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Motivation for fruitful physics learning

Fouad Mounier Yehya[a*], VGJ6+MW7 Université Saint Joseph - Campus des Sciences Médicales, Beirut, Lebanon. fouad.yehia@usj.edu.lb

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Abstract

This research paper attempts to highlight the effect of motivation in the process of learning physics. For that purpose, some factors that affect motivation are described, using as a starting point the answers obtained from a questionnaire given to 68 students in their secondary education. The study adopted the pragmatic paradigm. It was further enhanced as it relied on quantitative research methods to make a critical evaluation of learners' motivation toward physics learning. Quantitative data was collected from a survey that was filled out by learners at secondary schools in Sharjah-UAE. The findings of the descriptive statistics show the major role of factors such as students' interests and awareness towards the importance of physics, the interference of physics in students' daily habits, and teachers' professionalism in engaging students. Finally, recommendations for a teaching methodology are proposed with the intention of future development to be provided for fruitful physics learning.

Keywords: Learning; motivation; motivational factors; physics; physics teachers; students' interests.

* ADDRESS FOR CORRESPONDENCE: Fouad Yehya, Faculty of Education, Saint Joseph University (USJ), Beirut, Lebanon. *E-mail address*: fouad.yehia@usj.edu.lb or Yehya_fouad@yahoo.com / Tel.: +961-3-861063

1. Introduction

Physics is the foundation of many sciences, engineering, and technology fields. Physics generates fundamental knowledge needed for future technological improvements that will continue to drive the economic engines of the world. The role of physics in secondary schools' curricula has increased throughout the world and the necessity of fully understanding it by learners is generally accepted. Understanding its importance and relevance in the real world can motivate students to learn more (Tinedi, et al., 2018). Physics develops learners' higher-order skills and provides trained workforces needed for scientific discoveries (Bao & Koenig, 2019). Nevertheless, how physics is addressed in the classroom is still insufficient which is demonstrated in the results from continuous assessments in comparison with the other communities (Yehya, 2019b). This result is even worse if we focus our attention on literature classes which is classified as having a "low level of physics". In this context, two assertions can be made: We recognize the importance of physics; We are struggling to improve our physics levels, but we are doing it inaccurately.

Regarding the first statement, it is important to mention that the consideration of physics as an essential tool for development has forced policymakers and educational institutions to attach importance to its presence in the learning development of intermediate and secondary classes. Consequently, all learners in intermediate and secondary education are taught physics as one of their compulsory subjects. Furthermore, the Ministry of Education introduced physics for literature classes (the third year of compulsory secondary education) in 2021, which was designed for students who wanted to improve their scientific skills before their graduation and continue their university education. Having discussed the first statement, let's now turn our attention to the second statement concerning the struggle to improve physics learning at the secondary level. We can expect that it is partially accurate because the contemporary measures aren't satisfactory, which is shown in some poor results.

One of the main criticisms of the physics secondary curriculum at the international and national level is that learners spend approximately six years learning physics at school but that few of them end secondary education with a good level (Williams, et al., 2003; Buabeng, et al., 2015; Wulantri et al., 2020) or to be physicist in the future (Akpan & Kennedy, 2020). Consequently, this research will focus on the different factors that affect students' motivation in secondary physics classes to highlight if there is a link between their low physics levels and their motivation.

1.1. Literature review

1.1.1. Motivation and learning physics

Physics is an ever-evolving field that requires dedicated and motivated learners (Yehya et al., 2018). The idea of motivation is a repetitive topic throughout the history of physics teaching that plays an essential role in the learning and success of physics students. This long journey of motivation in the literature of learning highlighted the fact that there is difficulty in describing the motivation and its role in the process of learning physics due to its various definitions. So, it is worth illuminating some of the problematic aspects of the term "motivation". Tokan & Imakulata (2019) summarize that the final process of motivation is completing an action that can provide satisfaction. Hattie et al. (2020) claimed that motivation is not a physical feature that can be observed directly. It is a complex mechanism that reinforces attitudes towards behavior as motivation can be both intrinsic and extrinsic (Norman et al., 2015).

Intrinsic motivation plays a crucial role in learning physics. This has been highlighted in a study by Tinedi et al. (2018), which highlights that students' intrinsic motivation is a major factor in the success of learning physics. The study found that the students who displayed high intrinsic motivation were significantly more successful in their understanding of the material when compared to those who had a low level of intrinsic motivation. This suggests that intrinsic motivation is important in the acquisition of knowledge in physics, as it motivates the student to learn and apply concepts (Arcoverde et al., 2022). Further, the study found that intrinsic motivation increases when students receive support from their teachers and peers, as well as when they are rewarded for their achievements. Additionally, the study found that intrinsic motivation is higher if students find the material interesting and relevant to their lives. This study demonstrates the importance of intrinsic motivation in learning physics and suggests that teachers should take steps to foster it in their classrooms.

On the other hand, Berger and Hänze (2009) have demonstrated that extrinsic motivation can have a significant impact on student success in physics. Extrinsic motivation involves a student being rewarded or punished to influence their behavior and can include rewards such as grades and punishments such as detention. The research conducted by Berger and Hänze (2009) found that students who are extrinsically motivated are more likely to succeed in physics than those who are not. They found that students who were extrinsically motivated were more likely to be engaged in the learning process, to pay attention to their studies, and to complete their assignments. Moreover, the research also showed that students who were extrinsically motivated were more likely to have higher grades and better results than those who were not. This indicates that extrinsic motivation can have a positive impact on student success in physics. Therefore, educators need to consider how to best use extrinsic motivators to maximize student success.

