STEM-oriented Students Perception of the Relevance of Physics

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STEM-oriented students' perception of the relevance of physics

Abstract

We present initial findings from an ongoing project regarding the factors that influence secondary and high school students to pursue a professional engineering career. In this article, we offer data from the analysis of a questionnaire administered to high school students who participated in a STEM competition. The review of the information gathered with these students is particularly critical in our main project since these students have a strong orientation toward STEM. Students had a choice to participate in up to two subjects out of five available: physics, mathematics, biology, chemistry and computer science. We administered a science and technology questionnaire and 657 students out of 721 who participated in the competition responded. The survey included 13 questions in a Likert scale regarding self-efficacy and perception of the importance of the subjects presented. In the first section of the questionnaire, students responded to queries that assess physics, biology, chemistry, mathematics and computer science self-efficacy. In the second section of the survey, students answered questions that determine their perception of the importance of physics, biology, chemistry, mathematics, and computer science on their current studies and their future professional career. This report contrasts self-efficacy and perception of the importance of physics between students who chose physics as the subject in their competition and those who chose a different STEM subject. The analysis presents the differences between students who are more exact science-oriented, i.e., mathematics and computer science, and those who are more natural science-oriented, i.e., chemistry and biology.

Introduction

The student's perception of the relevance of the sciences in everyday or professional life is related to attitudes [1]. However, attitude studies are rather general and do not emphasize the relevance of students' careers. In studies with pre-university students, the results show that there is a significant difference by gender between the perceptions of the relevance of sciences, in favor of the male student, and that this difference increases with age [2].

Porche, Grossman, Noonan and Wong [3] analyzed factors that influence young females to pursue a STEM career. Among their results, science and math self-efficacy were factors to consider. Eccles, Wigfiedl, Harold and Blumenfeld [4] analyzed the age and gender differences that elementary students have in self-efficacy.

The attitude that students have of themselves on science and mathematics is related to their school experience, the importance, and support that their family has given them as a child to understand science and math, and the type of intelligence, among other factors. Additionally, it is socially justified that a child does not do well in mathematics courses, especially if no one else in the family has done studies that require an advanced level of exact sciences. This situation is accentuated by gender, that is, in the case of women, the projection of a professional career is oriented more towards social areas than sciences and engineering.

Some researchers of the area have extensive experience on the evaluation of attitudes towards physics, as well as other variables such as learning, scientific reasoning, communication and collaborative skills by engineering students. However, we did not find many research studies devoted to the perception of the relevance of physics, particularly the relevance of physics on engineering. In two previous studies [5] and [6], we focused on the perception of the importance of physics in relation to engineering (both scholar and professional). The results indicated that students have a low perception and that perception decreases over time in university, similar to what one can find in mathematics [7].

Some studies focus on the perception of the relevance of mathematics and physics by gender; as with general results mentioned before, several factors like parents, peers, school and society expectations are to be considered [8]and [9]. Although their study does not focus on gender, Jones and Young [2] worked with pre-college students on their perception of the importance of science and showed that there are significant differences among male students compared to female students, favoring the former. They also found that the difference increases with age.

The relevance of the various branches of mathematics in engineering is very evident. However, school mathematics (which is taught in the classroom) may not make that relationship explicit enough for students to appreciate, recognize and value mathematics, not only in engineering but any activity [10]. That is why it is essential to identify what students perceive of math and sciences concerning its applicability, to the relevance of mathematics and sciences in their school and professional life.

Some of the participating researchers in this study have extensive experience in institutional assessments of engineering students' attitudes towards science, as well as other variables such as learning, scientific reasoning, communication and collaborative skills. Furthermore, the principal investigator of this research has worked with the measurement of attitudes toward science, the nature of science and the scientific reasoning of pre-university science teachers.

The authors of this paper have published reports on university engineering students' perceptions of the importance of physics and mathematics in their studies and their future professional life [5] and [6]. However, we found no evidence of this kind of work related to other STEM fields with pre-university students.

We present initial findings from an ongoing project regarding the factors that influence secondary and high school students to pursue a professional engineering career. In this article, we offer data from the analysis of a questionnaire administered to high school students who participated in a STEM competition. The review of the information gathered with these students is particularly critical in our main project since these students have a strong orientation toward STEM.

The general objective of this report is to contrast self-efficacy and perception of the importance of physics among students who chose physics as the subject in their first choice to compete and those who chose a different STEM subject. A secondary objective of this work is to present the differences with students who are more exact science-oriented, i.e., mathematics and computer science, and those who are more natural science-oriented, i.e., chemistry and biology.

Methodology

High school students attend the annual Science Contest organized by the university in which this study took place. In the 2017 version of the contest, 721 students assisted from 27 out of 32 states in Mexico. Students have the option of participating in two disciplines to present a test, choosing from physics, mathematics, computer science, chemistry, and biology.

At the registration table, before the contest began, we included a survey and asked students to answer it. The survey consisted of several questions divided into sections. The first section was demographic information. The second section consisted of items from which we want to understand the motivation for the contest. We do not analyze these questions in this article; however, the items are essential for a project regarding the factors that influence secondary and high school students to pursue a professional engineering career. The third section consisted of three self-efficacy questions for each of the five disciplines of the contest. The fourth section consisted of ten questions regarding their perceptions of the importance of the five subjects in their professional life and their studies. The last part consisted of two open-ended questions regarding their future. In this article, we present the analysis of students' answers to sections three and four.

We adapted from Porche et al. [3] three statements to ask for self-efficacy in the five disciplines. For this study, we analyzed those statements, which represent students' self-efficacy related to physics. Table I shows the statements.

TABLE I
STATEMENTS INCLUDED IN THE SURVEY FOR STUDENTS' SELF-EFFICACY FOR PHYSICS.
SE1, SE2, AND SE3 ARE LABELS FOR THESE THREE STATEMENTS

Statement	Physics
Statement 1 (SE1)	*I am very good at physics.*
Statement 2 (SE2)	*My interest in physics is an important part that identifies me.*
Statement 3 (SE3)	*In physics class, my grades are better than those of my classmates.*

In the case of perceptions for this study, we used the survey reported in [5] and [6] which studied the perception of the relevance of physics and mathematics in engineering in a Chilean and a Mexican university. The original survey consisted of eleven Likert-style statements, in which students had to choose from totally disagree, disagree, neutral, agree and totally agree. The statements dealt with students' perception of the relevance of physics and mathematics in engineering, that is, of scholar engineering and professional engineering practices. However, to adapt the survey for high school students, we kept 10 out of 11 statements, as one phrase was not suitable for High School students. The remaining ten statements are substantially the same as the items reported in [5] and [6]. However, instead of asking regarding engineering, the survey asks them for their professional career and their later studies. In addition, besides asking for the subject of physics or mathematics, the survey asks students for the other subjects: computer science, chemistry, and biology. In this report, we present results only for the items in the discipline of physics. Table II shows the statements.

