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Investigating the relationship between students' interest in physics and environmental attitudes in Georgia

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Abstract

This paper presents some aspects of the relevance of physics education from a Georgian perspective. Students' interest in physics is currently an important issue for effective learning and teaching in many countries. We report about the results of an extensive physics students' survey at the end of compulsory education and the beginning of upper secondary school in Georgia. Students' interest in physics was investigated in different contexts regarding 'out of school' experiences, attitudes toward environmental issues, and science and technology. Girls conveyed a higher interest in physics than boys. Some correlations are found between students' interest in physics and respect for environmental issues, nature, and science discoveries. The study suggests some recommendations for the development of physics curricula, textbooks and teacher education programs in the country.

Keywords: students' interest, physics education, physics curriculum

INTRODUCTION

The relevance of science education has been discussed by researchers from many countries (Belova et al., 2017; Sjøberg & Schreiner, 2010; Stuckey et al., 2013). The main issue appears to be associated with changing the philosophy of learning in science subjects. Different pedagogical approaches used in country-specific contexts is a major topic of the debates in many international conferences and research studies. The main aim of this paper is to identify students' interest in physics at the end of compulsory education and the beginning of upper secondary school in Georgia. For the analysis, items were chosen from the international ROSES (relevance of science education–second network) study that related to students' interest in physics. Results of this study will be very useful for improving science and physics education in Georgia.

Students' Interest in Physics

For many decades, students' attitudes towards studying science have become an important topic of research for science educators. Past studies have identified different factors, such as gender, age, learning environment, which may affect students' interest in science subjects (Gardner, 1998; Häussler et al., 1998; Hong & Lin-Siegler, 2012; Slovinsky et al., 2021). As reported in the literature, a negative attitude toward science leads to lack of interest in learning science (Simpson et al., 1994), while a positive attitude toward science "leads to a positive commitment to science that influences lifelong interest and learning in science" (Simpson & Oliver, 1990, p. 14). Thus, developing positive attitudes towards science and the learning of science has always been important for science educators.

As the present project investigates students' interest in physics, past research in physics education was studied. For example, some researchers examined the relationship between motivation and attitudes of students towards physics subjects (Jufrida et al., 2019); other educators argued that students become more interested in learning physics, if they see the connection between physics and the real world (Perkins et al., 2006). Market demand and future remuneration are also important for students' motivation and their choice of future professions. Many teachers believe that their students have difficulty studying physics, and they stress the importance of co-curricular activities and laboratory work to enhance the interest of their students in learning physics (Oon & Subramaniam, 2011).

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Contribution to the literature

- The study adapts ROSES (relevance of science education–second) instrument for measuring the relevance of science/physics education.
- The study gives an overview about the students' interest in physics at the end of compulsory education and beginning of upper secondary school, about their attitudes toward science and technology, environmental issues, and 'out of school' experiences.
- The study gives recommendations for curriculum experts, textbook authors, and teacher educators.

National Curricula in Physics in Georgia

Georgia has begun a process of modifying its science education as the part of a general education reform, which commenced in 2004 (World Bank, 2006). Student-centered teaching and learning has become a powerful force for changes in the country (Kapanadze et al., 2010). Significant changes have been made to the science curriculum, textbooks, and teaching methods and materials for secondary schools. Since the reform, three generations of national curricula have been implemented in Georgia. Physics and biology subjects have been taught as separate disciplines from 7th till 12th grade, and chemistry from 8th till 12th grade.

It is important to describe some of the requirements of the physics standards for Georgian secondary schools (http://ncp.ge/en/) as the results of the current study need to be analyzed from the perspective of these requirements. One of the requirements of the Standard is that students should have an interest in the study of physical processes, and three main directions are defined to make students learn physics appropriately:

1. **Physical phenomena:** Understanding the basic concepts of physics.
2. **Scientific inquiry:** Observing and conducting simple experiments by students.
3. **Science & technology:** Understanding the impact of science and technology on society and the environment; evaluating important scientific discoveries; understanding that scientific views and opinions evolve and may change over time.

New textbooks, which satisfy the requirements of the physics standard are approved by the Ministry of Education and Sciences of Georgia.

ROSES Study

This study is a part of an international research project ROSES (the relevance of science education, second–www.miun.se/en/Research/researchgroups/roses/), which commenced in 2019. ROSES is the second phase of ROSE (relevance of science education–https://roseproject.no/), which was initially conducted from 2004 to 2012. ROSE project developed an extensive questionnaire that was used with science students from nearly 40 countries in the network.