In this context, intrinsic motivation was associated with learners' interests and goals, that is, when they improve a skill for a task because it is their will. In contrast, extrinsic motivation consists of external stimuli that influence students' behavior regarding any subject of physics. Accordingly, both intrinsic and extrinsic motivation play crucial roles in learning physics. Intrinsic motivation fosters genuine curiosity and a love for the subject, driving students to explore concepts and deepen their understanding. On the other hand, extrinsic motivation, such as rewards or recognition, can provide an additional boost, encouraging students to stay committed and persevere through challenges. By binding both types of motivation, learners are more likely to develop a solid foundation and achieve success in their physics education.

1.1.2. Factors affecting learner motivation

A study conducted by Jufrida et al. (2019), and McLure et al., (2022) sought to explore the relationship between students' attitudes and motivation. The study found that there is a significant relationship between the attitudes and motivation of students in physics learning. Dörnyei and Skehan (2003) highlighted four motivating factors that can be summarized in the following: 1-The activities in the teaching/learning process that developed in class. 2- The learners' marks and results since good results are understood as a reward for the learner, whereas bad results are similar to punishment. 3- Internal motivation that is connected to the learner's ideas about the knowledge and skills as a consequence of their prerequisite. 4- Extrinsic motivation via external stimuli such as rewards or punishments.

In the outcomes extracted from Afjar & Syukri's (2020) research about the factors that affect motivation, four indicators were revealed via the ARCS Model that consists of four indicators including attention, relevance, confidence, and satisfaction. Attention attracts students by stimulating their interest and curiosity in understanding the concepts in the teaching and learning process. Relevance to the material presented is to the learners' abilities to solve problems that exist in the materials learned. Confidence focuses on building positive expectations for achieving success among learners and finally, satisfaction provides opportunities for learners to use the skills and knowledge they have just acquired in real-life situations.

Additionally, teachers are the key factor in student learning (Yehya et al., 2019a); Teachers' behaviors are the most influence on learners' motivation to succeed (Yehya, 2020b). Teachers who are disorganized, inexperienced, unfair, and disinterested are likely to interfere with learners' desire to succeed in class (Green & Kelso, 2006; Ekatushabe, et al., 2021). In the same context, Ekiz and Kulmetov (2016) mention the factors affecting learners' motivation in English language education and classified them into four main factors: 1. The teaching and learning environment; 2. The teacher and the applied teaching method; 3. The content of the course; 4. The testing and assessment. The lack of interesting topics, lack of activities, lack of educational technology tools, and incompetence of teachers are the most demotivating factors for students toward learning (Maulana et al., 2023; Alyousif & Alsuhaibani; 2021; Yehya, 2021a).

Moreover, Students' perspective towards a discipline plays a crucial role in the construction of knowledge and their perceptions. Students' perspective toward learning physics is crucial for motivation, meaningful learning, overcoming challenges, fostering long-term interest, and creating a positive classroom environment (Dichev et al., 2020; Mintzes et al., 2020). When students are motivated, engaged in activities, and have a sense of purpose their physics, learning experiences are more effective and meaningful (Yehya,2020a; McLure, et al., 2022; Meccawy, 2023). Consequently, the perspective students develop toward physics can influence their long-term interests and career paths. If students have a positive experience with physics education, they are more likely to perceive physics as relevant, interesting, and applicable to their lives, and they are more likely to engage in deep learning. Educators should strive to nurture and encourage positive perspectives, promoting an inclusive and engaging learning experience for all students.

1.2. Purpose of study

Thus, to fill the knowledge gap about learners' motivation and their perception of physics to achieve a more effective learning experience the following questions are addressed: what is the role of physics in the learner's life? What is the teacher's role in the student's motivation? What are the current factors that affect motivation in physics learning in secondary school in Sharjah-UAE? The coming methodological framework section will reveal the answer.

2. Materials and Methods

The methodological framework below will reveal the research design and the approaches to collecting data for analysis and explanation.

2.1. Research Design

The study adopted the descriptive research design to make a critical evaluation of the level of motivation. The pragmatic paradigm was considered for mixed methods research. Thus, the study depended on both quantitative and qualitative research methods to answer the questions and analyze the results.

In this study, a structured survey with closed-ended and open-ended questions was prepared and used as a research instrument to obtain data relevant to the study's objectives and research questions. The survey was reviewed and modified many times by other researchers and pretested among a small subset of target respondents to check if it serves to collect appropriate comparable data and to determine its feasibility and usefulness as a research instrument. The measures of central tendency (mean M) and dispersion (standard deviation SD) of the descriptive statistics were used to interpret data to generate descriptive information and to lead to significant recommendations.

2.2. Participants

The population that was considered in this study is all the secondary learners in the scientific section in the participating school which form a population of 300 learners from different cultures without gender discrimination. The sample was designated by intentional sampling from the population of the secondary schools. The sample was formed of 68 learners who were in their last secondary year, and their ages ranged from 14 to 17 years without any gender discrimination. Grade 12 learners are selected in this sampling process because learners at this level are aware of their learning and because there is a massive difference in their skill levels and also in their motivation. It can be considered that at this level, motivation as a key factor in the learning process is easier to identify and study.

2.3. Data collection instruments

A survey and period observation were used as two main tools to address the research aims and answer its questions.