TABLE II
TEN STATEMENTS INCLUDED IN THE SURVEY FOR THE RELEVANCE OF PHYSICS IN THEIR FUTURE

Statement	**Physics**
Statement 1 (PDA)	*I can see how the physics skills that I am currently developing will be useful in my professional career*
Statement 2	*The ways of thinking being taught to me in physics will remain with me long after I graduate*
Statement 3 (SDA)	*Physics classes are needed for other courses in my future studies*
Statement 4 (SDB)	*Physics classes expose me to ideas which I know I will need later in my future studies*
Statement 5 (SDC)	*I feel that the physics course I am currently taking teaches me how to formulate and solve problems that are directly related to my future studies*
Statement 6	*I see being able to communicate effectively using physics arguments I am taught as an important skill to have*
Statement 7 (PDB)	*The formal and rigorous aspects that I have learned in physics classes are important for my future professional career*
Statement 8 (PDC)	*It is important to learn physics to find a better job*
Statement 9	*For me, in physics I only want to learn what I feel is likely to be assessed*
Statement 10	*At some stage during my studies, I have been so overwhelmed by the physics classes that I have considered not studying a career in that area*

Results

Out of 721 students, 657 responded to the survey. From them, we divided students according to their first choice of the subject to compete. There was a second choice because students participated in up to two out of five subjects; we are not considering the second choice.

Demographic results

Since this is a national contest, participating students were from over 27 out of 32 Mexican states. Figure 1 presents the distribution of students' first choice to compete.

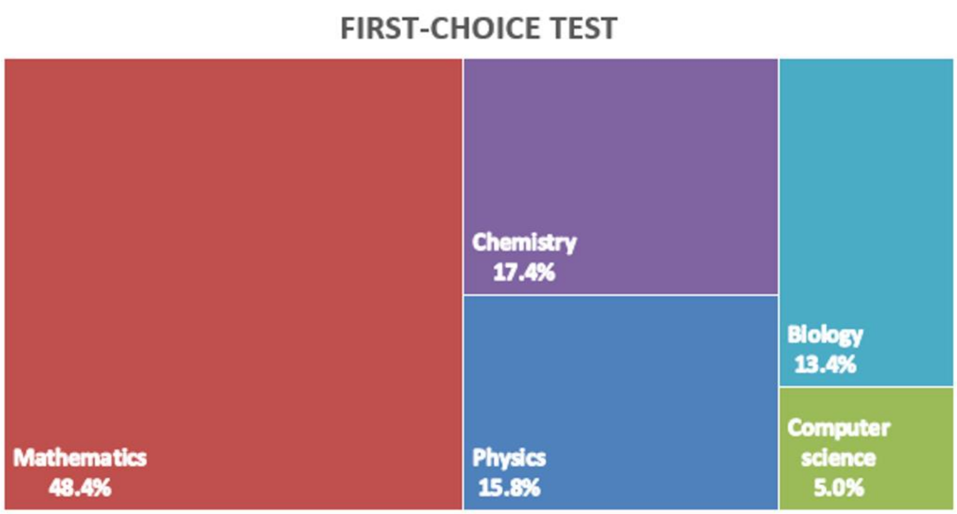

Fig. 1. Distribution of students according to their first choice of the subject in which they wanted to compete (n = 657, n-math = 318, n-chem = 114, n-phys = 104, n-biol = 88, n-compsc = 33).

Almost half of the students had mathematics as their first choice (318). Chemistry was the second rank in students' first choice (114). Not far from that number, 104 students chose physics, and 88 students selected biology. Far from the others, 33 students chose computer science as their first choice.

Figure 2 presents the distribution of gender according to the subject of students' first choice and the distribution of gender for all students.

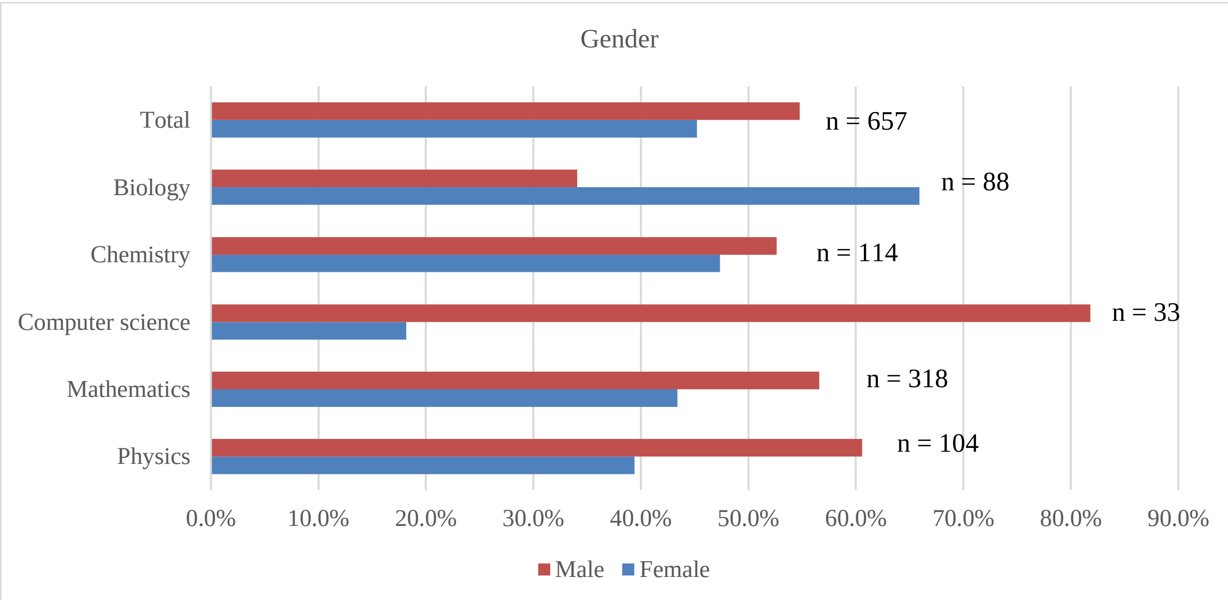

Fig. 2. Percentage of male/female students in each of the first-choice subject and for the total population. A total of 297 female students and 360 male students participated in the survey.