ROSES is a more extensive collaboration using an updated questionnaire and an expanded network that covers more than 50 countries. ROSES study has produced information about students' interests in learning science and technology topics in different contexts at the end of compulsory education. The study also explores students' views and attitudes to science and scientists in society, to environmental challenges, to science in schools, and to using social networks in their everyday life.

The present paper gives a clear picture about the students' level of interest in physics in Georgia.

The research questions investigated in this study are:

1. What are the students' levels of interest in learning physics?
2. What physics topics are students interested in?
3. Are there any significant correlations between students' interests in physics and other factors defined in ROSES study?

MATERIALS AND METHODS

The basic philosophy of ROSES project is the same as for the previous ROSE project. ROSES questionnaire is based on the initial ROSE questionnaire, with various updates and the addition of some new variables. The extensive questionnaire developed within the framework of ROSES project is a four-point Likert-type questionnaire, consisting of 12 sections (A to L) with a number of questions (items) in each section. There are 174 items in total and two open-ended questions.

ROSES questionnaire was translated into the Georgian language and adapted for the culture and context of Georgian students. For the present study results of the sections A, C, and E, which deal with the students' interest in physics content, are discussed and analyzed. These sections (A, C, and E) "What I want to learn about" cover 78 questions. SPSS was used for quantitative data analysis. EFA (exploratory factor analysis), correlation and frequency analysis were conducted, and mean scores and t-tests were calculated.

Sample and Data Collection

The data were collected from 50 schools throughout Georgia. These schools are members of the Georgian Science Education Research Center (SALiS) Network,

Table 1. Eight scales of interest

Scales	Items in the scale	Cronbach's alpha
1. Interested in environment & sustainable development	11	.899
2. Interested in space & physical phenomena	21	.897
3. Interested in plants, animals, & nature	13	.882
4. Interested in unexplained phenomena	6	.783
5. Interested in science inventions & discoveries	11	.872
6. Interested in issues related to sex & reproduction	6	.804
7. Interested in eating disorders & skin care issues	4	.798
8. Interested in factors affecting health & healthcare	6	.811
Overall scale	78	.964

Table 2. Correlation analysis among eight interest scales

Scales	1	2	3	4	5	6	7	8
1. Interested in environment & sustainable development	-	.702**	.656**	.392**	.717**	.514**	.371**	.567**
2. Interested in space & physical phenomena	.702**	-	.720**	.486**	.686**	.489**	.452**	.545**
3. Interested in plants, animals, & nature	.656**	.720**	-	.452**	.614**	.472**	.404**	.548**
4. Interested in unexplained phenomena	.392**	.486**	.452**	-	.506**	.432**	.409**	.423**
5. Interested in science inventions & discoveries	.717**	.686**	.614**	.506**	-	.513**	.376**	.588**
6. Interested in issues related to sex & reproduction	.514**	.489**	.472**	.432**	.513**	-	.495**	.572**
7. Interested in eating disorders & skin care issues	.371**	.452**	.404**	.409**	.376**	.495**	-	.503**
8. Interested in factors affecting health & healthcare	.567**	.545**	.548**	.423**	.588**	.572**	.503**	-

with whom the authors of this publication have a long-term collaboration. Science teachers of this network are motivated and open to educational innovations, participate in different workshops and conferences, try to implement new learning and teaching approaches in classrooms. This might be a reason that the results of this study could not be generalized for all over the country. Permission from the Ministry of Education of Georgia and confirmation from the university ethical board was obtained before the data collection.

Participants of the study are the students of 9th and 10th grade. 9th grade is the last stage of the compulsory education in Georgia and 10th grade is the beginning of the upper secondary level. The authors of this study were particularly interested in observing the differences (if any) between students' interest in physics when they are in the final stage of compulsory education and when they start upper secondary education. The geographical distribution of students' responses was also of interest. Data were collected from most regions in the country (eight regions from 11). 1,541 students participated in this study: including students from public and private schools, and from rural and urban regions. Some of the schools participating in this study run extracurricular science clubs, including Young Explorers Clubs, where students work on hands-on and inquiry projects.

Data collection was organized electronically. A Google form was prepared and sent to all participant schools. Science teachers were supported by the research team in collecting the data, and their students were contacted in order to explain the aims of the study.

