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Individual, Vocational, and Societal Dimensions of Relevance of Science Education

Nino Javakhishvili[1]*, Marika Kapanadze[2], Lia Dzagania[1]

[1]D. Uznadze Institute of Psychology, School of Arts and Sciences, Ilia State University, Tbilisi, Georgia, [2]School of Business, Technology and Education, Ilia State University, Tbilisi, Georgia

***Corresponding Author:** nino.javakhishvili.3@iliauni.edu.ge

ABSTRACT

The relevance of science education and its individual, societal, and vocational dimensions is important issues for the modern learning and teaching process in many countries. These dimensions are considered based on the data obtained from 1541 Georgian students. The study was conducted within the frames of the international ROSES project. The structure analysis of the ROSES questionnaire was conducted to define scales and individual items, which then were processed accordingly and relevant conclusions were drawn. The study findings reveal that Georgian students from basic and secondary schools demonstrate motivation and interest in learning science, participate in extracurricular activities, use social media for study aims, are concerned about environmental problems, and consider science classes interesting. However, the levels of interest, motivation, and positive attitudes are not high and the correlations between them are weak. The study shows that the vocational and societal dimensions of the relevance of science education are relatively better represented in our sample, but the individual dimension lags behind. Both structural and content findings might serve educators from similar contexts.

KEY WORDS: Relevance in science education; basic and secondary school students; interest, experience, and attitude to science.

INTRODUCTION

School curricula include disciplines that are seen as necessary components of the education path that parents, stakeholders, and countries offer to school students to achieve an ultimate goal of schooling: to educate young people so that they can plan their future career, develop their talents and skills, pursue their interests while being considerate of others' needs, understand social issues and use evidence-based scientific information (Dauer et al., 2017; Ayuso Fernández et al., 2022; Mujtaba et al., 2018), as set out in the theories of Allgemeinbildung and Activity (Stuckey et al., 2013). One of these disciplines is Science; therefore, all stakeholders seek to promote science learning at schools by exploring all relevant personal and situational factors (Dori et al., 2018; Ferreira and Morais, 2018; Jaber and Hammer, 2016; Kuhn et al., 2017). Personal factors include the interest and motivation of students to study science, as well as their positive attitude toward science and technology (Bolte et al., 2013; Sheldrake R. 2020)). In terms of situational factors, these include the environment in which students learn about science, whether in the school setting, such as in classrooms, or outside of school, such as visiting institutions or using various media. (Belova et al., 2017; Osborne et al., 2003; Stuckey et al., 2013). In addition, certain demographic factors, such as gender, age and school type, have been seen relevant for learning science disciplines (Hong and Lin-Siegler, 2012; Slovinsky et al., 2021; Trumper, 2006). In general, boys have a more positive attitude towards science than girls. However, if specific disciplines of science are studied, this is not always the case, for example, girls show a more positive attitude towards biology and boys toward physics and chemistry (Weinburgh, 1995), and according to Reed (2022)," This gender effect has been found to be variable among science disciplines, with male students having a larger positive attitude toward physics than biology." The above-listed factors are exhaustively presented and have been aimed to study within the international Relevance of Science Education/ROSE project (https://roseproject.no/), particularly its current, second phase – ROSES (https://www.miun.se/en/Research/researchgroups/roses/), with more than 50 countries worldwide participating. ROSES consider attitudes of young learners at their final stage of compulsory education to science and technology (S&T). The purpose of ROSES is to gather and analyze information from learners about several factors that have a bearing on their attitudes to S&T and their motivation to learn science. The study gives a clear picture about students at the end of compulsory education, their interests in learning different S&T topics in different contexts, their views, and attitudes to science and scientists in society and at school; to environmental challenges and the use of social media in everyday life (Jidesjö et al., 2020). The researchers involved in the project analyze the rich data and detect notable links among the above-listed variables, which then enable them to provide recommendations to local as well as international educators (Jidesjö et al., 2021; Oliveira et al., 2022).

The Relevance of Science Education Study/ROSES did not initially aim but has evolved to address three dimensions of relevance in science education: individual, societal, and vocational, as defined by Eilks et al. (2019). The future job-related section considers the vocational dimension; the section on attitudes to science and environmental challenges corresponds to the societal dimension, while that on informal experience, social media, opinions on science classes, and interests in science topics represent the individual dimension (Eilks et al., 2019).

Georgia, a former Soviet republic from South Caucasus with majority of population being ethnic Georgians who speak their native language and use a unique alphabet, has recently joined the project and collected data for the first time using the ROSES questionnaire, which, usually studies ninth and tenth grade school students. In Georgia, Grade 9 is the end of basic, compulsory education, while Grade 10 is the beginning of secondary, non-compulsory school education. The data analysis led to interesting and useful findings. However, before data processing, factor analysis of the ROSES questionnaire was conducted to unite items under the sections into the corresponding scales.