In general, there were more male students (360) than female students (297) who answered the survey. That trend was stronger in computer science where there were 82% of male students and 18% of female students. In physics and mathematics, there were also more male than female students. In chemistry, it was more balanced, with 53%/47% male/female ratio. The only subject in which there were more female students was biology: 66% were female students, and 34% were male students.

Figure 3 presents the distribution of age according to the subject of students' first choice and the distribution of age for all students.

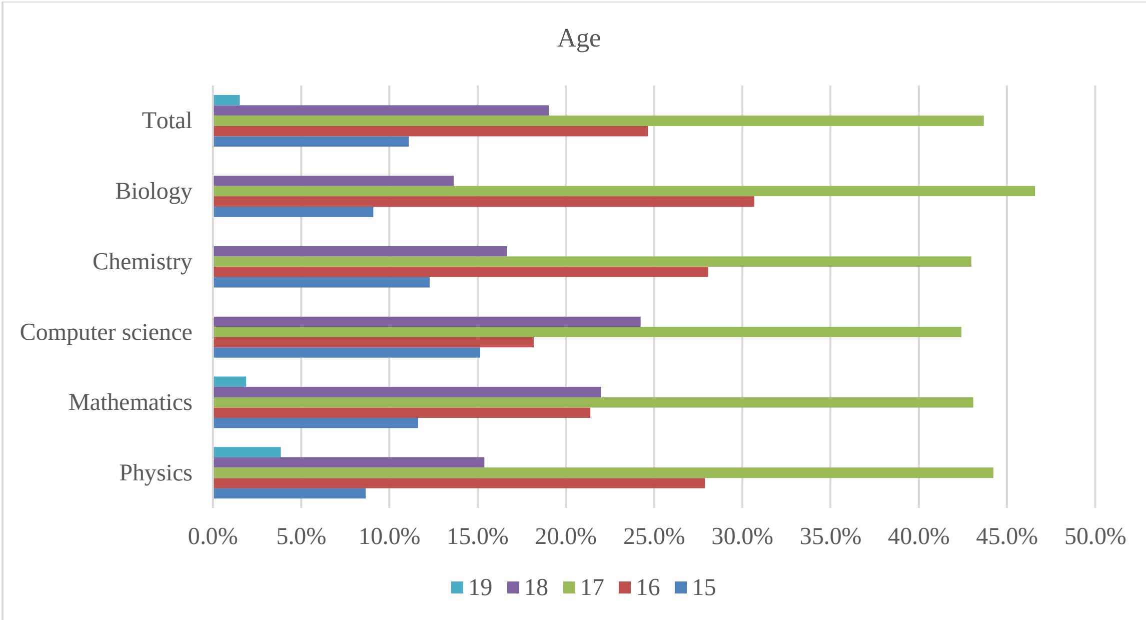

Fig. 3. Distribution of students' age for each of the first-choice subject and for the total population.

In general, and for each category, the distribution of students' age is similar. For each case, almost half of students were 17 years old at the time of the contest. For students whose first choice were physics, chemistry, and biology, the second higher proportion of students were those who were 16 years old. The opposite occurred for computer science students whose second more significant proportion of students were 18 years old. In the case of mathematics, there was almost the same number of 16 and 18 years-old students.

The survey included a question in which we asked students what they would think their highest degree they might obtain in the future. Figure 4 presents these results.

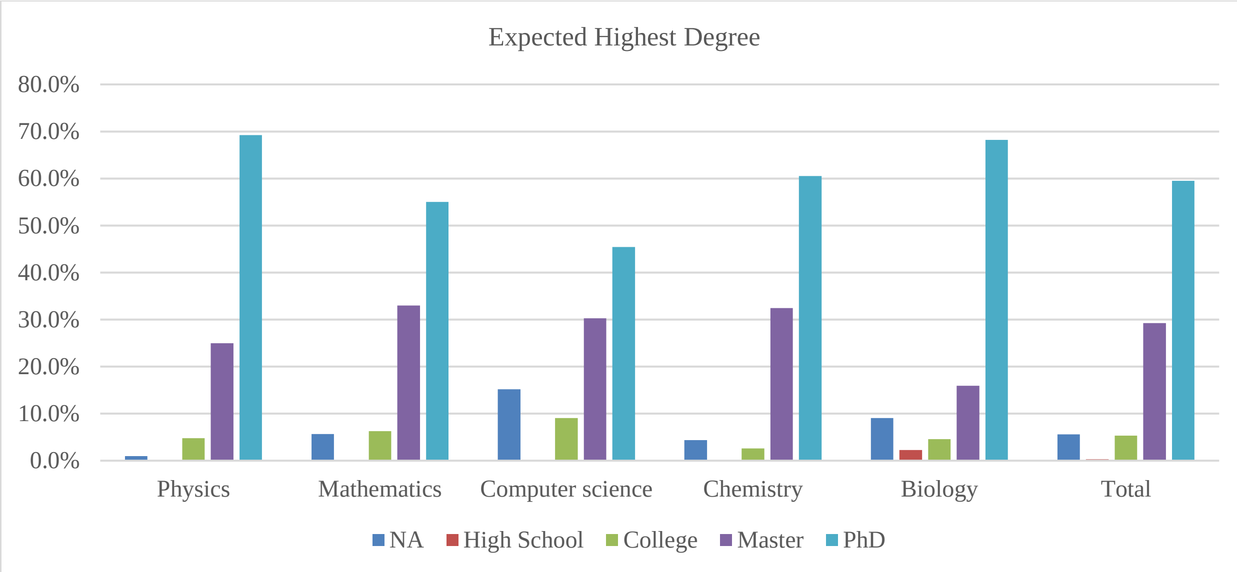

Fig. 4. Distribution of students' highest degree they think they would attain according to their first-choice subject and for the total population.

The results of this question are surprising. Almost 60% of students answered that they think they will obtain a Ph.D. degree and only 5.3% of students responded that their highest degree would be a college degree. These results are evidence of the kind of students these are and that the students in the science contest are students with high aspirations.

According to their first choice, physics has the highest percentage (almost 70%) of students who think they would obtain a Ph.D. degree, followed by biology. The lowest proportion in this regard is students who chose computer science as their first choice, 45%. However, the percentage of students saying their highest degree would be a Master is similar to those students who chose mathematics and chemistry. It might affect the fact that as high as 15.2% of students who selected computer science as their first choice, did not answer this question.

Self-efficacy results

The survey included three self-efficacy statements, called SE1, SE2 and SE3 from the abbreviation of Self-Efficacy. Students had to answer whether they agreed or not to the statements. We combined the answers *"completely in agreement"* and "*in agreement*" into the "*Agree*" answer shown in Figure 5. In the same way, we combined the answers "*completely in disagreement*" and "*in disagreement*" into the "*Disagree*" answer as shown in Figure 5. We present the *neutral* choice on its own.