RESULTS

Exploratory Factor Analysis

EFA of nine sections with closed questions was conducted to define scales within sections. As a result, items in some sections united under one scale; in other sections number of scales, or scales and individual items were detected. Overall, 18 scales (eight of these are interest scales) and 13 individual items were formed. The detailed description of this procedure and all resulted scales and individual items will be provided in another research paper (in preparation), while this study is focused on 78 items from the three ROSES sections: A, C, and E "What I want to learn about". 78 items loaded on eight different interest scales, with high internal consistency indicators. Also, Cronbach's alpha for all 78 items is quite high and thus enables us to also calculate the overall interest score, provided in **Table 1**.

The second scale includes 21 items, which addresses issues such as space, chemicals, physical phenomena, and nuclear weapons. We identify this scale as a characteristic tool for students' interest in physics.

Correlations

Correlation analysis is conducted to detect notable links among the scales of interest. We found that the links between the scales were high or moderate, according to the effect size classification by Cohen (1988). A particularly high correlation is observed between the first and the second, the first and the fifth scales, the second and the third scales and second and the fifth scales (**Table 2**). It means that students, interested in physics (scale 2) are also interested in environmental and sustainable issues–ecology, food,

Table 3. Correlation analysis among interest in physics & other scales

Scales	1	2	3	4	5	6	7	8	9	10
1. Interested in space & physical phenomena	-	.510**	.254**	.410**	.321**	.164**	.156**	.476**	.382**	.297**
2. Having a positive attitude to science & technology	.510**	-	.316**	.428**	.390**	.222**	.169**	.358**	.295**	.242**
3. Delegating environmental responsibility	.254**	.316**	-	.184**	.168**	.216**	.293**	.153**	.221**	.292**
4. Taking personal environmental responsibility	.410**	.428**	.184**	-	.230**	.079**	-	.479**	.436**	.215**
5. Having informal science experience through visiting relevant institutions	.321**	.390**	.168**	.230**	-	.105**	.136**	.196**	.147**	.158**
6. Having informal science experience through using social media	.164**	.222**	.216**	.079**	.105**	-	.411**	.149**	.144**	.221**
7. Using social media in science classes	.156**	.169**	.293**	-	.136**	.411**	-	.063*	.119**	.170**
8. Preferring independent/individual work career	.476**	.358**	.153**	.479**	.196**	.149**	.063*	-	.526**	.484**
9. Preferring teamwork career	.382**	.295**	.221**	.436**	.147**	.144**	.119**	.526**	-	.327**
10. Preferring a high income/high status career	.297**	.242**	.292**	.215**	.158**	.221**	.170**	.484**	.327**	-

Table 4. Correlation between individual items & interest scale in physics

Individual items & interest scale in physics	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Science & technology are cause of environmental problems	-	.296[a]	-	-	.131[a]	.143[a]	.244[a]	.101[a]	.127[a]	.128[a]	.211[a]	.251[a]	.182[a]	.211[a]
2. Science & technology benefit mainly developed countries	.296[a]	-	-	-	.149[a]	.145[a]	.167[a]	.216[a]	.059[b]	.148[a]	.150[a]	.173[a]	.156[a]	.218[a]
3. In school, I am using social & digital media in my schoolwork	-	-	-	-	-	.082[a]	.061[b]	-	-	-.068[a]	-	-	-	-
4. I am using social & digital media at home	-	-	-	-	-	.067[a]	-.071[a]	.081[a]	.065[b]	-.116[a]	-.137[a]	-.089[a]	-	-.131[a]
5. Information I find on social & digital media for learning science & technology is reliable	.131[a]	.149[a]	-	.206[a]	-	.306[a]	.266[a]	.264[a]	-	.118[a]	.151[a]	.101[a]	.109[a]	.175[a]
6. Information I find on social & digital media for learning science & technology is better than my science textbook in school	.143[a]	.145[a]	-	-	.306[a]	-	.246[a]	.311[a]	.141[a]	-.155[a]	-	.096[a]	.104[a]	.057[b]
7. Information I find on social & digital media for learning science & technology is encouraged by school	.244[a]	.167[a]	.206[a]	-	.266[a]	.246[a]	-	.189[a]	.084[a]	.114[a]	.156[a]	.208[a]	.129[a]	.209[a]
8. Information I find on social & digital media for learning science & technology could be better used for learning in school	.101[a]	.216[a]	-	-	.264[a]	.311[a]	.189[a]	-	-	.101[a]	.120[a]	.072[a]	.108[a]	.182[a]
9. School science is a difficult subject	.127[a]	.059[b]	-	-	-	.141[a]	.084[a]	-	-	-.155[a]	-.127[a]	-	-	-
10. School science is interesting	.128[a]	.148[a]	-	-	.118[a]	-.155[a]	.114[a]	.101[a]	-.155[a]	-	.494[a]	.215[a]	.093[a]	.433[a]
11. I like school science better than most other subjects	.211[a]	.150[a]	.095[a]	.064[b]	.151[a]		.156[a]	.120[a]	-.127[a]	.494[a]	-	.426[a]	.225[a]	.388[a]
12. I would like to become a scientist	.251[a]	.173[a]	-	-	.101[a]	.096[a]	.208[a]	.072[a]	-	.215[a]	.426[a]	-	.478[a]	.323[a]
13. I would like to get a job in technology	.182[a]	.156[a]	.080[a]	-.072[a]	.109[a]	.104[a]	.129[a]	.108[a]	-	.093[a]	.225[a]	.478[a]	-	.252[a]
14. Interested in space & physical phenomena	.211[a]	.218[a]	-	-.123[a]	.175[a]	.057[b]	.209[a]	.182[a]	-	.433[a]	.388[a]	.323[a]	.252[a]	-