The “Survey”, developed by the researcher based on the literature review of previous research and was considered the main measurement tool. It dealt with the factors that affect learners’ motivation. The learners’ names were not requested so that they would answer the questions unguardedly and spontaneously. The survey in its first section focused on participants’ demographic background, whereas the items of the second section were grouped into three different organizational fields: 1- Items connected to physics itself and students’ interest, comprising inquiries about homework and students’ study habits, etc. 2- Items devoted to “physics in the classroom” including items revealing learners’ perspectives towards their classroom. 3- Items related to “physics teachers in physics classes,” with questions about the teachers’ proficiency.

The validity of the survey statements was checked and reviewed by Ph.D. educators and instructors in the related field of study and modifications were made based on their instructions and feedback. Besides, draft copies from this survey were tested with many learners, not part of the sample, to check clarity, and their comments were taken into consideration. Thus, the items are presented, accurately reflect the information the student is being asked about, are closely related to the students and their contexts, and are relevant to the study of motivation. Moreover, the reliability of the questions that deal with learners’ perspectives was measured by Cronbach's alpha. The measure of the internal consistency between the survey’s questions is 0.786. The survey was shared with learners. They were informed that all data will be kept confidential.

Period Observation:

In the field of education, observation is a vital tool for data collection, usually as a supplement to other techniques. The observation used in this investigation is non-systematic that searches for the Level of interaction in the physics classroom.

2.4. Ethics and procedure

The survey was emailed to the school principal, who in turn accepted its distribution to learners. Also, learners and school physics teachers were met to be informed about the aim of the research and the observation period. The collected data from both surveys and observations were analyzed, and the findings were shown in the "Results" section.

2.5. Data Analysis

Data that were collected from the survey was managed using the Statistical Package for Social Sciences (SPSS v19) which is one of the most popular databases used in research. Descriptive statistics were used in summing the data including percentages, frequencies, means, and standard deviations. For the qualitative data due to the period observation, charts were designed to collect data.

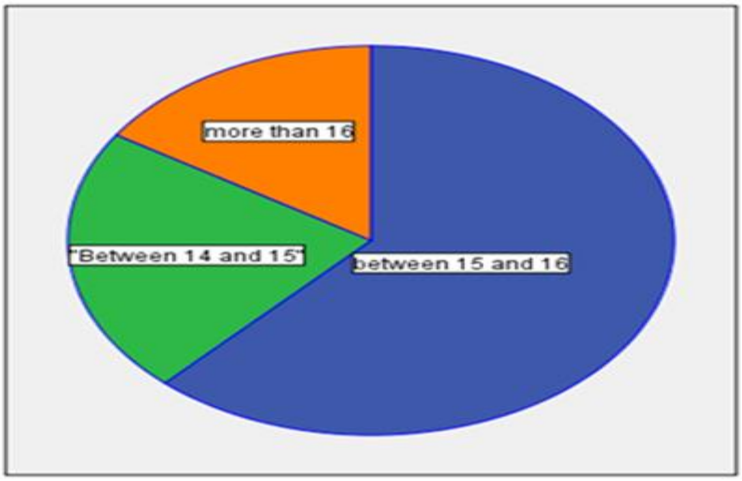
3. Results

The following section reveals the results quantitatively and qualitatively in the context of the research questions to finally come up with a discussion that investigates physics learning motivation.

3.1. Personal Information

The average age of the participants in this research (figure 1) is 15 years, which means the average age is appropriate for the level of grade 12 (15–16 years).

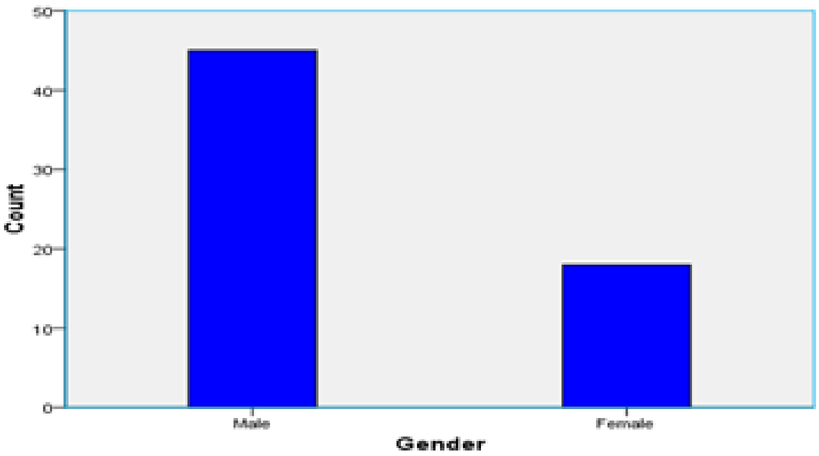
Figure 1
Learners' age



Regarding students' gender (figure 2), there were a total of 68 students, 45 males (66.2%) and 23 females (33.8%). The greater number of male students compared to the female students, if it has any statically meaning, is outside the concern of this study.