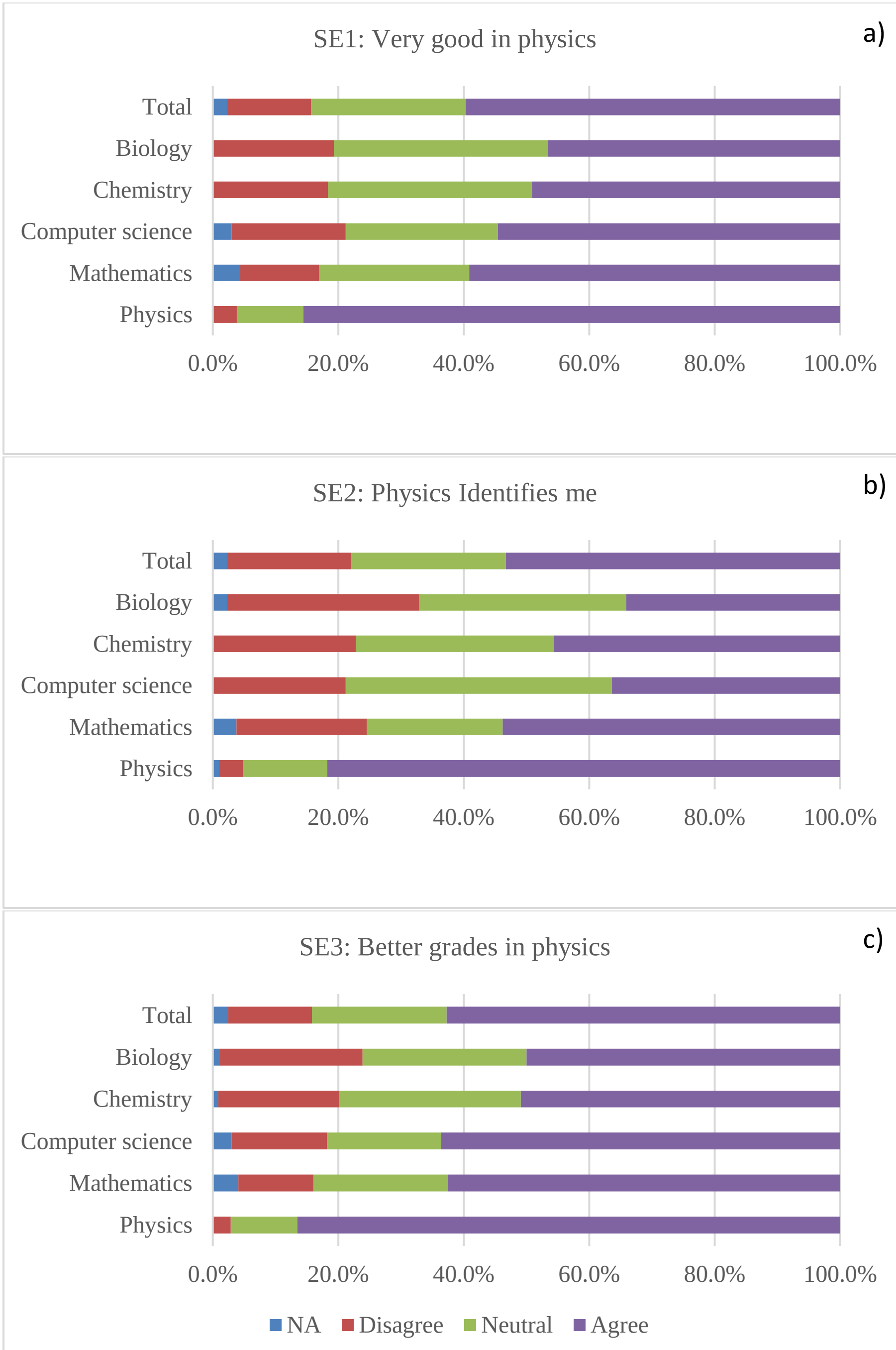

Figure 5. Distribution of students answers to the three self-efficacy statements. The figure swhos disagreement/neutral/agreement for a) SE1, b) SE2 and c) SE3 according to their first-choice subject.

From students who answered the survey, those who chose physics as their first choice agree more for the three self-efficacy statements. For SE1 "*I am very good at physics*", and SE3 "*In physics class, my grades are better than those of my classmates*," students who selected the exact sciences (mathematics and computer science) agree more with the same statements than those who chose the natural sciences (chemistry and biology), thus being closer to the physics students' results. The exception occurred in SE2 "*My interest in physics is an important part that* *identifies me*" in which students who chose computer science agree less than students who selected mathematics and chemistry.

Figure 6 shows another way to present results that can give us an insightful perspective on the data.