Thus, the present study has a dual aim: one of them is methodological in nature and is related to the structuring of the ROSES questionnaire, which allowed us to detect scales and individual items. This, in turn, enabled us to proceed to further analysis of the data and address the second aim of the study, that is, to describe the overall picture of Georgian students' interests and attitudes to science in general and to their science classes in particular, and to find notable relations among their experiences, interests, and attitudes. In other words, explore the individual, vocational, and societal dimensions of relevance of science education.

METHOD

Materials

The ROSES questionnaire developed within the frames of the ROSES project is a 4 score Likert-type scale (Jidesjö et al., 2021) consisting of 12 sections each with a different number of items (Table 1) and seven questions on demography. There are two open-ended questions in sections *J* and *L*, where students write their personal opinions about scientists and motivation for their future occupation. The remaining 10 sections contain 169 items: *sections A, C,* and *E* aim to generate empirical evidence on the content students are interested in. *Section B* provides information about students' priorities and their motivation for their future career. Data from *section D* can be used to analyze whether or not young people consider environmental challenges to be severe. *Section F* highlights various aspects of students' perceptions of their science classes. *Section G* is directed toward different aspects of how students perceive the role and function of S&T in society. *Section H* gives information about students' use of social and digital media, and how they evaluate the provided information. *Section I* details students' out-of-school S&T experiences, while *section K* contains only one item asking about the number of books at home:

Table 1: Sections of the ROSES questionnaire

Section A, C and E	What I want to learn about – interest scale
Section B	My future job
Section D	Me and the environmental challenges
Section F	My science classes
Section G	My opinions about science and technology
Section H	My experiences of social and digital media
Section I	My informal science experiences
Section J	Myself as a scientist
Section K	How many books are there in your home?
Section L	What occupation would you like to have in the future?

Sections of the ROSES questionnaire

The ROSES questionnaire is translated into the Georgian language; the process went on in close collaboration with the authors of the questionnaire. The contents of science teaching in Georgia are very similar to that of the international material, thus, no special adaptation of item meaning was needed. The authors of this paper (who are educators) discussed the translated version and introduced the necessary changes after coordinating the meanings of certain items with them. Then, a pilot study was carried out on 10 school students, whose comments were used to further refine the items. The final Georgian version of the questionnaire was used for data collection, before that Ilia State University IRB approval was obtained. An electronic version of the questionnaire was developed and sent out to schoolteachers, who then distributed the links to their students and supervised the whole process. The data were collected during the pandemic in 2021 when schools were mostly online.

Sample

Ilia State University's School of Education established the Science Education Research Centre/SaLiS network, which aids science teachers in advancing their knowledge, skills, and interests; therefore, the sample was made up from 50 schools, members of the SALiS network, in the capital as well as other cities/towns and villages in Georgia. A total of 1541 students participated in the study, of which 22.3% were from urban private schools, 66.3% from urban public schools, and 10.6% from rural public schools. The study sample consists of 52.6% of students in Grade 9 and 47.4% in Grade 10. Similarly, gender distribution is close to equal: 54.5% of girls and 45.5% of boys. In addition, 23.2% of the participants joined the Young Explorers Clubs functioning at their schools, which offer students various activities related to practicing science. 62.8% of club members are girls and 37.2% are boys.

Data Analysis

The SPSS program was used for quantitative data analysis. EFA (Exploratory Factor Analysis), reliability, correlation analysis, and mean scores were calculated. For correlation analysis, we used Pearson's r coefficient with scale data and Spearman's ρ coefficient for ordinal data. Significance of difference between mean scores was calculated with a repeated measures t-test, repeated measures ANOVA or MANOVA (Fisher's F).

RESULTS

Structuring the Measurement Instrument/ROSES

For this study, all sections of the questionnaire were processed, except for J and L, which are categorical. Questions on each of the analyzed nine sections are united under a general theme and thus can be considered as a scale, with the exception of sections *A, C*, and *E,* which are united under the same theme of interest and, therefore, can be understood as one interest scale. We started data processing with exploratory factor analysis to find out if items in a section (nine sections in total, tenth section K contains one item) unite under the same scale. We also calculated the consistency of items under the same factor through Cronbach alpha coefficients (acceptable values for which should be higher than 7). In addition, the content or meaning of the factors was considered that should provide different information. Thus, the final decisions about the structure were made considering a combination of factor, reliability (Cronbach alpha), and content/meaning analysis.

Exploratory factor analysis showed that some sections retained an overall scale structure. The section *My opinions about science and technology* consists of 13 items, 11 of which loaded on two scales, with seven and four items, respectively. However, both of them describe the importance and positive role of science and technology and there is no significant difference between them. In addition, a high Cronbach alpha for all 11 items allows us to calculate the overall score. Thus, this section produced one scale and two individual items. The section *My experiences of social and digital media* contains 16 items, which are already grouped into three subgroups, as they have three different response scales. Thus, we checked Cronbach alphas for three scales; however, only one scale yielded a sufficient Cronbach alpha value. As a result, there is one scale with 10 items relating to the use of *the social media in classes*. The remaining six items are considered independently from one another.