Figure 2

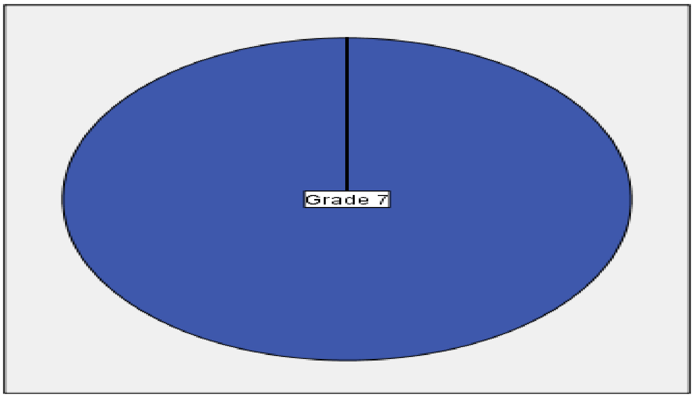
Learners' gender



Also, the demographic data (figure 3) shows that all students of the sample (100%) began to study physics in the elementary school in` grade 7 (10-11 years); learners may have a better understanding of the concepts of physics if they are aware of physics subjects at elementary level due to the amount of exposure. Hence, the age and the amount of input can be determining factors in learning physics.

Figure 3

Learners' first physics course

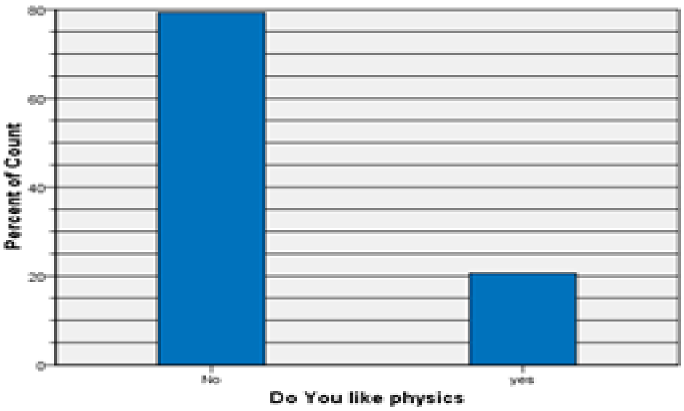


3.2. Students' perception of physics

This section of the survey is essential to describe students' general perspective and their motivation towards physics itself as a subject in their life. Determining whether or not students have an affinity for physics is a crucial factor, as those who enjoy the subject are typically more inclined to be motivated in their learning compared to those who don't. Learners (N=68) have answered the question "Do you like physics in general?". Results show that 21% of the students liked physics, and the remainder (79%) did not (figure 4).

Figure 4

Leaners' attitudes toward physics



Moreover, participants (N= 68) replied to the survey's section that deals with physics as a subject and learners' interests. This section was formed of 10 statements about students' interest in their physics courses with a Likert scale format consisting of 5 points distributed as follows: (5= Strongly agree; 4= agree; 3= neither agree or disagree; 2= disagree; 1= strongly disagree). Unanswered statements were indicated with 3 and considered as neither agree nor disagree. The mean "M" and the standard deviation "SD" for each statement were calculated and accordingly, the results were presented in (Table1). The analyses of the results were based on the following criteria:

- A mean score less than 2 (M< 2) out of 5 is regarded as a significantly low mean.
- A mean score between 2 and 3 (2 <M < 3) out of 5 is considered a low mean.
- A mean score between 3 and 4 (3< M< 4) out of 5 is considered as medium mean
- A mean score greater than 4 (M>4) is considered a very good mean

Table 1

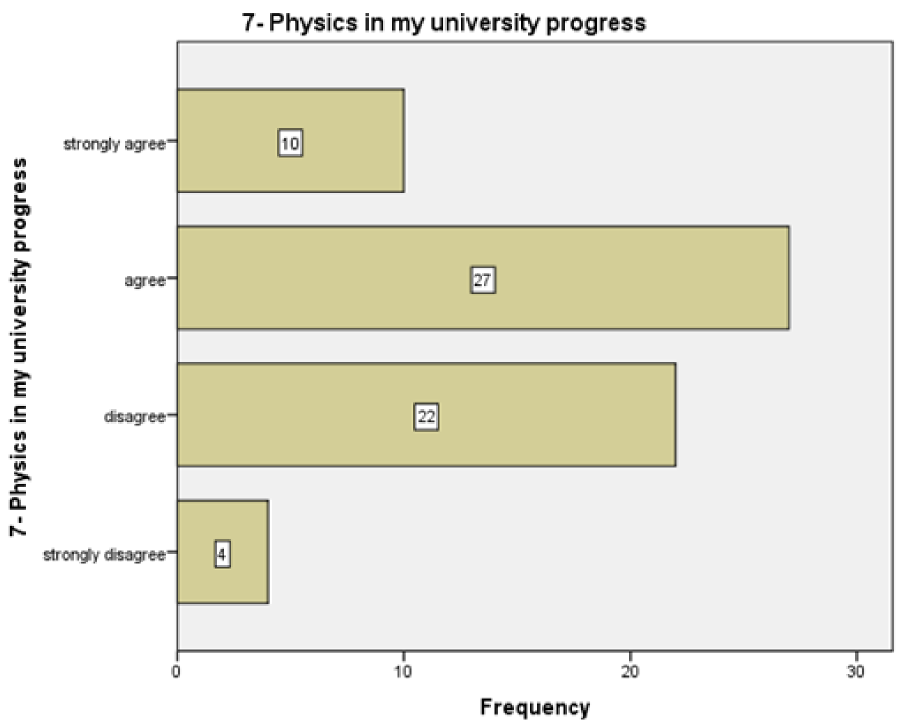
learners' interest in physics

Report	Mean	N	Std. Deviation
1- Physics itself is interesting, easy, beautiful, etc	2.46	63	.895
2- Physics is boring	3.24	63	1.088
3- Lot of laws and theories	2.59	63	1.159
4- Knowledge related to real life	3.10	62	1.238
5- Skills related to real life	3.00	63	1.283
6- Technology in learning physics	2.70	63	1.186
7- Physics in my university progress	3.32	63	1.280
8- Opportunities in the future.	3.25	63	1.150
9- Physics every day	2.62	63	1.184
10- physics with my family.	2.62	63	1.184