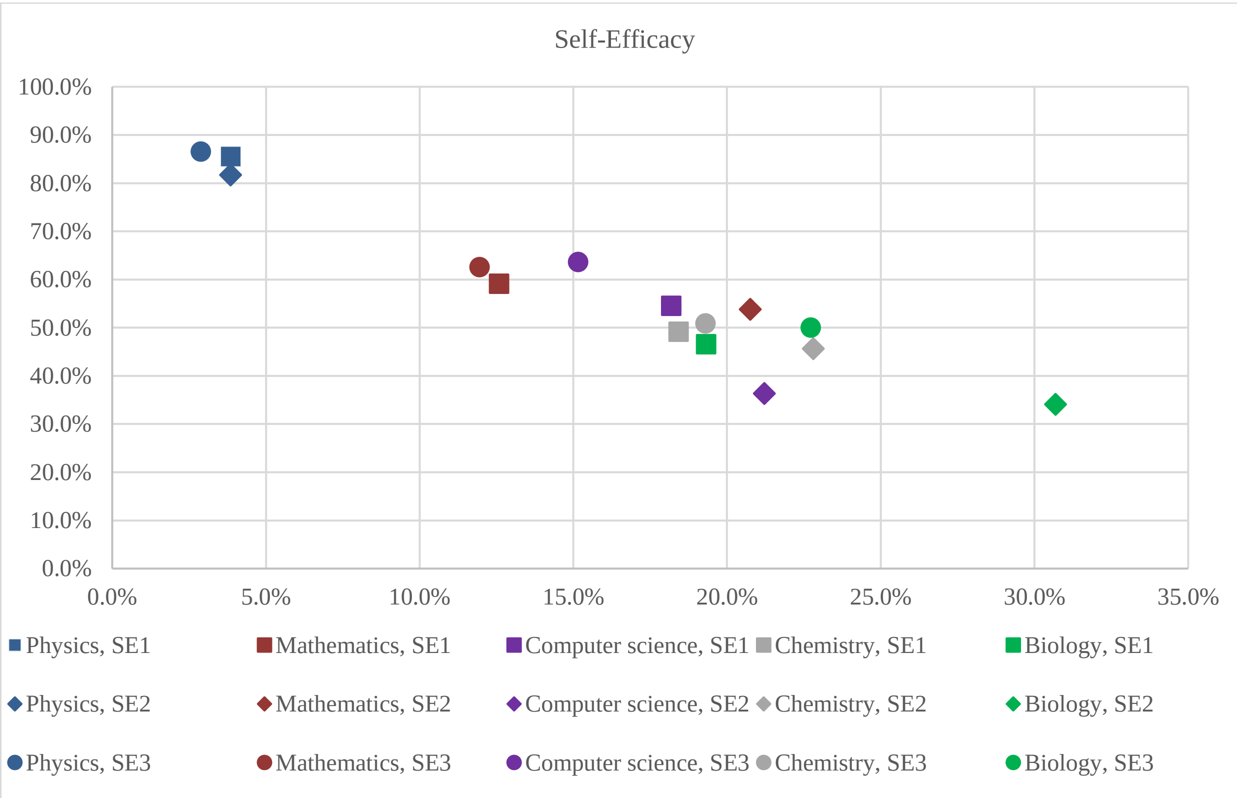

Figure 6. Distribution of percentages of students who agree (vertical axis) and disagree (horizontal axis). The symbols represent the statements. Colored by discipline.

From students who answered the survey, those who chose physics as their first choice agree the most and disagree the least. This is not a surprise; the self-efficacy statements were regarding physics. However, the behavior of the other students' answers is interesting.

Mathematics and computer science students, although different among them, they answered similarly. In both cases, the highest agreement and lowest disagreement are SE3 followed by SE1 and then SE2. That is, "*In physics class, my grades are better than those of my classmates*" is the statement with the highest agreement, followed by "*I am very good at physics*" and then "*My interest in physics is an important part that identifies me*." Even though mathematics and computer science students believe they do better in physics, they do not feel that discipline identifies them.

In the case of chemistry and biology students, they behave similarly and in less agreement to what the results for mathematics and computer science students are. Opposite to what happened to mathematics and computer science students, SE1 is the first, followed by SE3 and then SE2. In every case, for students whose first choice was not physics, SE2 "*My interest in physics is an* *important part that identifies me*” is the statement with the lowest agreement and the highest disagreement.

Perceptions of the importance of physics results

The survey included ten items regarding the perception of the importance of physics. In the same way, as with self-efficacy items, students had to answer whether they agreed or not with the statements. We combined the answers *“completely in agreement”* and “*in agreement*” into the “*Agree*” answer shown in Figure 7. In the same way, we combined the answers “*completely in disagreement*” and “*in disagreement*” into the “*Disagree*” answer as shown in Figure 7. We present the *neutral* choice on its own.

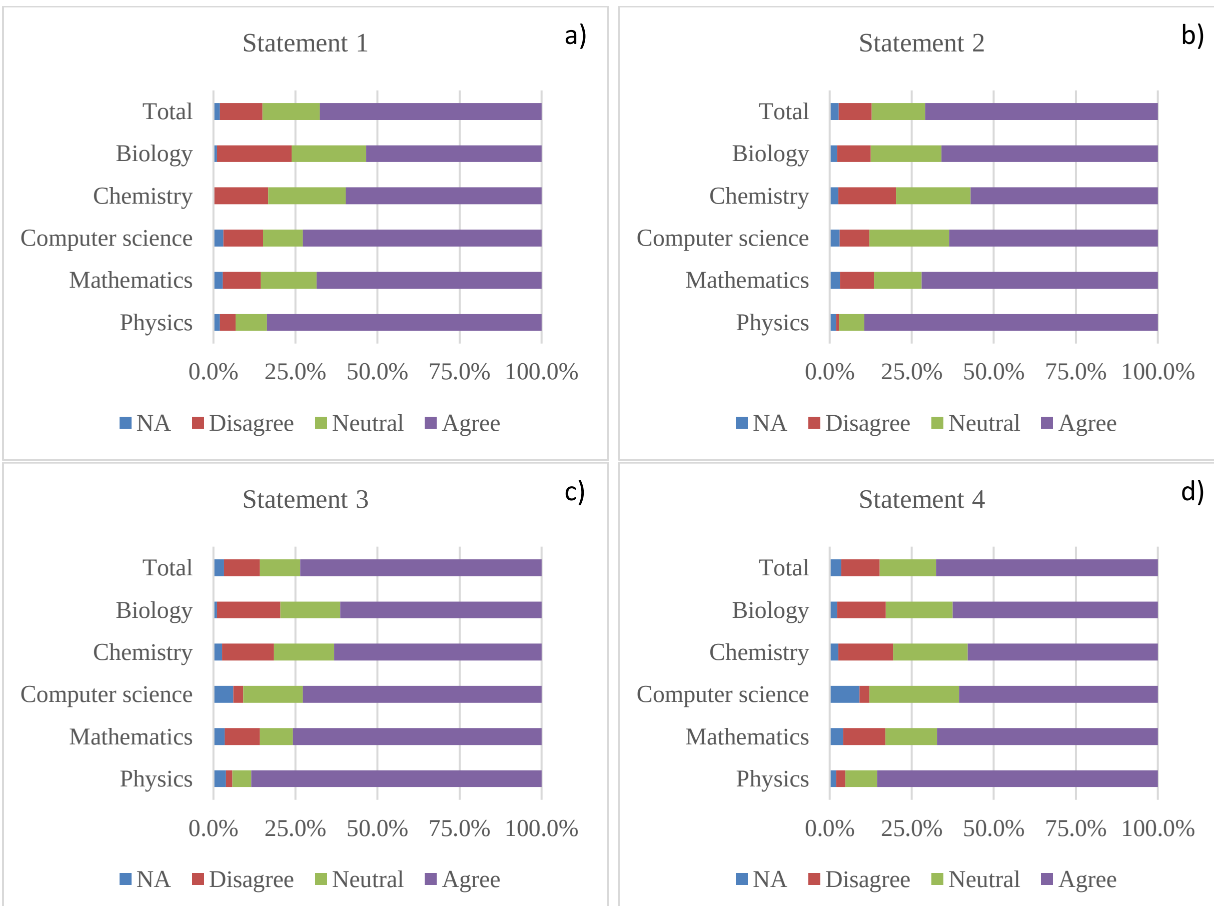

Fig. 7. Distribution of students' answers to the ten statements of the perception of the importance of physics survey. The figure presents disagreement/neutral/agreement for a) statement 1, b) statement 2, c) statement 3, d) statement 4, e) statement 5, f) statement 6, g) statement 7, h) statement 8, i) statement 9, and k) statement 10, according to their first-choice subject.