Note. We show only statistically significant data; Spearman's rho is calculated for ordinal data ("In school, I am using social & digital media in my schoolwork"; "I am using social & digital media at home"); [a]Significant at 0.01 level (2-tailed); [b]Correlation is significant at 0.05 level (2-tailed); Pearson's correlation for rest of data; [a]Correlation is significant at 0.01 level (2-tailed); & [b]Correlation is significant at 0.05 level (2-tailed)

and agriculture (scale 1), nature–animals, plants (scale 3), as well as science inventions and discoveries (scale 5).

Next, we calculated correlations among interest in physics and other scales. As seen from **Table 3**, almost all of them are significantly connected with each other, but most of coefficients are weak to moderate. A relatively high coefficient was detected with "having a positive attitude to science and technology" and "interested in space and physical phenomena" (**Table 3**).

We have also calculated correlations of interest scale in physics with 13 individual items. Negative correlation is found between physics interest and using social networks at home. Students who get interested in physics use social and digital media at home less (-.123) (**Table 4**).

Table 5. Frequency of physics scale statements

Statements	Not very interested	Somewhat interested	Interested	Very interested
	1	2	3	4
1. Chemicals, their properties, & how they react	13.4%	27.6%	37.0%	22.0%
2. Atoms & molecules	18.1%	27.1%	30.7%	24.2%
3. Light around us that we cannot see (infrared & ultraviolet)	10.2%	19.1%	**32.4%**	**38.2%**
4. How different musical instruments produce different sounds	24.9%	27.7%	26.1%	21.3%
5. Black holes, supernovas, & other spectacular objects in outer space	6.4%	11.4%	**21.0%**	**61.2%**
6. How meteors, comets, or asteroids may cause disasters on Earth	6.6%	13.3%	**28.6%**	**51.5%**
7. How atom bomb functions	12.0%	17.7%	**24.7%**	**45.7%**
8. Explosive chemicals	10.5%	21.3%	29.1%	39.1%
9. Biological & chemical weapons & what they do to human body	8.7%	19.2%	**30.6%**	**41.5%**
10. Effect of strong electric shocks & lightning on human body	6.7%	15.9%	**31.6%**	**45.7%**
11. How it feels to be weightless in space	6.9%	11.2%	**21.1%**	**60.7%**
12. How eyes can see light & colors	5.8%	15.1%	**32.9%**	**46.2%**
13. How ears can hear different sounds	10.3%	22.8%	**33.2%**	**33.8%**
14. Rockets, satellites, & space travel	10.1%	15.5%	**24.6%**	**49.8%**
15. How X-rays, ultrasound, etc. are used in medicine	16.3%	23.8%	**30.0%**	**30.0%**
16. How a nuclear power plants function	17.7%	24.4%	26.4%	31.6%
17. How a cell phone works	10.9%	14.7%	**32.5%**	**41.9%**
18. Why stars twinkle, & sky is blue	9.6%	15.3%	**29.6%**	**45.5%**
19. Why we can see rainbow	17.5%	21.7%	29.0%	31.8%
20. How sunset colors sky	13.2%	17.2%	29.6%	40.0%
21. Detergents, soaps, & how they work	24.9%	26.6%	26.7%	21.8%

Table 6. Mean scores of interest scales

Scales	Mean	Standard deviation
1. Interested in environment and sustainable development	2.80	.713
2. Interested in space and physical phenomena	2.95	.585
3. Interested in plants, animals, nature	3.05	.608
4. Interested in unexplained phenomena	3.27	.672
5. Interested in science inventions and discoveries	3.14	.630
6. Interested in issues related to sex and reproduction	2.88	.730
7. Interested in eating disorders and skin care issues	2.58	.898
8. Interested in factors affecting health and healthcare	3.23	.672
Overall score	2.99	.522

Frequencies and Mean Scores

We have also considered items from the interest in physics scale independently from each other. Frequency analysis shows that students are the most interested in perception of light and colors, issues related with space, such as meteors, comets, black holes, etc. and the effect of electric shock on human body.