In general, the results for students' interest in physics classes revealed that students didn't feel physics itself was an interesting, beautiful, and easy topic (M=2.46; SD= 0.8). Most of the students' answers are related to specific aspects of physics such as its difficulty, the required effort, and so forth. Results revealed that students did not see its importance in their daily life. They described physics topics as boring because of the repetition of physics topics at the secondary level (M= 3.24, SD=1.08). We can say that students usually like physics not as a theoretical subject but as knowledge (M=3.10; SD= 1.2) and skills (M= 3.0; SD= 1.2) related to students' real life. It is also significant to mention that 37 learners out of 63 (59%) intend to improve their physics levels (figure 5) because they are aware of its current importance in their university progress (M=3.32; SD=1.2).

Figure 5

Improving Physics level in university



Additionally, 59% of the learners in the sample (figure 6) think that physics can give better opportunities in the future (M=3.25; SD= 1.1).

Furthermore, the results (figure 7) showed that despite the massive presence of the Internet in students' lives and the vast simulations and YouTube videos that they can now access, they haven't gotten its benefits for learning physics. Nearly 66% of the students responded that they were not accustomed to watching YouTube and using interactive simulations in physics (M=2.7; SD =1.1).

Figure 6

Physics as a future opportunity

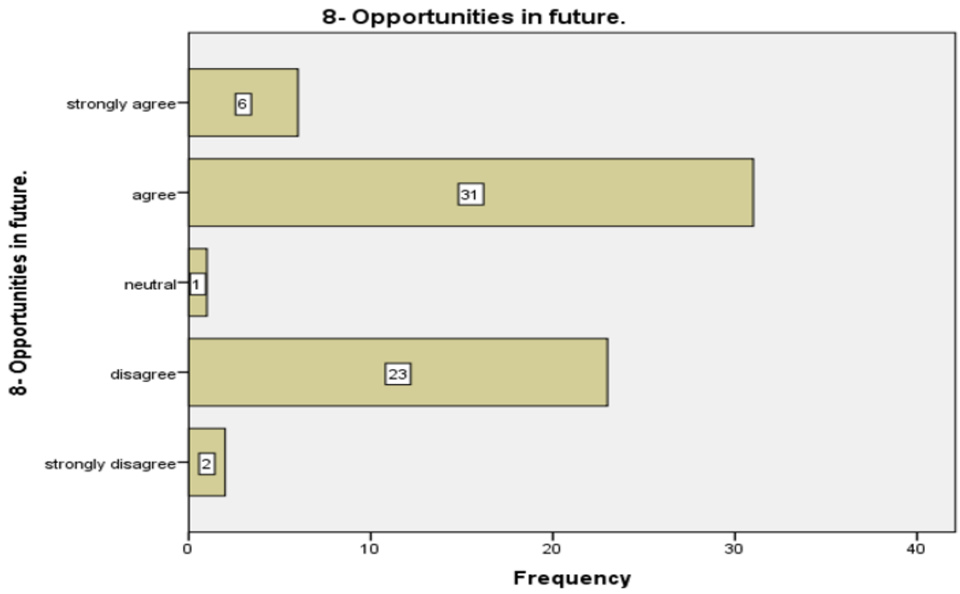
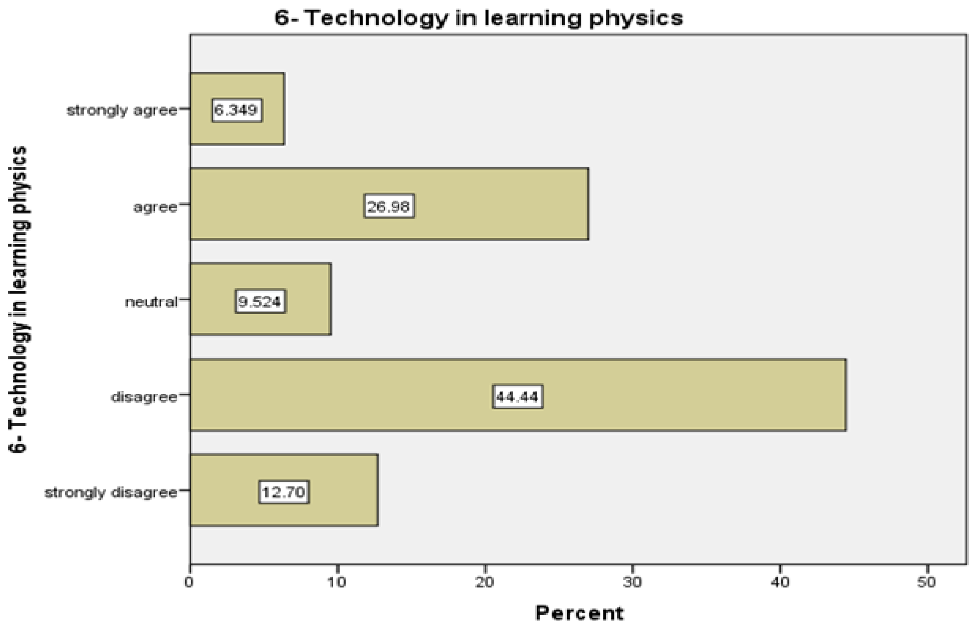


Figure 7

The usage of technology in Physics courses



Pearson's r for the correlation (Table 2) shows that there is no statistically significant correlation between students' liking for physics and their use of technology in learning physics (r = 0.064 and the Sig (2-Tailed) value = 0.618). The result shows that the students who may use educational technology to learn physics are not those who confessed that they like it.