The first eight items are positive statements, and the last two are negative. In every item, students who selected physics as their first choice answered with better perceptions than those who chose another subject.

However, there are two exceptions, statements 6 and 10. Statement 6 reads: "*I see being able to communicate effectively using physics arguments I am taught as an important skill to have*." In this case, both groups, physics, and computer science students agreed and disagreed similarly. For students who physics was their first choice, 78% of them agreed with the statement. In the case of students whose first choice was computer science, 76% agreed with the statement. They believe that physics arguments are important in their future.

Similarly, in statement 10 "*At some stage during my studies, I have been so overwhelmed by the physics classes that I have considered not studying a career in that area*," physics and computer science students have similar perceptions. This is a negative statement in which 70% of physics students and 67% of computer science students disagreed. All other groups of students had a disagreement percentage between 50% and 59%.

Statement 2 was the highest in agreement for students who chose physics as their first choice, 89.4% agreed with the statement: "*The ways of thinking being taught to me in physics will remain with me long after I graduate*." Opposite to that is the students who chose chemistry as their first choice. For those students, only 57% of them agreed with the statement.

Another way to present results that can give us an insightful perspective of the data uses the dimensions of the perception survey. The professional dimension includes items 1, 7 and 8. Figure 8 presents these results.

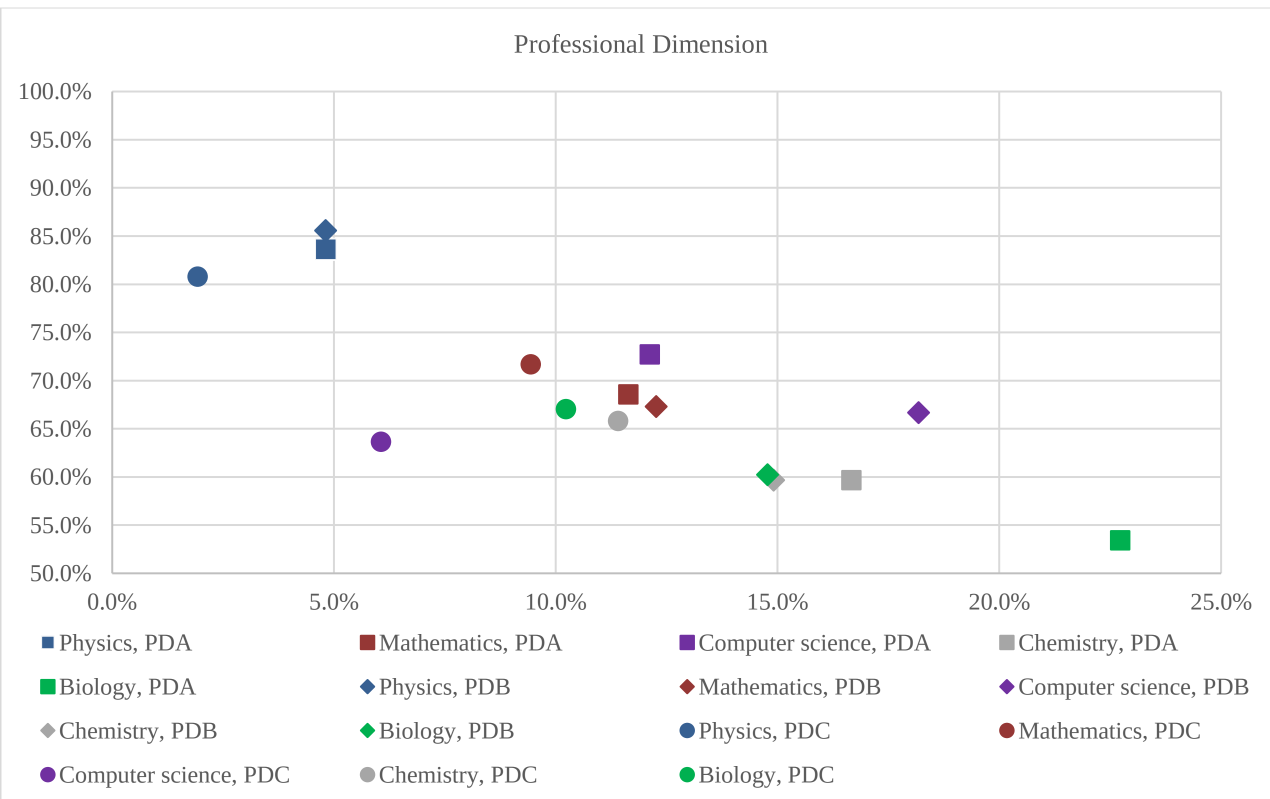

Fig. 8. Distribution of percentages of students who agree (vertical axis) and disagree (horizontal axis). The symbols represent the statements. Colored by discipline.

From students who answered the survey, as expected, those who selected physics as their first choice agreed the most and disagreed the least. However, the behavior of the other groups of students is interesting.

Again, students who chose the exact sciences, mathematics and computer science, behave similarly; the students who selected natural sciences, chemistry, and biology, behave similarly between them and different from the first two groups. For all four groups, mathematics, computer science, chemistry and biology, the highest agreement occurred for statement PDC: "*It is important to learn physics to find a better job*." The second statement is different. For the group of mathematics and computer science it was statement PDA: "*I can see how the physics skills that I am currently developing will be useful in my professional career*", and the third was statement PDB: "*The formal and rigorous aspects that I have learned in physics classes are important for my future professional career*". Contrary to that, for the group of chemistry and biology, the second highest is statement PDB, and the third is statement PDA.

For students who have a strong orientation to STEM, they believe, in general (about 70%), that learning physics is important to find a better job. This proportion is similar, although a little higher than the results presented in [6]. It is also interesting that besides that natural science groups answered lower than exact science groups; the behavior was opposite regarding the second and third statement in this dimension.

For the case of the scholar dimension, items 3, 4 and 5, Fig. 9 presents these results.

