Exploring the evolution of student interest: Investigation of the scientific aspects of learning physics towards renewable energy

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Abstract. Science teaching in today's schools has important scientific implications for attracting students and ensuring continuous, sustainable, and successful schooling, across the different components of the education system. These implications are mainly linked to the development of scientific literacy among all students. The present work highlights the interest of Moroccan secondary school students in physics as an important discipline in the science field. The main objective of this research is to explore the changing interest of these students by identifying environmental education and the mathematization of physics as an important scientific context in learning the discipline. To achieve this goal, we conducted an empirical study among students in the Fez-Meknes region of Morocco. The results showed that exploring the mathematization of physics can develop students' interest in the discipline. In addition, the engagement of physics with environmental education will influence favorably the students' understanding and therefore motivation for scientific careers in mathematical modeling of environmental systems.

Index Terms— Environmental Education, Interest, Learning, Morocco, Physics, Renewable Energy, Scientific aspects, Student.

1 Introduction

The representation of modern education should emphasize the connection between students and the subjects they study, as well as the quality of teaching and learning. Today's schools need to integrate evaluative educational processes into their programs that consider all the factors involved in students' engagement with science [1]. Students' interest in science has become an important and ongoing concern for education systems worldwide [2]-[4].

The relationship between students and science requires a reflective pause to explore the concept of students' interest in learning science. This exploration can lead to a better understanding of students and their learning processes, and to the development of an education system that prepares young people to meet the demands of global scientific progress [5], [6]. Consequently, the increase in interest in science will positively influence students' understanding of scientific subjects and their motivation to pursue a scientific career in the long term [7], [8].

Most researchers in this field generally treat science as a homogeneous discipline, or focus solely on a specific curriculum subject [9]. Unfortunately, studies focusing specifically on students' interest in physics are rare, especially in the Moroccan context. Similarly, each scientific discipline, such as physics, has unique characteristics compared with other subjects in the same disciplinary field, such as mathematics and the environment [10]-[13]. Understanding these specific features is crucial to the present study, which places physics as an important discipline in science education.

The integration of environmental education, such as the study of some renewable energy systems, is a means of evolving students' interest and aspects of physics learning [14], [15]. Thus, how can renewable energies be integrated into developing a stronger student interest in physics?

Focusing on tangible examples, such as solar and hydroelectric power, we can help students grasp fundamental physical concepts while raising their awareness of environmental and sustainable development issues related to these energy sources [11], [14], [15]. This approach promotes a deeper understanding and increasing motivation among students, encouraging them to pursue their studies in physics. In addition, integrating environmental education into physics teaching gives students a greater appreciation of sustainability and environmental preservation, preparing them to become responsible citizens dedicated to protecting our planet [16].

By incorporating mathematical principles into the study of renewable energies [11], [12], we can improve our understanding of these systems, optimize their performance, and contribute to their sustainable development. Mathematization not only deepens our understanding of these systems but also enables us to use renewable resources more efficiently and responsibly to meet our society's current and future energy needs.

2 Methodology

2.1 Participants

The research sample is made up of 70% girls and 30% boys. **Fig. 1** shows the distribution of the target population according to current educational level.

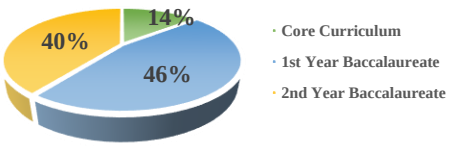

Fig. 1. Students' distribution according to their current level of education.

2.2 Collect and analysis of data

To achieve our research objective, the present study used a questionnaire consisting of 6 items. The questionnaire was designed in Arabic and French, which are the languages used for teaching and learning in Morocco. It aimed to assess students' interest in physics in the Moroccan context. The questionnaire was administered using Google Forms. It was distributed to a group of eligible secondary school students in the Fez-Meknes region, Morocco. Students were informed that the questionnaire was anonymous and unrelated to their studies.

