or individuals who already have a degree in physics [20].

4. Results and analysis

4.1 Overall results

Table 2 shows student distribution and overall favorability according to engineering program. The general percentage of favorability when considering the entire sample population (56.5%) does not differ from the results obtained by Adams [2] in the United States (62%), nor from those obtained by Slaugther [20] in the United Kingdom (67%), or those by Alhadlaq et al. [21] in Arabia (55%). This implies that the students in our university do not show great discrepancies in their attitudes and beliefs towards physics compared with students in

Table 2. Summary of the engineering students, gender and their percentage of favorable overall responses

Engineering Program	N	Women	Men	Overall Favorability (%)	Standard Deviation
Civil Eng. (CE)	183	68	114	53.9	16.9
Electric Eng. (EE)	77	21	57	55.8	17.8
Industrial Eng. (IE)	176	88	88	53.9	14.7
Electronic Eng. (EIE)	56	13	43	60.2	16.0
Mechanical Eng. (ME)	150	24	126	62.5	17.1
System Eng. (SE)	77	9	68	55.7	17.2
Total	719	223	496	56.5	16.8

other parts of the world. Noteworthy, there is a noticeably high percentage of males in our study.

Interestingly, all engineering programs present a fairly consistent student favorability (agreeing with experts) towards physics (Fig. 1). While the highest favorability is observed for mechanical engineering students (62.5%), the lowest favorability is shown by civil and industrial engineering students (53.9%).

4.2 Analysis by categories and specific questions

Highly favorable results were observed for the Personal Interest (PI) and Real World Connection (RWC) categories (72% and 74.2%, respectively). These two categories represent the way in which students consider physics, both in terms of their engineer career and in terms of connecting to the surrounding world—that is, how physics laws govern real-world behavior. This is evident in the answers to question 14 "I study physics to learn knowledge that will be useful in my life outside of school" (77.1% favorability), question 30 "Reasoning skills used to understand physics can be helpful to me in my everyday life" (80.9%), and question 28 "Learning physics changes my ideas about how the world works" (83.1%). The mechanical engineering students exhibited the highest values of favorability with respect to these questions (question 14, 87.3%; question 30, 86.7%; and question 28, 88.7%).

We also found favorable results for the Problem Solving General (PSG, 65.9%) and Problem Solving Confidence (PSC, 67.2%) categories. This is likely because engineering students consider the ability to pose and solve problems as highly important for their careers. Interestingly, both question 26 "In physics, mathematical formulas express meaningful relationships among measurable quantities" and question 16 "Nearly everyone is capable of understanding physics if they work at it" stand out with a high favorability (79.0% and 73.1%, respectively).

A favorability of 65.3% was obtained for student beliefs about Sense Making and Effort (SM/E). When physics becomes difficult for students, professors expect them to try to solve problems using a variety of individual and group techniques such as reading examples in physics textbooks, practicing with additional problems, talking to peers, and in general, trying to use any available tool to make sense of the subject. The CLASS instrument uses questions 11, 23, 24, 32, 36, 39 and 42 to evaluate this belief. Notably, the results of question 11 "I am