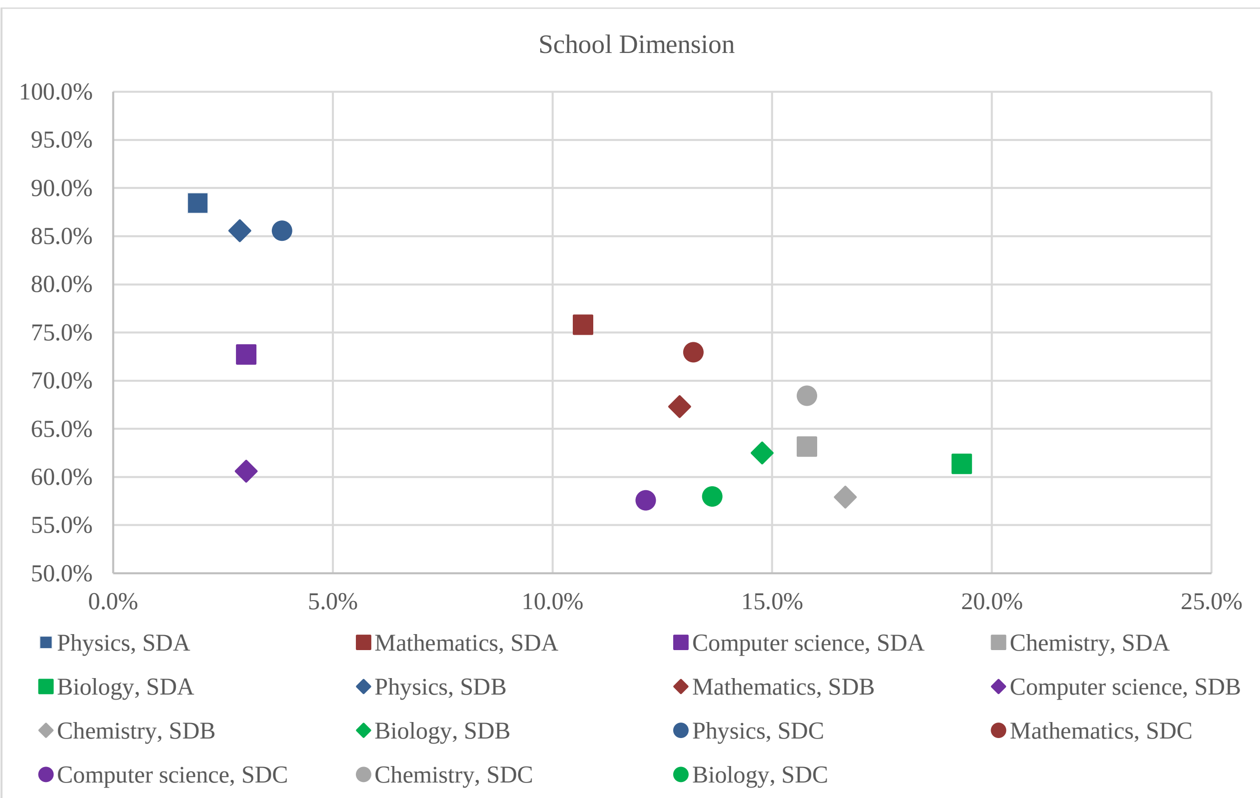

Fig. 9. Distribution of percentages of students who agree (vertical axis) and disagree (horizontal axis). The symbols represent the statements. The colors represent the discipline.

From students who answered the survey, as expected, those who chose physics as their first choice agree the most and disagree the least. However, the behavior of the other groups of students is interesting.

In this dimension, the results are different from those of the professional dimension or self-efficacy questions. Students who chose computer science as their first choice, in two statements, SDA: "*Physics classes are needed for other courses in my future studies*", and SDB: "*Physics classes expose me to ideas which I know I will need later in my future studies*", responded similarly in disagreement to what physics students did, less than 5%. The agreement is different, more than 85% of physics students for both statements, and 73% and 61% of computer science students for SDA and SDB respectively.

For the other groups, one specific result is worth mentioning. The statement SDA: "*Physics classes are needed for other courses in my future studies*," for all groups has the highest score, i.e., high agreement and low disagreement. However, the exception is for those students who chose biology as their first option. For that group, SDA is the lowest score, i.e., low agreement and high disagreement. It seems that for students who tend to like biology better, physics is not as important for their career.

Discussion

One might expect that students who chose physics as their first option score better than other students in both self-efficacy and perceptions of the importance of physics. The results confirmed these expectations. For each statement in both self-efficacy and perceptions of the importance of physics, these students performed better than other students who chose another subject as their first option. Physics-oriented students tend thinking they perform better in physics, they identify themselves more strongly to physics, and feel they get better grades in physics than their classmates. Additionally, these students think that physics is important for their studies and their professional life.

Comparing results, in the self-efficacy items, a significant proportion of physics-oriented students agree with the three statements. The agreement goes from 81.7% in SE2 to 86.5% in SE3. Students from other subjects tend towards agreeing less to those statements. SE3 "*In physics class, my grades are better than those of my classmates*" is the item in which students from other subjects agree the most, 58% on average. Since the statement is about getting better grades in physics than their classmates, this result is evidence that these are high-performance students. Even though these students are, on average, good students in physics (SE1 and SE3), they do not see themselves as someone who physics identifies them (SE2).

There were ten items in the section about the perception of the importance of physics. Statement 2: "*The ways of thinking being taught to me in physics will remain with me long after I graduate*" presents an item which assesses the perception of the importance of physics for life. The majority, 89.4%, of physics-oriented students agreed with it. On the other hand, other STEM discipline-oriented students agreed in a range of 57.0% of chemistry-oriented students to 72.0% of mathematics-oriented students. If we compare these results to [6], (73% for statement 2), we can see that first-year engineering students on that other study have lower perceptions in that statement than that of physics-oriented students in this study, and similar perceptions to mathematics-oriented students in this study. However, students in [6] were engineering students who we do not have the type of orientation they had; students of this study are high school students who we do not know what they will end up studying in college.

In the professional dimension, it is interesting to note two results, statement 7 (PDB) and statement 8 (PDC). The statement PDB: "*The formal and rigorous aspects that I have learned in physics classes are important for my future professional career*" had the highest agreement for physics-oriented students in this dimension. However, the difference to other students was also the greatest. It seems that physics-oriented students like and consider the importance of formal and rigorous aspects of physics, opposite to what other students think. We do not know what career will these physics-oriented students pursue in college, but it seems that they could opt for a physics degree. If we compare these results to [6], (73% for statement 7), the physics-oriented students again have better perceptions than those students in engineering. The difference between the items is that [6] asked for the importance of students' engineering career, instead of the more open form, professional career in this study.

PDC: "*It is important to learn physics to find a better job*" had the lowest performance in this dimension (80.8% agreement) for physics-oriented students and the least difference to the results of other students. In this case, in general, high-performance STEM-oriented students have a high opinion of the importance of physics for their future job. Another evidence to say this is that [6] state that only 63% of engineering students agreed with this statement, a fraction lower than any group in this study.