The data from this research will be presented along two main axes. The 'Axis 1' relates to the place of physics in the science curriculum. 'Axis 2' focuses on the relationship between physics, mathematics, and the environment and its impact on students' interest in learning the subject. **Table 1** summarizes the questions of the first axis.

Table 1. Items to the questionnaire Axis 1.

	Questions	Proposed Answers
Axis 1	(Q1): The subjects I like most at school.	Languages
		Science
		Other
	(Q2): The reasons why I prefer these subjects.	Are highly accessible and easily understood.
		Offer engaging and enjoyable content.
		Align with my personal preferences and fulfill my needs.
		Other
	(Q3): Of all the science	Strongly disagree

	subjects, physics is the most interesting.	Disagree
		Agree
		Strongly agree

Fig. 2 summarizes the results of the first question Q1 concerning students' order of preference for a scientific specialty. Among them, 80% of students chose sciences: Physics, Biology, Math ... On another hand, 17% preferred languages: English, French, Arabic..., while 3% of students ticked Others. This choice was made in a way that students can specify their choice. The results showed that computer science and philosophy are also preferred by the target population.

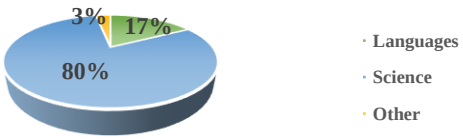

Fig. 2. Percentages of students' responses regarding their subject's preference.

These students justify their choice by the fact that science is very accessible and easily understood (34%), offers engaging and enjoyable content (32%), matches their personal preferences, and meets their needs (21%). Also, 13% of students ticked Others: develop their scientific mind (8%) and have captivating and entertaining material (5%) (**Fig. 3**).

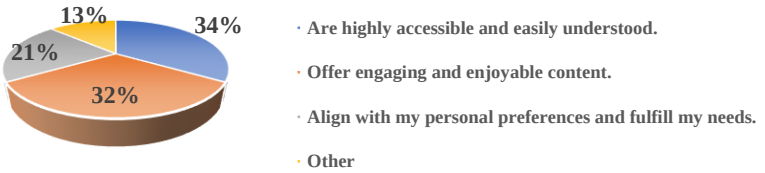

Fig. 3. Percentages of students' responses regarding the reasons why they prefer these subjects.

On another hand, around 89% of students find physics fascinating compared to other subjects in the same scientific field (41% agree and 48% strongly agree). In contrast, only 11% of students disagreed (9% disagree and 2% strongly disagree) (**Fig. 4**).

Fig. 4. The percentages of students' responses regarding their physics interests.

Table 2 summarizes the questions of the second axis:

Table 2. Items to the questionnaire Axis 2.

	Questions	Proposed Answers
Axis 2	(Q4): The physics I learn in school is always related to environmental education.	Strongly disagree
		Disagree
		Agree

	Strongly agree
(Q5): Physics could be a profession in my future.	Strongly disagree
	Disagree
	Agree
	Strongly agree
(Q6): The relationship between physic, environment, and mathematics influences my scientific interests.	Strongly disagree
	Disagree
	Agree
	Strongly agree

In contrast, students' responses for *Axis 2* indicate that their preference for physics can lead to interest or disinterest in the subject. A majority (77%) of students disagree that physics learned at school is always linked to environmental education (42% strongly disagree and 35% disagree (Q4)) (**Fig. 5**).

Fig. 5. The percentages of students' responses regarding the application of environmental education in physics learning.

On another hand, student's interest in a career in the same scientific field can be correlated with success in that field (Q5): Around 81% of students agree (51% agree and 30% strongly agree). In contrast, only 19% of students disagreed (10% disagree and 9% strongly disagree) (**Fig. 6**).

Fig. 6. The percentages of students' responses regarding their environment, mathematics, and physics interests.