Table 2

Correlation between student's physics like and the use of technology

Correlations

		Do You like physics	6- Technology in learning physics
Do You like physics	Pearson Correlation	1	.064
	Sig. (2-tailed)		.618
	N	63	63
6- Technology in learning physics	Pearson Correlation	.064	1
	Sig. (2-tailed)	.618	
	N	63	63

The question that is related to the students' habits about studying physics at home shows that only 19% of the students usually study physics every day (figure 8). Another interesting point is students didn't use their knowledge and skills in physics to discuss natural phenomena with their families (figure 9).

Figure 8

Study physics everyday

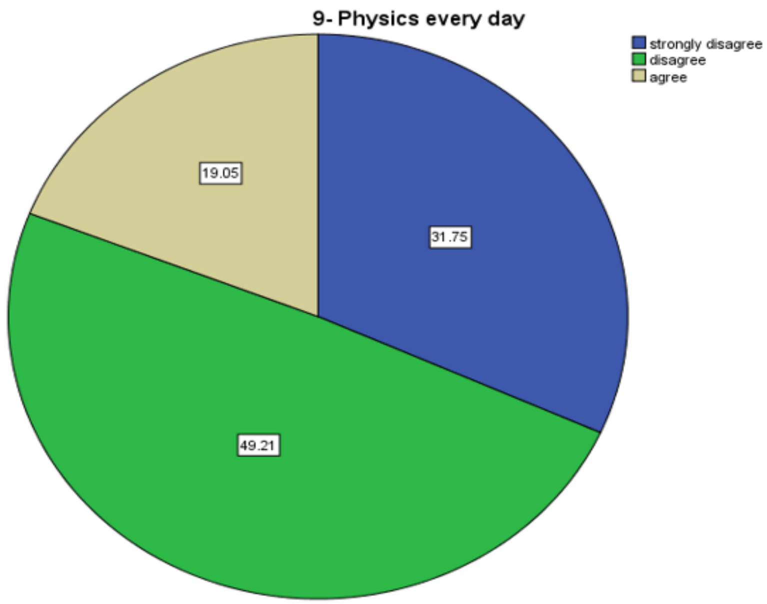
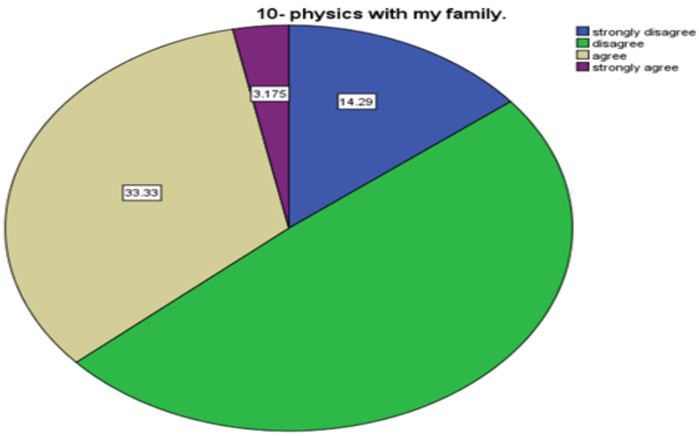


Figure 9

Using Physics to discuss natural phenomena



3.3. Learners' Perception of Physics in the Classroom

In this section, the point of interest is the connection between students' opinions about physics and how it is approached in the classroom. Students had to describe the characteristics of their physics classes.

The results (figures 10,11, 12, and 13) show that most students showed positive adjectives in describing their physics classroom, such as interesting (65%), useful to daily life activities (60.2%), funny (54%), and innovative (58.7 %). Moreover, it is interesting to highlight that only 42.7% of the students considered their physics classes difficult (figure 14).