The section *Me and the environmental challenges* contains 13 items that loaded on two scales, with eight items in the first and five items in the second scale. The difference between these scales is that in the first one, the responsibility to solve these challenges is delegated to others, experts, or developed countries, while the second scale displays personal responsibility.

The section *My informal science experiences* consists of 14 items that loaded on two scales: scale 1 contains eight items that mainly deal with visiting out-of-school locations, such as a zoo, botanical garden, museum, etc.; scale 2 contains six items related to digital media.

Twenty-three items from the *My future job* section yielded three scale solutions: the first scale unites 11 items describing workplaces related to individual work and requiring maximum realization of personal abilities; the second scale contains seven items related to group work and having relatively more free time for family and friends, while the third scale contains six items and is connected with top managerial work and material gain.

The *My science classes* section contains 12 items, seven of which loaded on a scale, while five items are considered separately. The scale denotes the positive attitudes of students toward science classes.

Three sections of *interest* "What I want to learn about" contain 78 items that loaded on eight different interest scales: Scale 1 consists of items concerning interest in our environment and sustainable development; Scale 2 relates to mostly physical phenomena and the space, the issues that are usually considered in physics classes; Scale 3 is about botany and zoology issues; Scale 4 contains items on unexplained events that can be considered at any natural science class; Scale 5 accumulates items on inventions and discoveries; Scale 6 considers reproduction issues; Scale 7 deals with topics of skin care, while scale 8 is related to healthy lifestyle.

Finally, 18 scales were identified, plus 13 individual items that did not converge in scales. Then mean scores were calculated (the maximum score is 4) for the scales and the items and were compared through t and F tests. The expanded names of the 18 scales denote the information they convey and are presented in Table 2, along with the results of mean scores comparison:

Georgian Basic and Secondary School Students' Experiences, Future Plans, Interests, and Attitudes to Sciences

The scale *Preferring independent/individual work career* gained the highest score, followed by *Taking personal environmental responsibility.* Next, it comes *three* scales with equal scores: *Preferring teamwork career*, *Interested in science inventions and discoveries,* and *Interested in unexplained phenomena*. The lowest mean scores were gained *using social media in science classes* and *having informal science experience through visiting relevant institutions*. We have additionally calculated t-test for the difference between mean scores of two similar scales *using social media in classes* and *having informal science experience through using social media,* as some items are formulated in the same way: $t(1520) = 30.232$, $p = 0.000$; thus, there is a significant difference between students' use of social media at home and at school.

Next, we calculated mean scores and standard deviations for individual items off the scales, provided in Table 3. The highest score items show that school science is considered rather interesting and students wish to use social media more:

We checked whether gender, class, school location, and type, as well as club membership, had any effect on scale scores. Comparison was done using MANOVA. Four models were statistically significant: F (18, 1485) = 48.772, $p < 0.000$; Wilk's $\Lambda = 0.628$, $\eta 2 = 0.372$ for gender differences; F (18, 1485) = 3.841 $p < 0.000$; Wilk's $\Lambda = 0.956$, $\eta^2 = 0.044$ for class differences, F (18, 1485) = 4.95, $p < 0.000$; Wilk's $\Lambda = 0.943$, $\eta^2 = 0.057$ for school location differences and F (18, 1485) = 4.544, $p < 0.000$; and Wilk's $\Lambda = 0.948$,

Table 2: Number of items, Cronbach alpha values, mean scores, t-tests and ANNOVA values of 18 scales

Scale	Items	α	*M*	Criteria to compare mean scores
Delegating environmental responsibility	8	0.658	2.45	t (1530) = -53.359, p=0.000
Taking personal environmental responsibility	5	0.646	3.37	
Having informal science experience through visiting relevant institutions	8	0.851	2.28	t (1521) = -19.794, p=0.000
Having informal science experience through using social media	6	0.696	2.77	
Preferring independent/individual work career	11	0.762	3.41	F (3,1529) = 317.173; p=0.000
Preferring teamwork career	6	0.717	3.30	
Preferring a high-income/high-status career	6	0.662	2.99	
Having a positive attitude to science classes	7	0.893	2.92	
Having a positive attitude to science and technology	7	0.852	2.86	
Using social media in science classes	10	0.810	2.22	
Interested in environment and sustainable development	11	0.899	2.80	*F* (7,1520) = 303.099; p=0.000[1]
Interested in space and physical phenomena	21	0.897	2.95	
Interested in plants, animals, nature	13	0.882	3.05	
Interested in unexplained phenomena	6	0.783	3.27	
Interested in science inventions and discoveries	11	0.872	3.27	
Interested in issues related to sex and reproduction	6	0.804	3.14	
Interested in eating disorders and skin care issues	4	0.798	2.88	
Interested in factors affecting health and healthcare	6	0.811	2.58	

All scale mean scores significantly differ from one another, except the 4th and 8th scales.