In question 6, we asked students to analyze the relationship between physics, mathematics, and the environment: 56% of students agreed that the relationship between physics, mathematics, and environmental education influenced their interest (36% agree and 20% strongly agree). On the contrary, 44% of students disagree (30% disagree and 14% strongly disagree) (**Fig. 7**).

Fig. 7. The percentages of students' responses regarding their physics interests.

3 Results

For question (Q1) concerning the order of preference, the results show that students prefer science (**Fig. 2**). These students agree that physics is an interesting subject compared

to all other subjects in the same scientific field (**Fig. 3**). Indeed, research into the teaching of physics shows that it is a subject that draws on perspectives from several disciplines at once, such as mathematics and the environment. However, results show that students' engagement with science can be influenced positively or negatively by formal school experiences such as an easy understanding of physics content and informal practices of the discipline outside the classroom. This confirms that an increased interest in science has a positive impact on students' understanding of scientific subjects and their motivation for a long-term scientific career in the context of environmental education (**Fig. 4**). The results also show that students' preference for physics can be the source of interest and/or disinterest in the subject (**Fig. 7**). In this context, student interest in this research is based essentially on the practice of these disciplinary fields of mathematics and the environment in learning physics (**Fig. 6**).

The results confirmed that the higher the level of interest in science, the greater the positive influence on students' understanding of scientific subjects and, consequently, on their motivation to pursue scientific careers in the long term. Our study takes an interest in physics as its central object, noting the scientific challenges of the discipline of environmental education, which is a real issue for current learning in the discipline (**Fig. 5**).

Analysis of the results is particularly relevant in the context of teaching physics. This suggests that students show an interest in environmental education in physics. It is essential to take this perception into account in the teaching of physics in the Moroccan curriculum.

4 Discussion

The present research highlights the interdisciplinary nature of physics, involving other components such as mathematics and the environment [13]. Thus, students' engagement with science, including physics, is influenced by their understanding of the subject and their informal experiences [17]. The study focuses specifically on physics and recognizes the significant relationship between physics, mathematics, and environmental education, which is a crucial factor in learning the discipline.

The integration of mathematics into physics is not new and plays an essential role in various aspects of physics, including equations, formulas, and problem-solving [18]. While students often consider that mathematics makes physics difficult, the intertwined nature of the two disciplines throughout the history of science is well established [19]. The integration of mathematical knowledge and skills is necessary to understand and solve physics problems. The complexity does not lie in students' ability to produce correct mathematical answers, but in their interest and motivation to continue solving physics problems [20].

In this sense, physics forms the basis for understanding the fundamental processes underlying renewable energy technologies [11], [12]. Mathematical models and simulations are used to describe and predict the behavior of these systems [7], [8], [21]. Mathematical equations and techniques help to analyze variables such as energy conversion, efficiency, and optimization of renewable energy systems [22].

The close links between physics, mathematics, and environmental education are complex for training and teaching, which reflects the challenges posed by their representation in the curriculum [23]. Research into the mathematization of physics and environmental education emphasizes that the complexity of physics goes beyond a student's

ability to produce correct mathematical answers for specific problem situations, as well as renewable energy systems.

5. Conclusion

In this study, we developed and validated a questionnaire that considers students' interest in physics at school. The empirical study of this work affirms that the interdisciplinarity of mathematics and physics has an impact on changing Moroccan students' interest in learning the discipline, acquiring a scientific culture to keep up with the current scientific advancement, and to pursuing a scientific career.

The mathematization of physics is closely linked to renewable energies. It enables the modeling and analysis of renewable energy systems, the formulation of equations to describe the physical phenomena involved and forecasts and simulations for renewable energy planning and integration. By integrating mathematization, we deepen our understanding of systems, optimize their performance, and promote their sustainable development by harnessing renewable resources efficiently and responsibly to meet current and future energy needs. The results of this work call for reflecting on the kind of school-based interventions allowing to develop students' interest while promoting the learning of physics in the Moroccan context.

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