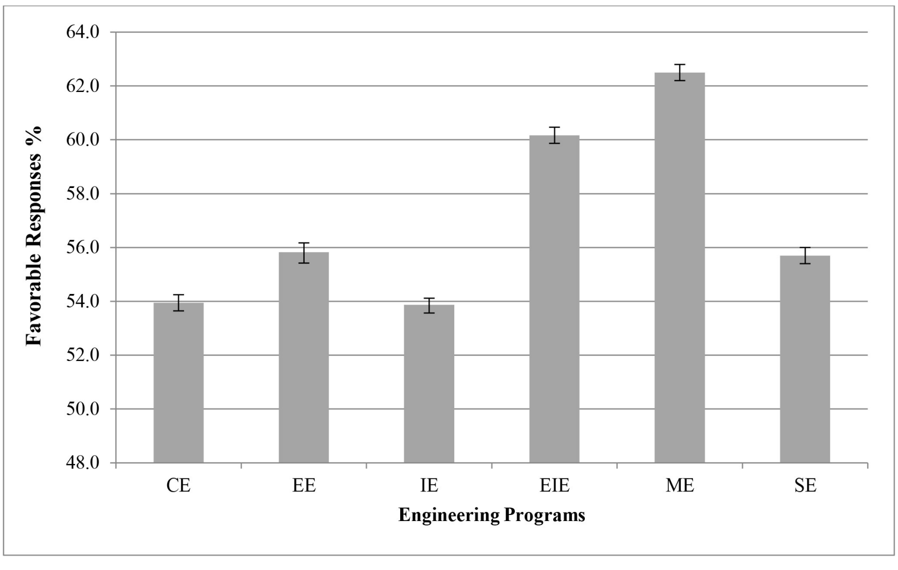

Fig. 1. Percentage of favorable responses (agreeing with experts) in the CLASS survey for all engineering programs. Bars represent average standard error.

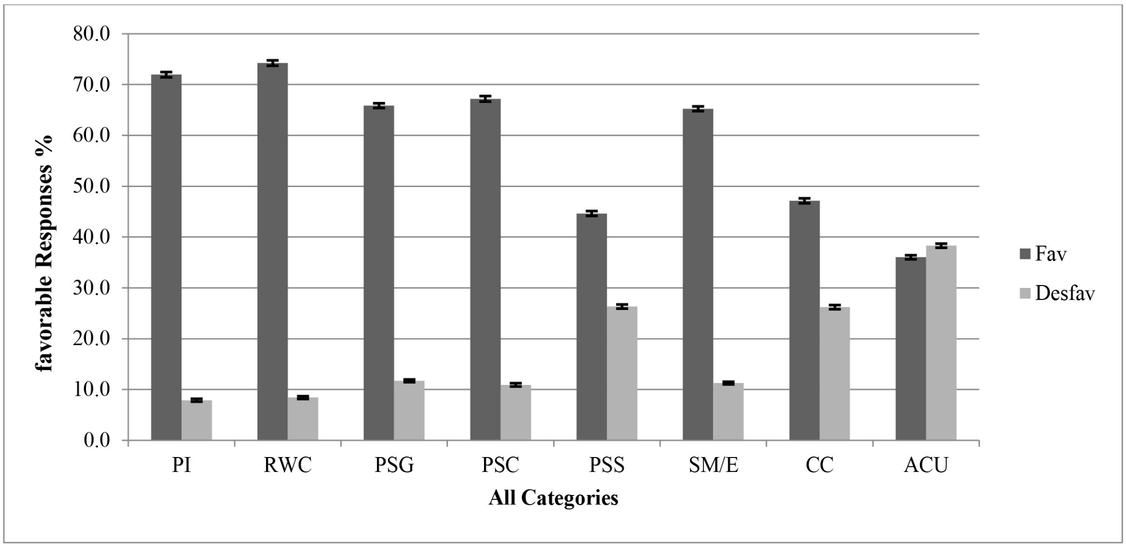

Fig. 2. The average percentage of favorable (agreeing with experts) and unfavorable responses for each of the eight categories proposed by the CLASS study: Personal Interest (PI), Real World Connection (RWC), Problem Solving General (PSG), Problem Solving Confidence (PSC), Problem Solving Sophistication (PSS), Sense Making/Effort (SM/E), Conceptual Connections (CC) and Applied Conceptual Understanding (ACU).

not satisfied until I understand why something works the way it does'' and question 42 ''When studying physics, I relate the important information to what I already know rather than just memorizing it the way it is presented'' stand out with favorability percentages of 70.5% and 70.0%, respectively. This demonstrates a favorable student attitude with respect to wanting to understand how things work and not only wanting to know the result of a problem. Furthermore, this positive attitude is extended in the fact that students want to relate new information with a situation instead of simply memorizing it. Interestingly, while experts completely agree with question 36, ''There are times I solve a physics problem more than one way to help my understanding'', we find that the majority of students either do not agree or have a neutral opinion. Specifically, the majority of students (57.7%) are satisfied with solving problems in a single way, as long as their answer coincides with the author. In other words, students do not consider it necessary to study problems from different perspectives.