Figure 10

Physics in the classroom is interesting

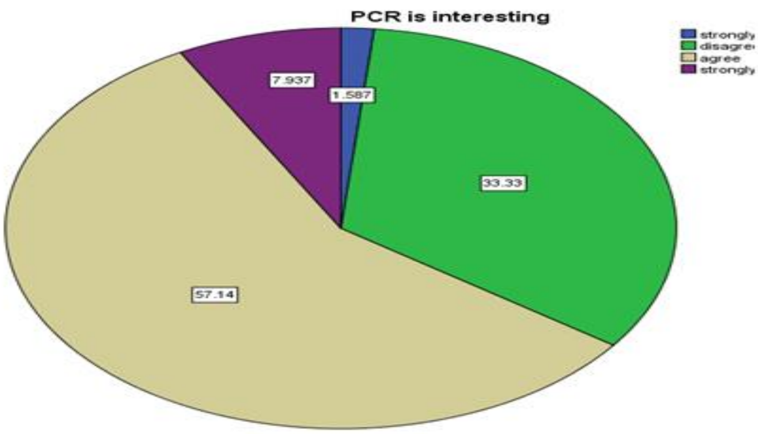


Figure 11

Physics in the classroom is useful to understand daily life activities

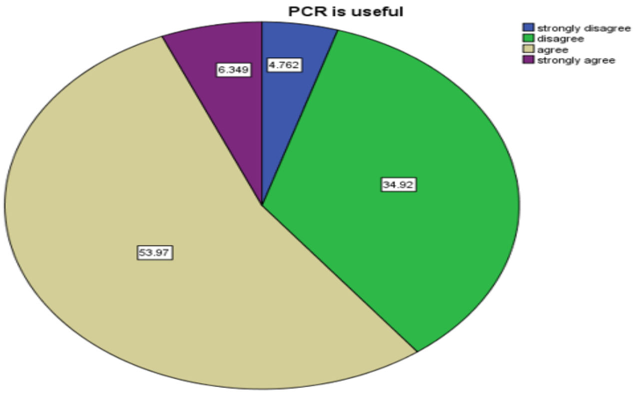


Figure 12

Physics in the classroom is funny

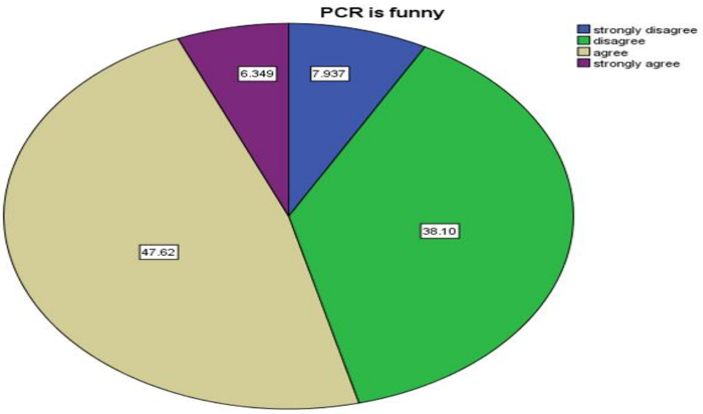


Figure 13

Physics in the classroom is innovative

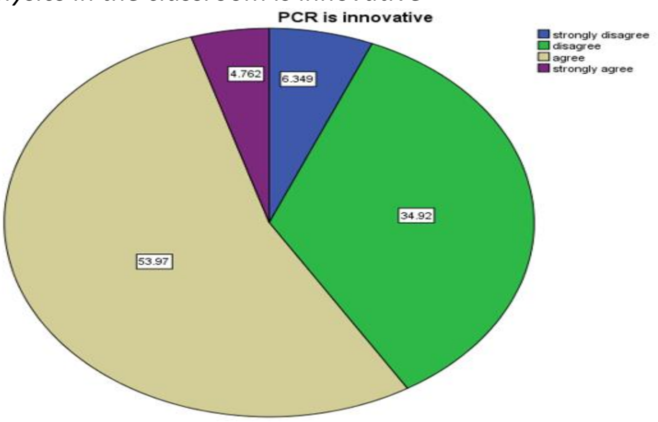
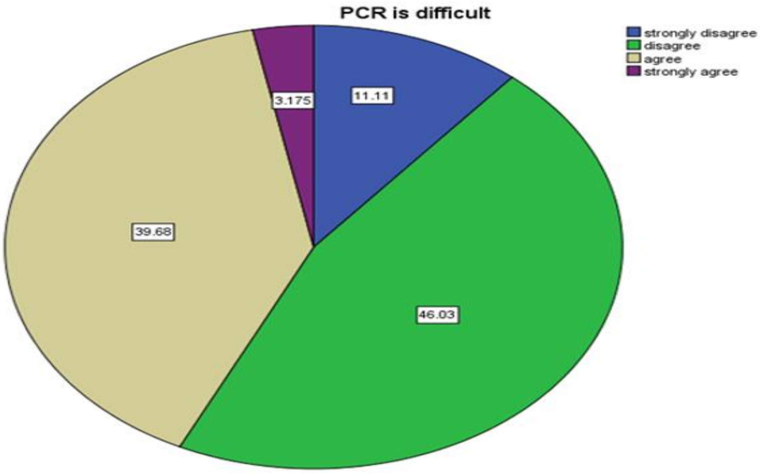


Figure 14

Physics in the classroom is difficult



The students were also asked about the characteristics of a good physics teacher. These are the results: "having a good level of physics" (88 %), "being strict" (27%), "making participative lessons" (66.7%), and funny lessons (78.8%). At the end of the list, they included characteristics such as lenient (8%), and "don't ask for homework or give homework" (15%). As a final point, students had to answer questions about the skills that can be acquired in physics courses. The results were presented and explained with students' justifications. Most of the students (80%) consider Communication during the pear-pear interaction and teacher-student interaction as the most important skill, mainly because they think that it is the skill, they will use most often in real life to communicate. (50%) of the students mentioned problem-solving and decision-making as important skills that engage them in the learning process and prepare them for the challenges of real life. In this reasoning, we can recognize how students understand physics mainly as a tool for problem-solving, one of the main characteristics of the decision-making approach. Nevertheless, although students recognize the importance of problem-solving skills, they consider it as the most difficult skill.

4. Discussion

The most significant results of the factors that affect motivation in the study of physics in grade 12 are highlighted in this section. It was discovered that currently, students are aware of the importance that physics will have in their futures. A strong understanding of physics can be valuable in many careers, including those in science, engineering, and technology. Therefore, one of their primary motivations to learn physics is to have better opportunities to attend universities and get better opportunities in the future job market.