Table 3: Mean scores and standard deviations of individual items

Individual items	M	SD
Science and technology are the cause of the environmental problems	2.34	0.950
Science and technology benefit mainly the developed countries	2.87	0.888
In school, I am using social and digital media in my schoolwork	1.65	0.724
I am using social and digital media at home	2.63	0.976
The information I find on social and digital media for learning science and technology: Is reliable	2.78	0.782
The information I find on social and digital media for learning science and technology: Is better than my science textbook in school	2.48	0.975
The information I find on social and digital media for learning science and technology: Is encouraged by the school	2.43	0.899
The information I find on social and digital media for learning science and technology: Could be better used for learning in school	3.22	0.800
School science is a difficult subject	2.60	0.971
School science is interesting	3.25	0.880
I like school science better than most of the other subjects	2.46	1.037
I would like to become a scientist	1.82	0.997
I would like to get a job in technology	2.30	1.135

$\eta^2 = 0.052$ for club membership differences. The effect size values show that overall gender explains 37% of variance, while class and club membership explain 4.4% and 5% respectively. Girls have higher scores across all significant differences except for three cases: boys delegate responsibility over environmental issues to others and use social media more both in the classroom and informally. Ninth grade students have higher mean scores across all significant differences. However, effects are very small and thus negligible. The only meaningful difference is in having a positive attitude toward science classes, producing a 2% effect size value. Club members also have higher mean scores across all significant differences. However, the effect sizes are mostly small, except for interest in environment, sex and reproduction, eating disorders and skin care issues, factors affecting health and healthcare; having positive attitude to science classes and having informal experience through visiting other institutions. No significant difference was found across school type: F (18, 1483) =.995, p <.485; Wilk's Λ =.965, $\eta^2 = 0.012$. The corresponding mean scores, standard deviations, F scores, p, and effect size values are presented in the Appendix 1.

Section K of the ROSES questionnaire contains one question about the number of books students have at home, with answer options starting from no books and gradually increasing to "more than 500 books". The frequency distribution of answers, provided in Figure 1, is close to normal. Relatively, fewer students have very few or very many books, almost 44% having from 51 to 250 books:

Correlations among the individual items were also calculated and we found out that most of them positively but weakly correlate with one another, with the exception of the correlation between two items from the section *My experiences of social and digital media*: The item "I am using social and digital media at home" negatively and weakly correlates with the item "The information I find on social and digital media for learning science and technology is encouraged by the school" (see the correlations in Appendix 2).

Correlations among all 18 scales are mostly weak to moderate. Strong correlations were found between *interested in science* *inventions and discoveries* and *having a positive attitude to science and technology*, as well as within some interest scales: Between *interested in plants, animals, nature,* and *interested in space and physical phenomena* scales, between *interested in environment and sustainable development* and *interested in science inventions and discoveries* scales.

Most of the correlations among individual items and scale scores are positive but weak. Only the item *I am using social media at home* correlates negatively but weakly with most of the *interest* scales, as well as with *having informal science experience through visiting relevant institutions* and *Preferring teamwork career* (see the correlations in the appendix). Differently from most of the scales and items, answers to the item about the number of books at home align on the ordinary scale. Thus, Spearman's ρ was used. The number of books either does not or weakly correlates with some scales, specifically, the correlation is negative with *delegating environmental responsibility* and *interested in plants, animals, nature*, and positive with *having informal science experience through visiting relevant institutions*.

DISCUSSION

The present study has two aims: first, to structure the measurement instrument, items within the sections of the ROSES questionnaire, and second, to analyze Georgian basic and secondary school students' experiences, future plans, interests, and attitudes to science. Therefore, the findings are presented below in two parts.

Structuring the Measurement Instrument/ROSES

In the present study, we analyzed 10 out of 12 sections of the ROSES questionnaire, as two sections, *J* and *L*, contain open-ended questions. In total, the questionnaire contains 178 items. Therefore, uniting them under the corresponding scales is important as otherwise, it is almost impossible to analyze such a large number of items and find relations among them. The fewer the scales, the easier to analyze them and obtain interesting and useful results. We utilized a complex approach to check the factor structure of the Georgian version of the ROSES scale. In terms of statistical data processing, we used exploratory factor analysis to find the factorial structure of the originally proposed scales/sections. At the same time, we conducted reliability analysis through calculating Cronbach alphas. This approach has been used by the developers of the ROSE questionnaire (Schreiner and Sjøberg, 2004), as well as other authors (Trumper, 2006; Uitto et al., 2004). In addition, we also considered the results of statistical analysis content-wise, as even if the factor analysis yields different factors or scales in our case, they should convey different information; otherwise, calculating scale scores does not make sense. An illustration of this approach is the scale *My opinions about science and technologies*, where 11 items loaded on two factors – seven in the first and four in the second scale. However, as items in both of them contained the same information, we decided to structure the items as a one-factor scale.

In most sections, the items did not unite under one scale but were divided into two or three, which suggests that Georgian students have different opinions and attitudes toward different parts of the initial sections. For example, 23 items from the section *My future job* loaded on three scales, etc. The section *My experiences of social and digital media* initially was formulated in a way that its items contained three different response scales. Therefore, this section could not produce one scale.