The Conceptual Connections (CC) category, which shows a low favorability (47.1%) compared to experts, is evaluated by the results of questions 1, 5, 6, 13, 21 and 32. The result of question 6 ''Knowledge in physics consists of many disconnected topics'', which has a 70.9% favorability, indicates that most students agree with the expert opinion that physics is a system of interconnected and coherent concepts. Surprisingly, question 12 ''I cannot learn physics if the teacher does not explain things well in class'' has a favorability of only 19.5%. As such, very few students agreed with the experts that they can learn physics independently of the teacher. In this way, we can assume that a high percentage of students consider that the explanations presented by the teacher play a fundamental role in their ability to learn physics. This clearly implies that there is a great dependence on the way the teacher approaches the subject. According to Redish et al. [10], independence in learning physics involves an active process of reconstructing our own understanding. This is quite different from the simple reception of information from the instructor (dependency). Question 22 ''If I want to apply a method used for solving one physics problem to another problem, the problems must involve very similar situations'', although belonging to the Applied Conceptual Understanding (ACU) category, has a favorable percentage of only 17.7%. This indicates that only a small percentage of students consider that problem solving methods can be extended to other problems in different situations. This makes sense because students will generally feel more secure in solving problems when they are similar to examples given by the teacher or found in the textbook. The result obtained in question 1 ''A significant problem in learning physics is being able to memorize all the information I need to know'', reached a favorability of 24.2%, suggesting that this belief depends, to a large extent, on the format of the exams. For instance, professors can decide whether to provide additional information to students during an exam (i.e., an exam sheet including equations, formulas, constants, etc.). A student who responds favorably to this question likely realizes that the large number of different equations and outcomes discussed in physics can be structured and organized in such a way that only a small amount of information needs to be memorized, with the remainder being easily deducible as necessary. In order to determine whether students can derive a structure, or merely rely on memorization, it is important study this belief more in depth. Indeed, if students are allowed to use an exam sheet, or if the exams are open-book, students would not perceive memorization as a problem [12].

Question 13, "I do not expect physics equations to help my understanding of the ideas; they are just for doing calculations", belongs to both the CC and PSG categories. This question is intended to investigate whether students perceive physics problems as simple mathematical calculations, or if they are aware of the fundamental role played by physics laws, theorems and concepts in the resolution of complex problems. In Colombia, most students take their first physics classes in the last two years of high school, and in general, physics is presented as a subject where "strange" problems are solved by looking for an adequate formula. The typical process thus involves finding the correct equation, manipulating the equation (if necessary), and finally calculating the result. Presenting physics in this way explains why a low favorability result was obtained for this question (50.7%). This result however, should show a substantial improvement after taking physics courses at the university level, when they are taught with these other aspects connected with the physics law and real world, which are included in the methodology that we follow at the university level.

The category of ACU, which is closely related to the coherence of physics, is inspected with questions 1, 5, 6, 8, 21, 22 and 40, and highlights a favorable outcome of only 36%—the lowest of the entire survey. Question 8 "When I solve a physics problem, I locate an equation that uses the variables given in the problem and plug in the values", presents an unfavorable result of 82.7%. This implies that most of the students think that entering data into the most appropriate formula is the most productive strategy to solve problems in physics. If we associate the analysis of question 22 with the analysis of question 8, we find that the intention to use "formula-situation" patterns is more emphasized than the possibility of carrying out deeper analysis of the applicability of physics principles and laws for a variety of situations.

The PSS category is evaluated using questions 5, 21, 22, 25, 34, and 40. Two skills associated with problem solving distinguish an expert from a novice. First, the ability to quickly identify the ideas and information (problem defining), and second, the ability to determine the strategy required to solve the problem (solution planning). These abilities stand out even more when the problem is more complex. The PSS category relates with these skills when the problem requires a greater degree of sophistication than for the PSG category. Question 22 is useful for examining these skills since it allows probing student beliefs upon affronting a problem that is not similar to others the student has previously solved. The low percentage of favorability (17.7%) obtained in this question indicates that the students are more novice-like with respect to developing these skills. In general, the favorability results for these questions were low. The greatest favorability (61.7%) was obtained in question 40: "If I get stuck on a physics problem, there is no chance I'll figure it out on my own". However, this question reflects that about one third of the students are likely unable to solve more difficult problems.

4.3 Gender comparison

Similar favorability results are observed in males and females for the RWC, PSG, SM/E, CC, and ACU categories. In contrast, gender differences become apparent for the PI, PSS and PSC categories. In general, men exhibit a greater favorability in these categories (except for CC), with the PSS category having the greatest difference.