Most of the students in this research have the intention to improve their physics knowledge and skills, and most of them have clear plans for this approval. Another important factor that affects their motivation levels is the idea that physics is present in every aspect of their daily lives. Consequently, they recognize that physics is present in many aspects of their real life, and they can discover its principles and applications by exploring their surroundings. Students can see physics by observing the expansion and contraction of materials, in the movement of objects, playing sports, riding a bicycle, or driving a car. They can see physics by observing the behavior of liquids and gases, such as water flow, air resistance, and buoyancy. They are becoming familiar with the concept of hearing through echoes, and musical instruments, and to the concept of gravity by experiencing the sensation of weight and understanding why objects fall when dropped. Also, they are discovering electricity and magnetism using electronic devices such as smartphones and computers, and observing the interaction of magnets. Additionally, they are discovering optics by observing the reflection and refraction of light by mirrors, lenses, prisms, and so on.

Additionally, how other factors in their lives and their classrooms may affect their motivation was studied. Specific factors were considered, such as the following:

The role of physics in students' lives. As was mentioned before, physics is present in nearly every hobby, and therefore, it plays an important role in students' lives. Driving a car involves understanding the principles of acceleration, momentum, and friction, cooking involves understanding the principles of heat transfer and thermodynamics, while sports involve understanding the principles of motion and force. Despite this, some students are likely to use it to discuss some natural phenomenon with parents and friends and are not afraid of it, but a small part of them are still on guard. Moreover. the results show us that students are more motivated when the focus of the lesson is on skills; they do not enjoy a high emphasis on theoretical aspects and they missed some extra practice in other skills such as hands-on activities and laboratory skills. Most students agree with the idea that the most important (or at least the most useful) skill is problem-solving, and therefore, they are ready to learn more and enjoy more in lessons in which this skill plays a central role. In contrast, more than half of the students agree with the fact that mathematical concepts in physics are the most difficult aspect of learning physics. It is not necessary to discuss the importance of physics in this process, and consequently, it cannot be neglected, but it can be approached in different ways, likely in ways that are more related to students' interests.

The teacher's role in the student's motivation levels. This is likely the factor that was most directly related to students' motivation in the classroom. The students' responses showed that in general, they preferred teachers with good physics levels, although this was not a determining factor for them, and they didn't show any teacher age preferences. Yet, from the students' points of view, some factors are important such as having good experience in teaching, having good communication and interaction, and making funny and participative lessons. Because of this, we can observe that students are more motivated by teachers who show proficiency in their subject and who teach it through funny and participative activities. Apart from these results, specific student comments showed the importance of the teacher in their learning of physics.

Other factors such as the importance of games and diversity in the materials used in class. In general, most students like the use of new educational technology tools in class to improve their learning opportunities. The challenge in students' motivation in physics classes refers to proposing a methodology that contains all of these factors to give students more reasons to be motivated. Some guidelines are proposed here to consider in developing future work:

It is important to follow an experiential approach to the theory because experiential learning is often more engaging and enjoyable for students compared to traditional lecture-based approaches. It brings an element of excitement, curiosity, and discovery to the learning process. Consequently, this increased motivation and engagement can lead to higher levels of student participation, enthusiasm, and overall academic achievement in physics. Moreover, experiential learning promotes the development of critical thinking and problem-solving skills. specific time should be devoted in each lesson to hands-on activities that "force" students to use the concepts to solve real-life situations.

5. Conclusion

Through hands-on activities and experiments, students are encouraged to explore, analyze, and evaluate data, make observations, and draw conclusions. This process enhances their ability to think critically, approach problems from different angles, and devise creative solutions. The use of authentic materials, similar to what students will have to face in real life, is important. In this way, they will understand physics as a real tool for their personal development. By actively manipulating objects, conducting experiments, and observing outcomes, students can build mental models that facilitate conceptual comprehension.

It would also be interesting to follow a task-based approach because each task can be oriented to a specific field of the student's interests, and in each of these tasks, different materials can be used. Then, all tasks should lead to a final task in which students must demonstrate what they have learned. This is also a stratagem for considering attention to diversity, referring to the differences between higher and lower achievers. Additionally, results have shown that students feel sometimes demotivated because of the repetition of concepts in their learning process. Thus, the idea of scaffolding is important in this issue, that is, building students' new knowledge in connection with their prior knowledge to avoid the problems students reported about repetitive content each year without learning anything new. Scaffolding is also essential for students at lower levels because if a teacher knows a student's starting point, it will be easier to target new concepts to that student.

Regarding the classroom itself, teachers must encourage and foster the intrinsic motivation of their students in the learning experience. Accordingly, teaching should be with kindness and enthusiasm and the class should be organized to create a positive attitude in the classroom. Creating a positive working atmosphere, encouraging students' performance, and avoiding tension and anxiety in the classroom. Thus, they will be intrinsically motivated to explore, apply knowledge and take responsibility for their learning.

Finally, learning physics is a challenging journey due to its abstract nature and complex mathematical concepts, and a positive mindset helps students develop problem-solving skills, critical thinking abilities, and resilience, which are essential not only in physics but in various aspects of life. Thus, it's important to keep students motivated and persistent in their efforts to master this exciting subject.

The main limitation of this study is the data collection process. Data collection was very exhausting and challenging. A delay in responding to the survey questions and sometimes ignoring the survey was the main constraint of this study.

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