At the same time, students are the least interested in detergents and soaps, musical instruments. Results are shown in **Table 5**.

We calculated mean scores for eight interest scales and compared them via ANOVA, which is statistically significant: F(7, 1,520)=303.099, p=.000. All means differ from each other, except between 4th and 8th scales (**Table 6**).

Phenomena, that scientists still cannot explain and *factors affecting health and its care* attract the highest interest in participants. The lowest interest score is observed for *eating disorders and skin care issues*. Interest in physics is slightly less than the overall interest score.

It is worth to mention, that our study shows a statistically significant difference by gender, grade and out of school club membership for this scale. Girls show a higher interest in physics–M=3.08, SD=.497, then boys–M=2.89, SD=.532; t(1,541)=7.129, p=.000. Mean interest score for the 9th grade students is M=3.04, SD=.521, and for the 10th grade students is M=2.89, SD=.580; t(1,541)=3.204, p=.001. The mean interest in physics score for out of school club members is M=3.13, SD=.525, while for non-members is M=2.95, SD=.513; t(1,541)=5.781, p=.000. No statistically significant difference was found by the school type.

DISCUSSION

Our study shows that the average score of the subscale about the interest in physics out of a maximum of four points is 2.95, which is slightly below the average score of the full scale 2.99. It means that physics is not a subject of great interest to the students at the end of compulsory education and beginning of the upper secondary level in Georgia, thus, one of the main requirements of the national standard is weakly addressed. It is worth mentioning that students at the end of compulsory education are more interested in physics compared to the beginning of upper secondary school. It could be elucidated that for the upper secondary level Georgian students have already chosen their future professions, which probably are not connected with physics subject. Analysis of the section *L "What occupation would you like to have in the future?"* shows that students who marked three ("I'm interested") and four ("I'm very interested") for interest in physics, mostly think of medicine as their future profession, only few of them consider profession of a physicist, or scientist in general.

One of the reasons that students have less interest and do not connect their future jobs with physics could be also physics curricula, what the students learn and how they learn physics. After detailed analyses of the physics scale it is clear that students are mostly interested in astronomy and astrophysics ("black holes, supernovas and other spectacular objects in outer space"–A, statement 13). It is very promising that some basic aspects of astrophysics are added to the third version of national curricula, which will be implemented from 2024 in Georgia (http://ncp.ge/en/).

Based on current physics curricula (discussed in the introduction part of this paper), teaching and learning process at schools should be based on inquiry–students' involvement in simple experiments is part of the curricula (second direction of the physics standard). Here raises the questions–are the schools equipped with the appropriate equipment and are the teachers qualified to teach physics according to the new curricula.

We've observed in Georgia very interesting and promising results regarding gender compared to other countries. In general, girls show a higher interest in physics, than boys for the whole sample in our study. The results of the PISA study stated that Georgia was one of 18 countries, where girls are more motivated in science learning than boys (NAEC, 2017; OECD, 2016). Different from our results, less interest toward physics is observed for girls than for boys in many countries (Hoffman, 2002; Lavonen et al., 2005; Trumper, 2006).

There is a small difference observed when the comparison is done due to the type of the school (private and public). It means that the situation is similar in all types of schools regarding the quality of lessons, or motivational environment. For urban private schools the mean score was even lower than for public schools. It might mean that private schools have other priorities, than enhancing motivation of their students in physics.

It was predictable that if the students are involved in out of school activities, their motivation should be higher, then that of the other students. Many schools of the science teacher network in Georgia have the Young Explorers' Clubs, established with the cooperation of Copernicus Center in Warsaw, Poland (https://www.kopernik.org.pl/en). The main aim of this project is to gather students with different interests and age groups under the purpose of conducting scientific projects, hands-on activities and experiments in the field of natural sciences. These out of school activities help students develop critical and creative thinking and get more interested in science (Grolnick et al., 2007; Yildirim, 2020). Our prediction is confirmed after correlation analysis, as the interest in physics is in moderate positive correlation with having informal science experience through visiting relevant institutions; in other words, students who have interest in physics often visit scientific centers, zoos, aquariums, take part in different science events (like science picnic) and read scientific journals. Such out of school experiences, in turn, help educators reach the third direction of the national standard, which is understanding the impact of science and technology on society and the environment as well as the importance of scientific discoveries.