By employing a complex approach, we adapted the Georgian version of the ROSES questionnaire, to calculate 31 scores in total: 18 from scales and 13 from individual items. *Section K* (about the number of the books at home) contains only one item and as no factor or reliability analysis was needed, it was automatically included among individual items. However, based on frequency distribution and correlation analysis, we consider this item as unnecessary, as it did not produce any meaningful correlations with other items or scales, nor can it be considered as a proxy to socioeconomic status.

We gave corresponding names to the finally yielded 18 scales to be able to meaningfully use them in the subsequent analysis and discussion. As an illustration, items from the *Me and the environmental challenges* section loaded on two separate factors, which were named according to the students' locus of control: scale one – *Taking personal environmental responsibility* and scale two – *Delegating environmental responsibility*. Likewise, Uitto et al. (2004) and colleagues found the same two factors for the Finnish study (in addition to other two factors, because the ROSE questionnaire, the former version of the ROSES questionnaire, contained 22 items). Scale 1 contained six items referring to internal locus of control, which they named as positive attitudes toward environmental responsibility and six items referring to external locus of control, named as negative attitudes toward environmental responsibility (Uitto et al., 2004). In the Finnish students' case, negative and positive attitude scales were negatively correlated; likewise, Schreiner and Sjøberg (2005), found two – negatively and positively worded item scales that are in negative correlation with each other, while in our case, correlation is positive but weak.

Table 4 summarizes the results of the applied complex approach to finding structure in the ROSES sections:

The results of the factor, reliability, and item content analysis are further confirmed by the scale mean scores comparison results: The mean scores statistically differ from one another, as shown in Table 2. Correlational analysis also confirms the scale structure identified: correlations between the scales are weak in almost all cases; also, scales and items correlate with only one scale out of two or three scales from the same section. As an illustration, let us consider the scale preferring a high income/high status career, which weakly correlates with preferring teamwork career and moderately with preferring independent/individual work career. Students motivated to achieve individual success and material gain are less interested

Table 4: Initial sections and the final scale structure of the ROSES questionnaire

Initial sections	Derived scales
Interest, sections - A, C and E	Eight interest scales according to different topics of interest
future job, section – B	Three future job scales according to the type of job
Responsibility over environmental challenges, section – D	Two scales according to locus of control over environmental challenges
Opinions about science classes, section - F	One scale and five individual items
Opinions about science and technology, section - G	One scale and two individual items
Experiences of social and digital media, section - H	One scale and six individual items
Informal science experiences, section - I	Two scales according to the type of informal experience

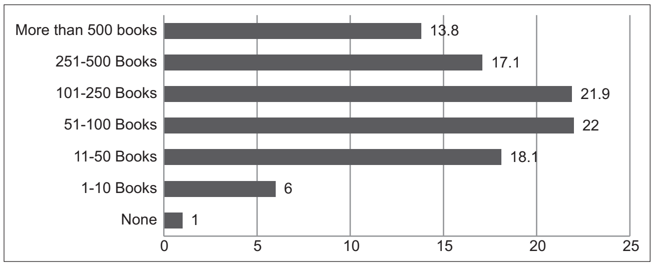

Figure 1: How many books are there in your home?

in teamwork as it requires consideration of other team members' interests and potentials and, therefore, may create an obstacle for individual success. Moderate correlation with preferring independent/individual work career scale means that individual success may be more related to individual job. However, these two are still quite different from each other – one may want to work individually but not be much interested in a high-rank position, etc. The correlations among the three scales prove that the three-factor structure holds true for our participants.

Thus, we were able to present the structure of the ROSES questionnaire for the first time, as no account of such analysis was published (it has to be noted that colleagues from different countries have conducted similar analysis but have not reported their results yet Westman et al., 2022). The final structure of the questionnaire enabled us to proceed with the analysis of the data and obtain interesting findings, as well as develop relevant recommendations, which is the second aim of the present study.

Georgian Basic and Secondary School Students' Individual, Vocational, and Societal Dimensions of Relevance of Science Education

Mean scores of the scales and items align around 3 (maximum 4 scores can be obtained), which indicates positive assessment. This means that overall students demonstrate motivation and interest in learning science, are engaged in extracurricular activities, use social media for study aims, are concerned with environmental problems, and consider science classes interesting. These represent the individual dimension. Particularly, promising prospects are reflected in the highest scores gained by *preferring independent/individual work career* and *preferring teamwork career* scales, meaning that students are almost certain what type of job they want to have and that they prefer these types of job to material gain type jobs. This represents the vocational dimension. Quite a substantial difference in mean scores between two scales of locus of control over environmental challenges shows that students are more inclined to undertake personal responsibility over environmental problems rather than delegate them to others, which is a positive sign and may be attributed to the curriculum, as well as special trainings because, as stated above, the school teachers participating in the study are members of the science SALiS network. Furthermore, logically, this variable is weakly linked with prospects for material gain jobs. Taken together, the results point to students' mature attitude to these issues. Interestingly enough, girls take personal responsibility over environmental problems, while boys delegate the responsibility for solving environmental problems to others. This represents the societal dimension. Likewise, Finnish 9th grade girls have an internal locus of control, while boys show an external locus of control (Uitto et al., 2004). A similar difference was found in Turkey (Cavas et al., 2009).