As mentioned above, students who begin a new physics course with a positive attitude are more likely to achieve better results and have a more thorough understanding of physics. Thus, an important question is: What can teachers do to promote positive attitudes and beliefs towards physics? According to Redish [13], there is "no single approach that works for all students. Both individual differences and the particular populations in a class need to be taken into account" (p.115). Therefore, physics courses should be oriented or prepared in such way so that students can reinforce (strengthen) their attitudes and beliefs. Teachers should employ strategies that focus on developing high levels of confidence. For example, this could be in the form videos prepared or recorded by students to explain a daily physical phenomenon. This task would help students to connect physics with the real

Table 3. Overall and category-specific average percentage of favorable responses according to gender

Gender	N	Overall	PI	RWC	PSG	PSC	PSS	SM/E	CC	ACU
Male	496	57.2	73.9	74.8	67	69.3	46.3	65.9	46.3	36.2
Female	223	54.8	67.5	72.9	63.2	62.6	40.8	63.6	48.8	35.5

world and improve their conceptual connection and ACU. Another possibility would be to hold classroom debates about physics topics. This would help students to develop different perspectives about a specific issue or phenomenon, enforcing the idea that there is not only one correct way to get reach a solution or solve a problem. Debates enable students to explore and discuss alternative viewpoints. This technique would help students to improve SPG, SPS and SPC. A third possibility would be for students to engage in small science projects. This requires some time for advance planning, group work, sharing and presenting. Furthermore, computer simulations or small computer programs, which students can make themselves, would bring students in contact with real situations. Chang [22] show that teachers who choose and combine supportive functions such as conducting experiments, are able to improve student performance in simulation-based learning. In addition, another option as published by Mazur [23] is peer-instruction. An article from Smith [24] claims that peer discussions result in better understanding due to more knowledgeable peers influencing their student neighbors.

In general, it is advantageous for teachers to explore different approaches in order to enhance classroom participation and foster better learning environments.

5. Conclusions

In this study, we have developed a Spanish version of the CLASS survey to evaluate the beliefs and attitudes of students from a Colombian university about physics. This version has been validated by physics experts and supported by student opinions.

In general, we found that the student population exhibits an overall favorability of 56.5% with respect to their beliefs and attitudes towards physics. These results are similar to the results found in other countries such as Saudi Arabia (55%), and only slightly lower compared to results obtained in the US (62%) and UK (67%). This suggests that beliefs and attitudes about physics are a universal phenomenon that are independent of country, culture, age, or language. Similarly, we see no large or marked differences with respect to gender, with both men and women showing comparable levels of beliefs in this study. This leads us to think that efforts made in certain countries to produce a positive change in these beliefs might represent an important and valuable meaningful point for the teaching of this science. Since this study did not follow up on possible belief and attitude changes of the students since the start of the physics course, it should only serve as a first diagnostic approximation. Nonetheless, we highlight the favorability expressed by students (compared to expert physicists) in terms of the attitudes and beliefs included in the CLASS instrument. We found students to have a high favorability (>70%) in terms of PI and RWC, suggesting that most of the students understand the importance of and are committed to pursuing physics courses. We also found an above average favorability (>50%) for the SM/E, PSG, and PSC categories. In contrast, a favorability below 50% was found for the PSS, CC, and ACU categories, with the ACU category showing the lowest favorability. The difference between the commitment and interest that students have for physics, and the little importance they give to its scientific nature, describes a panorama of disconnection among the concepts and applicability of physics. This view of "feeling" physics as a set of "problem-solving" formulas and disconnected topics presents a great challenge for professors who teach physics. Physics courses should be oriented or prepared in such way so that students can strengthen their attitudes and beliefs. Strategies focused on developing high levels of confidence should be taken into account. Thus, in order to decide which strategies will better fit to the desired learning outcomes, it is important that teachers take time at the beginning of a course to collect previous information from the students, such as, the numbers of students, their prior knowledge related to the course, the previous calculus performance. Another possibility would be to implement physics topics in classroom debates in order to help students to develop their different perspectives about a specific issue or phenomenon. Students should be aware that there is not only one correct way to find solutions or solve problems. In other words, this strategy might contribute to improve SPG, SPS and SPC.

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