Our study finds that students with the interest of physics are curious about the environmental issues, nature and science inventions and discoveries. They'd like to know more about whether chemical phenomena or nuclear weapons have an influence on environmental issues, or to get knowledge about the new discoveries in science. As it is stated in the study carried out in Finland "The … challenge is to increase human being context, health education and examples of life sciences to physics teaching … Some physical conceptions can be used in the context of various records of animals and plants (mass, weight, volume, acceleration, velocity, kinetic energy, etc.) instead of machines or cars or various physical instruments" (Lavonen et al., 2005). These results could be very useful for the Georgian education experts, who are involved in the development of national curricula in physics, also for Georgian textbook authors.

We also found that students who are interested in physics would like to know more about technologies. As the technical applications are part of students' everyday life, it is very important to integrate the technological context in school science (Prima et al., 2018). Some online applications, like PhET simulations (https://phet.colorado.edu/), Khan Academy, etc. are part of physics lessons in many countries. These tools help students to see the importance of technology in everyday life and in their learning. A short scale study has been done in Georgia by one of the authors of this paper (Nadiradze et al., 2020). The study concludes that the use of technology enhances the students' motivation in physics learning. It is worth mentioning that using technology helps students in understanding of physics concepts (Agyei & Agyei, 2021; Dega et al., 2013).

Negative correlation is found between physics interest and using social networks at home. Social networks are more for fun and free time leisure for many students in Georgia. There are some examples from other countries in the literature (Mahzum et al., 2020;

Page, 2015) that social media is used for engaging students in learning physics and fostering collaboration. Authors of this paper found only one article from a Georgian teacher (http://mastsavlebeli.ge/?p=2148) about using social network (Facebook) for getting information and resources to prepare class materials.

As it is discussed in the results section, we've observed the highest mean score (3.27) for the fourth scale "phenomena, that scientists still cannot explain". Relevant content to this scale is not considered in a new version of national curricula (http://ncp.ge/en/), but some authors discuss it in their textbooks. It could be very important information for the curriculum experts for the update, or further revision of physics curricula.

CONCLUSIONS

Based on the findings of the presented study some recommended/desired changes in physics education in Georgia are already visible. For example, some basic aspects of astrophysics are added to the third version of national curricula, which will be implemented from 2024 in Georgian schools.

Interest in physics is an important concern in most countries for girls. A different picture is observed in Georgia, where girls show a higher interest in physics than boys. It is a very promising result for involving girls in physics.

In general, the average score of interest in physics is not high. It means that changes in teaching approaches and curricular content are necessary for better involvement of Georgian students in the learning process. Our study shows that students would like to get more knowledge about topics like science inventions and discoveries. An integrative approach for all science subjects is also recommended, as it has been observed that students are interested in everyday life physics. Integration of technological contexts is also very important for enhancing students' motivation in physics (Gani et al., 2020; Rohim & Ellianawati, 2020; Susilawati et al., 2022). It is also stated from this study that students who are interested in physics would like to know more about technologies in science. Georgian students are also interested in science inventions and discoveries (**Table 2**), in understanding the impact of science and technology on society and the environment.

We think that all three directions in the national physics standard:

1. Physical phenomena,
2. Scientific inquiry, and
3. Science and technology

are very important for students' motivation and their achievements in physics. The present study identifies the subject content that students are interested in. Use of scientific inquiry will help students to be actively involved in learning and better understand the concepts (Kapanadze, 2019; Sotáková et al., 2020).

The results of the present study will be very useful for physics textbook authors and educational experts, who work on the development of physics curricula in Georgia. Physics teachers can enrich their lessons, including topics connected with astrophysics and not explained phenomena, and integrate technologies into the teaching process (moderate correlation).

The authors of this paper also recommend changes in teacher education programs at the universities, as the teacher qualification is crucial for the students' motivation and involvement in learning process (Sparkes, 1995). Some studies discuss the issue that physics is often taught by the teachers who have a lack of knowledge in physics and quality of teaching is very low (Osborne et al., 2003; Trumper, 2006). It is very important making teachers more proficient and flexible in teaching physics in an interdisciplinary way, ensuring the development of TPACK (technological pedagogical content knowledge) (Zhang & Tang, 2021) for technology integration in physics teaching and learning; development of teaching approaches for showing the interestingness of technical applications and their importance in everyday life.