In the scholar dimension, students, in general, have better perceptions than those in the professional dimension. The highest agreement occurred in statement 3, SDA "*Physics classes are needed for other courses in my future studies.*" Students, in general, realize that physics is important for other courses. However, in this case, engineering students in [6] agreed more with this statement (89%). This could be because for engineering students the question had examples of other courses (mathematics, chemistry, etc.) and that those students were taking those other courses. In the case of students in this study, the question did not specify what kind of courses and the question was more abstract since the statement mentioned "*other courses in my future studies.*"

Statement 4, SDB: "*Physics classes expose me to ideas which I know I will need later in my future studies*," was the item in which the difference in response of physics-oriented and other students was the greatest in the scholar dimension. As many as 85.6% of physics-oriented students agreed with the statement vs. a range of 57.9% for chemistry-oriented to 67.3% for mathematics-oriented students. This statement could be biased by what these other students might study in the future. In the case of engineering students [6], 80% of them agreed with the statement which is lower than the physics-oriented students and higher than the other STEM-oriented students in this study.

Statements 9 and 10 are the only two negative items of the survey. The results are also different between students who chose physics as their first option and those who selected another subject.

73.1% of physics-oriented students disagreed with statement 9: "*For me, in physics, I only want to learn what I feel is likely to be assessed*," while the range of disagreement for the other groups was from 55.3% for chemistry-oriented to 60.6% for computer science students. Only 55% of engineering students reported in [6] disagreed with this statement, which is interesting since those students were already in college. High school students, although high-performance students, had a better perception than engineering students regarding the learning of physics.

We established that there are differences between students who chose physics as their first option and those who selected another subject. The second objective of this study consisted of comparing the differences among students who did not select physics as their first option. The following discussion focuses on that objective. For that, we will refer to figure 6, responses to self-efficacy items, figure 8, answers for the professional dimension of the perception section of the survey and figure 9, responses for the scholar dimension of the perception section of the survey.

Figure 6 presents the three items' results for the self-efficacy section of the survey. Mathematics-oriented students have a better performance on those items followed by the computer science-oriented students. The last two groups are chemistry-oriented and biology-oriented students in that order. These three items represent the most important items regarding students' perceptions of their performance in physics. The items asked them whether they are good in physics, whether they get better grades in physics than their classmates do, and whether physics is a subject which identifies themselves. We found differences among students. Mathematics-oriented and computer science-oriented students outperformed chemistry-oriented and biology-oriented students.

The other issue we observed is the way the items behave within the group of students. For mathematics-oriented and computer science-oriented students, the results are similar. For chemistry-oriented and biology-oriented students, the results are similar. However, the results of the exact science subjects (mathematics and computer science) are different from the natural science subjects (chemistry and biology). Not only the difference is in their performance related to the statements, but also, the way the items behave within the self-efficacy group of items. In the case of the exact sciences subjects, students order form highest to lowest in their responses to the statements are SE3, SE1, and SE2. In the case of the natural sciences subjects, the order is SE1, SE3, and SE2. The exact science results are more similar to those of the physics-oriented students. The difference between SE3 (regarding grades) and SE1 (regarding how good they are) might seem to be subtle. However, what is meaningful is that there are differences between these two group of students (exact and natural sciences) and the exact-science group is closer to the physics-oriented group.

Figure 8 presents the three items for the professional dimension of the perception section of the survey. Mathematics-oriented and computer science-oriented students perform similarly regarding their agreement and disagreement of the statements. Mathematics-oriented students outperformed computer science-oriented students in PDB, the opposite happened in PDC, and they performed similarly in PDA. In the same way, chemistry-oriented and biology-oriented students perform similarly regarding their agreement and disagreement with the statements. Chemistry-oriented students outperformed biology-oriented students in PDA, the opposite happened in PDC, and they performed similarly in PDB. However, what is clear is that exact science groups outperformed natural science groups.

The other issue we observed is the way the items behave within the group of students. For mathematics-oriented and computer science-oriented students, the results are similar. For chemistry-oriented and biology-oriented students, the results are similar. However, the results of the exact science subjects (mathematics and computer science) are different from the natural science subjects (chemistry and biology). Not only the difference is in their performance related to the statements, but also, the way the items behave within the professional dimension items. In the case of the exact sciences subjects, students order form highest to lowest in their responses to the statements are PDC, PDA, and PDB. In the case of the natural sciences subjects, the order is PDC, PDB, and PDA.

Figure 9 presents the three items for the scholar dimension of the perception section of the survey. Mathematics-oriented and computer science-oriented students perform higher regarding their agreement and disagreement of the statements than chemistry-oriented and biology-oriented students. What it is interesting here is that SDA: "*Physics classes are needed for other courses in my future studies*" is a statement in which all STEM-oriented students agreed the most except biology-oriented students, which was the statement in which they agreed the least. It seems that biology-oriented students (and probably future biology-oriented university students) have the perception that their degrees will not need physics.

Conclusions

We had a high-performance group of students in a science contest, where 721 students had the option to participate in up to two disciplines among physics, mathematics, computer science, chemistry, and biology. They had to choose their first and second option to participate. We administered a survey, which 657 students responded. The survey consisted of questions related to a greater project in which we want to assess the factors for young students to choose a STEM major. In the study, we had sections for the demographic data, self-efficacy items regarding physics and perception of the importance of physics group of statements. We used these three sections of the survey for this study. We divided the 657 students considering their first option of the discipline in which they wanted to participate.

We found that physics-oriented students (those who chose physics as their first option) outperformed any other group of students in the self-efficacy items and the perception of the importance of physics items. The results showed that these students responded very high (agreeing to positive items and disagreeing to negative statements) to every item in the survey compared to the other students. They seem to be on the right track regarding their interest and expectations. On top of that, the physics-oriented students responded in a higher proportion compared to others that the final expected degree they would obtain is a doctoral degree. Another evidence of their high performance and high expectations.

The other students who chose mathematics, computer science, chemistry and biology as their first option responded differently among the different groups. There is evidence that mathematics-oriented students are more similar to computer science-oriented students (calling these two groups the exact science group) and that chemistry-oriented students are similar to biology-oriented students (calling these two groups natural science group). There is also evidence that the exact science group students outperformed the natural science group students and that the exact science group students are more similar to physics-oriented students.

This work was focused on self-efficacy related to physics and perceptions of the importance of physics. It is possible that if the focus were self-efficacy related to and perceptions of the importance of another discipline, the results would have been different. That is something we are going to analyze for future reports.

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