The results of individual dimension factor analysis show that students are interested in scientific discoveries and unexplained phenomena rather than other aspects of science, while the weakest interest was shown in health and health-care issues. Girls demonstrated stronger interest across almost all interest scales, especially, in eating disorders and skin care issues, unexplained phenomena, and health-care issues displaying a quite strong gender effect; while out-of-school club members showed higher scores on all interest scales, but, the differences are small and thus trivial, pointing to a negligible effect. These clubs participate in different projects, such as science picnics and national Science on Stage festivals, apparently, more such activities are needed.

Having interest in various aspects of a discipline has been shown to be a strong predictor of positive attitudes, thus intrinsic motivation of learning (Cheung, 2017; Levrini et al., 2019; Vossen et al., 2018). Therefore, it is important to raise students' interest in science issues (Bolte et al., 2013). Uitto et al. went further to demonstrate that interest in environmental issues is linked with taking environmental responsibility (Uitto et al., 2011). In our case, the interest score is lower than the score of environmental responsibilities and its correlations are moderate: around 0.4 with *taking personal environmental responsibility* and around 0.3 with *delegating environmental responsibility*. These are promising findings.

Science classes are rather appreciated; however, scores align around 3 and can be further improved. They are appreciated more by girls – similar results were found by Uitto et al., 2011 and by ninth grade students. The latter result can be explained by the fact that tenth grade students have already made future career decisions not in favor of science and know that science classes are not going to be much useful for them. Apparently, school system plays a decisive role here. For example, in Turkey, preference of choosing STEM university education increases along with the school grade (Kızılay et al., 2019). Extracurricular activities, on the other hand, deserve a rather low average score, especially those related to visiting various institutions. It could be explained by the lack of science centers or science museums in Georgia, also including the capital city. Girls and club members are more involved in visiting institutions outside schools, while boys show higher scores in using social media. Already 100 ago, specialists started considering the importance of linking school education to real life and called this a relevance of science education: students should be able to apply the acquired knowledge in their daily life as well as use out-of-school experiences in school. Thus, going outside of school and watching how science laws operate in real life should contribute to increasing students' interest in science (Stuckey et al., 2013).

The scales of *using social media in science classes* and *having informal science experience through using social media* for study reasons moderately correlate with each other, −0.411, as they represent different domains: in-school and out-of-school. However, they are connected, which suggests that, overall, using social media for study reasons is weak. Indeed, the scale *using social media in science classes* deserved the lowest score, slightly above 2. The same is true about similar individual items connected with the usage of social and digital media in schoolwork and the level of school support in using social media at schools. The reason might also be a low-speed internet, or in rural schools, especially in mountain regions, no internet connection at all. In combination with the finding that students are willing to better use social media at school for study reasons (this item has the second highest score among all individual items), this is a direct message to those in charge of equipping schools with internet technology and access to social media, as well as to those who plan class activities. The role of media has become much more important since the pandemic-related lockdowns, exposing the problem of Georgian teachers' "limited competency in using technology" (Country Gender Equality Profile of Georgia, 2021, p. 38), which is not surprising against the backdrop of a relatively small number of younger teachers and no special educational programs.

Alerting educators about the use of social media in school is further justified by findings on the individual item *I am using social media at home*, as it scored higher than the items on media use at school. Given mostly weak positive correlations among individual items, attention should be paid to weak but negative correlation of this item with most of the *interest* scales, as well as with *having informal science experience through visiting relevant institutions* and Preferring teamwork career These results mean that the more students use social media at home, most probably for entertainment, the less they are interested in various topics, less concerned about environment problems, have more negative attitudes to their science classes, and are less engaged in extracurricular activities. This finding calls on educators and parents to unite their forces in addressing the problem of students spending more time on online entertaining programs rather than on learning activities. To sum up, more extracurricular activities and a broader application of social and digital media as an educational tool would inevitably help improving science classes and reinforcing a positive attitude to them.

The effect of out of school club membership is expected but relatively small and, therefore, needs to be increased. Specifically, club members are more interested in various phenomena, have more positive attitudes toward science and more experience in visiting relevant institutions outside of school. These clubs actively cooperate and are engaged in the science SALiS center projects. Therefore, club effect should be considered above and over the effect of SALiS. Likewise, girls are more interested and have a more positive attitude to science, more experience in visiting relevant institutions outside school and a higher degree of personal responsibility over environmental problems, while boys delegate responsibility for solving environmental problems to others and use social media more. It should be noted that in China, girls showed higher interest in science than boys (Jia et al., 2020), while 2006 data of Israeli school students produced the opposite results (Trumper, 2006). However, much has been done since then to support girls in STEM disciplines worldwide and Israeli students' results may have changed over the years. In our study, gender effect is quite substantial and higher than that of club membership or school location and class. Also, there is an overlap between club membership and gender with almost 63% of club members being female, which points to the fact that overall girls are more active, motivated, and mature, which, at least partially, can be ascribed to various gender equality-aimed programs carried out at schools, mainly, with the support of international donor organizations and universities in Georgia (USAID, US Embassy, Millennium Foundation, and others). According to gender equality assessment in the education sector in Georgia, science knowledge, and competency indicators are close to equal; however, at the university level, science-related careers are pursued mostly by boys, while "women are underrepresented in STEM fields" (Country Gender Equality Profile of Georgia, 2021, p. 43). It has to be noted that the results of public and private as well as rural and urban schools do not differ from each other, which can be explained by the homogeneity of our sample as SALIS network members.