Limitations

The present study has a limitation, as the data is collected from 50 schools, which are members of the science teacher network (SALiS). Science teachers of this network are motivated and open to educational innovations, participate in different workshops and conferences, try to implement new learning and teaching approaches in classrooms. This might be a reason that the results of this study could not be generalized for all over the country. Thus, data collected from representative sample is desired for future analysis.

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REFERENCES

Agyei, E. D., & Agyei, D. D. (2021). Enhancing students' learning of physics concepts with simulation as an instructional ICT tool. *European Journal of Interactive Multimedia and Education, 2*(2), e02111. https://doi.org/10.30935/ejimed/11259

Belova, N., Dittmar, J., Hansson, L., Hofstein, A., Nielsen, J. A., Sjöström, J., & Eilks, I. (2017). Crosscurricular goals and raising the relevance of science education. In K. Hahl, K. Juuti, J. Lampiselkä, A. Uitto, & J. Lavonen (Eds.), *Cognitive and affective aspects in science education research* (pp. 297-307). Springer. https://doi.org/10.1007/978-3-319-58685-4_22

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Lawrence Erlbaum Associates, Inc.

Dega, B. G., Kriek, J., & Mogese, T. F. (2013). Students' conceptual change in electricity and magnetism using simulations: A comparison of cognitive perturbation and cognitive conflict. *Journal of Research in Science Teaching, 50*(6), 677-698. https://doi.org/10.1002/tea.21096

Gani, A., Syukri, M., Khairunnisak, K., Nazar, M., & Sari, R. P. (2020). Improving concept understanding and motivation of learners through PhET simulation word. *Journal of Physics: Conference Series, 1567*(4), 042013. https://doi.org/10.1088/1742-6596/1567/4/042013

Gardner, P. (1998). The development of males' and females' interests in science and technology. In L. Hoffman, A. Krapp, K. Renninger, & J. Baumert (Eds.), *Proceedings of the 2nd Conference on Interest and Gender* (pp. 41-57).

Grolnick, W. S., Farkas, M. S., Sohmer, R., Michaels, S., & Valsiner, J. (2007). Facilitating motivation in young adolescents: Effects of an after-school program. *Journal of Applied Developmental Psychology, 28*(4), 332-344. https://doi.org/10.1016/j.appdev.2007.04.004

Häussler, P., Hoffman, L., Langeheine, R., Rost, J., & Sievers, K. (1998). A typology of students' interest in physics and the distribution of gender and age within each type. *International Journal of Science Education, 20*(2), 223-238. https://doi.org/10.1080/0950069980200207

Hoffman, L. (2002). Promoting girls' interest and achievement in physics classes for beginners. *Learning and Instruction, 12*, 447-465. https://doi.org/10.1016/S0959-4752(01)00010-X

Hong, H.-Y., & Lin-Siegler, X. (2012). How learning about scientists' struggles influences students' interest and learning in physics. *Journal of Educational Psychology, 104*(2), 469-484. https://doi.org/10.1037/a0026224

Jufrida, J., Kurniawan, W., Astalini, A., Darmaji, D., Kurniawan, D. A., & Maya, W. A. (2019). Students' attitude and motivation in mathematical physics. *International Journal of Evaluation and Research in Education, 8*(3), 401-408. https://doi.org/10.11591/ijere.v8i3.20253

Kapanadze, M. (2019). Implementation of the Chain Reaction Project in Georgia. In *Comparative perspectives on inquiry-based science education* (pp. 70-81). IGI Global.

Kapanadze, M., Janashia, S., & Eilks, I. (2010). From science education in the soviet time, via national reform initiatives, towards an international network to support inquiry-based science education – The case of Georgia and the project SALiS. In I. Eilks & B. Ralle (Eds.), *Contemporary science education* (pp. 237-242). Shaker.

Lavonen, J., Byman, R., Juuti, K., Meisalo, V., & Uitto, A. (2005). Pupil interest in physics: A survey in Finland. *Nordic Studies in Science Education, 1*(2), 72-85. https://doi.org/10.5617/nordina.486

Mahzum, E., Farhan, A., & Ramadhani, E. (2020). The use of social media Instagram as instructional media for physics toward student's learning motivation. *Asian Journal of Science Education, 2*(1), 48-55. https://doi.org/10.24815/ajse.v2i1.14997

Nadiradze, L., Kapanadze, M., & Kvirkvelia, B. (2020). Use of technologies, as the effective instrument for enhancing of motivation in the process of physics teaching. In *INTED2020 Proceedings, 14th International Technology, Education and Development Conference* (pp. 2768-2773), https://doi.org/10.21125/inted.2020.0828

NAEC. (2017). PISA 2015 results (Georgia). *National Assessment and Examinations Center, Tbilisi*. https://naec.news/

OECD. (2016). *PISA 2015 results: Excellence and equity in education*. OECD Publishing. https://doi.org/10.1787/9789264266490-en

Oon, P.-T., & Subramaniam, R. (2011). On the declining interest in physics among students–From the perspective of teachers. *International Journal of Science Education, 33*(5), 727-746. https://doi.org/10.1080/09500693.2010.500338

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education 25*, 1049-1079. https://doi.org/10.1080/0950069032000032199

Page, K. (2015). Using social media in a high school physics classroom. *The Physics Teacher, 53*(3), 184-185. https://doi.org/10.1119/1.4908094

Perkins, K. K., Gratny, M. M., Adams, W. K., Finkelstein, N. D., & Wieman, C. E. (2006). Towards characterizing the relationship between students' interest in and their beliefs about physics. *AIP Conference Proceedings, 818*(1), 137-140. https://doi.org/10.1063/1.2177042

Prima, E., Putri, A. R., & Rustaman, N. (2018). Learning solar system using PhET simulation to improve students' understanding and motivation. *Journal of Science Learning, 1*(2), 60-70. https://doi.org/10.17509/jsl.v1i2.10239

Rohim, A. M., & Ellianawati, E. (2020). Improved understanding of student's learning concept and motivation in inclined plane material by PhET simulation. *Physics Communication*, *4*(2), 1-4.

Simpson, R., & Oliver, J. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education*, *74*, 1-18. https://doi.org/10.1002/sce.3730740102

Simpson, R., Koballa Jr, T., Oliver, J., & Crawley III, F. (1994). Research on the affective dimension of science learning. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 211-234). Macmillan.

Sjøberg, S., & Schreiner, C. (2010). *The ROSE project. An overview and key findings*. http://roseproject.no/network/countries/norway/eng/nor-Sjoberg-Schreiner-overview-2010.pdf

Slovinsky, E., Kapanadze, M., & Bolte, C. (2021). The effect of a socio-scientific context-based science teaching program on motivational aspects of the learning environment. *EURASIA Journal of Mathematics, Science and Technology Education*, *17*(8), em1992. https://doi.org/10.29333/ejmste/11070

Sotáková, I., Ganajová, M., & Babincakova, M. (2020). Inquiry-based science education as a revision strategy. *Journal of Baltic Science Education, 19*(3), 499-513. https://doi.org/10.33225/jbse/20.19.499

Sparkes, R. A. (1995). No problem here! The supply of physics teachers in Scotland. *The Curriculum Journal*, *6*, 101-113. https://doi.org/10.1080/0958517950060107

Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of 'relevance' in science education and its implications for the science curriculum. *Studies in Science Education, 49(1),* 1-34. https://doi.org/10.1080/03057267.2013.802463

Susilawati, A., Yusrizal, Y., Halim, A., Syukri, M., Khaldun, I., & Susanna, S. (2022). The effect of using physics education technology (PhET) simulation media to enhance students' motivation and problem-solving skills in learning physics. *Journal Penelitian Pendidikan IPA* [*Science Education Research Journal*], *8*(3), 1157-1167. https://doi.org/10.29303/jppipa.v8i3.1571

Trumper, R. (2006). Factors affecting junior high school students' interest in physics. *Journal of science Education and Technology*, *15*(1), 47-58. https://doi.org/10.1007/s10956-006-0355-6

World Bank. (2006). Georgia-Education system realignment and strengthening program. *World Bank*. https://documents.worldbank.org/en/

Yildirim, H. I. (2020). The effect of using out-of-school learning environments in science teaching on motivation for learning science. *Participatory Educational Research*, *7*(1), 143-161. https://doi.org/10.17275/per.20.9.7.1

Zhang, W., & Tang, J. (2021). Teachers' TPACK development: A review of literature. *Open Journal of Social Sciences*, *9*(7), 367-380. https://doi.org/10.4236/jss.2021.97027