According to Derek Cheung, students' interest in science classes is influenced by interest in science, gender, grade level, science self-concept, and class climate (Cheung, 2017). The results point to a larger-scale finding about the individual, vocational, and societal dimensions. Specifically, interest, attitudes, experiences, gender, and grade level are factors for the relevance of science education at schools.

CONCLUSIONS, LIMITATIONS AND FURTHER RESEARCH

The study shows that the vocational and societal dimensions of the relevance of science education are relatively better represented in our sample, but the individual dimension, especially, the use of social and digital media and out-of-school experience, lag behind. Georgian students demonstrate motivation and interest in learning science, are engaged in extracurricular activities, use social media for study aims, are concerned with environmental problems, and consider science classes interesting, but the levels of motivation, interest, and positive attitudes are not high and they are only weakly related with one another. In addition, gender has a significant effect on interests, experiences, and attitudes of students to sciences. Overall, the findings are rather positive, but not very promising.

These findings, on the one hand, can be used to explain Georgian students' poor performance in almost all international tests. Specifically, according to relevant reports (naec.ge), Georgian students' average PISA results seriously declined from 2015 to 2018. Likewise, according to TIMSS 2019 results, Georgian students' performance in science subjects is lower than the international average. On the other hand, the findings help us predict future development of the relevance of science education in Georgia as well as in other similar societies and provide recommendations to stakeholders. As students' attitudes influence their achievements (Cracker, 2006), more efforts are required from the policymakers, educators, and curriculum experts in Georgia to take special measures for raising students' motivation and positive attitudes to science. These findings serve as well educators from other countries with similar schooling environment and challenges.

From the methodological point of view, the main findings are that items in the ROSES questionnaire sections can be grouped into scales, which allows us to shrink the existing data and produce meaningful analysis across scales. The large number of items in the ROSES questionnaire makes it difficult to see the overall picture and analyze the results across different sections. This might be one of the reasons for the lack of publications (to the best of our knowledge) based on the entire questionnaire data (https://www.miun.se/en/Research/researchgroups/roses/publications/). This kind of analysis was made possible by the complex approach we developed, which can be used elsewhere as a methodological tool to reduce the number of items and process and analyze them in a parcel. Another methodological finding is to remove *section K* on the number of books at home as it does not produce any meaningful data or links.

The current study has certain limitations, one of which is the lack of specific data that would enable us to better explain our results. For example, we know that students use social media at home, but we are not completely sure if they use it exclusively or largely for entertainment. Furthermore, the questionnaire did not contain items inquiring about trainings or other awareness-raising programs carried out at schools. It is important that further research includes these items, as well as analyses of two categorical sections, J (Myself as a scientist) and L (What occupation would you like to have in the future?), which would provide more insight into our findings. Furthermore, our sample represents students from schools that participate in the science SALiS network, which excludes other schools in the country and limits our generalization scope. The limitation was due to lack of funds as well as pandemic-driven lockdowns and we aim to eliminate it in our future study.

With the dual aim, the current article addressed the main purpose of the ROSES international project: To assist educators worldwide in improving factors affecting science learning at basic and secondary schools through providing data and findings on the individual, societal, and vocational dimensions of the relevance of science education for informed decision, which in turn, will help to improve science learning (Sjøberg and Schreiner, 2019).

ETHICS STATEMENT

Permission for data collection from human subjects was obtained from the university research ethics board. Furthermore, the research plan was coordinated with the Ministry of Education of Georgia before data collection.

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APPENDICES

Appendix 1: MANOVA. Class, gender, school location and club membership effect on scale scores

Variables	Sex						Grade					
		M	*SD*	F	p	η2		*M*	*SD*	F	p	η2
Interested in environment and sustainable development	girls	2.81	0.724	0.009	0.923	0.000	9th	2.84	0.717	5.250	0.022	0.003
	boys	2.80	0.701				10th	2.76	0.708			
Interested in space and physical phenomena	girls	3.00	0.579	11.625	0.001	0.008	9th	3.00	0.584	14.237	0.000	0.009
	boys	2.89	0.587				10th	2.89	0.580			
Interested in plants, animals, nature	girls	3.12	0.597	19.883	0.000	0.013	9th	3.11	0.605	15.249	0.000	0.010
	boys	2.98	0.612				10th	2.99	0.605			
Interested in unexplained phenomena	Girls	3.46	0.578	150.773	0.000	0.091	9th	3.30	0.664	3.825	0.051	0.003
	boys	3.05	0.710				10th	3.24	0.680			
Interested in science inventions and discoveries	girls	3.21	0.602	18.595	0.000	0.012	9th	3.18	0.619	5.659	0.017	0.004
	boys	3.06	0.655				10th	3.10	0.641			
Interested in issues related to sex and reproduction	girls	3.00	0.713	48.377	0.000	0.031	9th	2.88	0.728	0.123	0.726	0.000
	boys	2.74	0.726				10th	2.89	0.733			
Interested in eating disorders and skin care issues	girls	2.98	0.761	455.283	0.000	0.233	9th	2.60	0.892	0.015	0.903	0.000
	boys	2.11	0.815				10th	2.57	0.904			
Interested in factors affecting health and healthcare	girls	3.33	0.627	39.677	0.000	0.026	9th	3.25	0.667	1.715	0.191	0.001
	boys	3.11	0.703				10th	3.21	0.677			
Preferring independent/ individual work in future career	Girls	3.49	0.381	62.176	0.000	0.040	9th	3.42	0.406	1.914	0.167	0.001
	boys	3.32	0.463				10th	3.39	0.452			
Preferring teamwork in future career	girls	3.34	0.526	8.905	0.003	0.006	9th	3.34	0.559	9.286	0.002	0.006
	boys	3.25	0.575				10th	3.26	0.540			
preferring a high income/high position career	girls	3.05	0.581	20.106	0.000	0.013	9th	3.04	0.588	9.758	0.002	0.006
	boys	2.91	0.600				10th	2.93	0.596			
Delegating environmental responsibility to others	girls	2.40	0.544	17.785	0.000	0.012	9th	2.48	0.571	6.270	0.012	0.004
	boys	2.51	0.560				10th	2.41	0.532			
Taking personal environmental responsibility	girls	3.45	0.466	36.690	0.000	0.024	9th	3.41	0.490	8.990	0.003	0.006
	boys	3.29	0.548				10th	3.33	0.531			
Having a positive attitude to science classes	girls	3.01	0.745	25.719	0.000	0.017	9th	3.02	0.728	32.155	0.000	0.021
	boys	2.81	0.755				10th	2.80	0.769			
Having a positive attitude to science and technology	girls	2.88	0.544	0.552	0.458	0.000	9th	2.92	0.565	13.897	0.000	0.009
	boys	2.85	0.584				10th	2.81	0.554			
Having informal science experience through visiting relevant institutions	girls	2.38	0.773	52.529	0.000	0.034	9th	2.32	0.757	3.259	0.071	0.002
	boys	2.17	0.754				10th	2.24	2.73			
Having informal science experience through using social media	girls	2.68	0.659	26.045	0.000	0.017	9th	2.81	0.675	5.569	0.018	0.004
	boys	2.88	0.680				10th	2.73	0.676			
Using social media in my science classes	girls	2.12	0.570	36.032	0.000	0.023	9th	2.23	0.652	0.331	0.565	0.000
	boys	2.35	0.693				10th	2.21	0.623			

Variables	Club						School location					
		M	*SD*	F	p	η2		*M*	*SD*	F	p	η2
Interested in environment and sustainable development	yes	2.97	0.716	24.648	0.000	0.016	other	2.89	0.701	32.772	0.000	0.021
	no	2.75	0.705				Tbilisi	2.68	0.708			
Interested in space and physical phenomena	yes	3.07	0.589	18.405	0.000	0.012	other	3.02	0.583	25.533	0.000	0.017
	no	2.91	0.579				Tbilisi	2.87	0.562			
Interested in plants, animals, nature	yes	3.18	0.588	18.679	0.000	0.012	other	3.13	0.584	36.655	0.000	0.024
	no	3.02	0.579				Tbilisi	2.94	0.624			
Interested in unexplained phenomena	yes	3.38	0.612	12.038	0.001	0.008	other	3.30	0.674	4.439	0.035	0.003
	no	3.24	0.686				Tbilisi	3.23	0.673			
Interested in science inventions and discoveries	yes	3.25	0.599	13.456	0.000	0.009	other	3.20	0.622	14.215	0.000	0.009
	no	3.11	0.636				Tbilisi	3.07	0.633			

(Contd...)

Appendix 1: *(Continued)*

Variables	Club	*M*	*SD*	F	p	η2	School location	*M*	*SD*	F	p	η2
Interested in issues related to sex and reproduction	yes	3.08	0.701	31.743	0.000	0.021	other	2.94	0.719	12.779	0.000	0.008
	no	2.83	0.729				Tbilisi	2.81	0.731			
Interested in eating disorders and skin care issues	yes	2.84	0.868	37.512	0.000	0.024	other	2.67	0.895	19.728	0.000	0.013
	no	2.50	0.892				Tbilisi	2.46	0.880			
Interested in factors affecting health and healthcare	yes	3.39	0.623	26.830	0.000	0.018	other	3.30	0.647	21.469	0.000	0.014
	no	3.18	0.678				Tbilisi	3.14	0.691			
Preferring independent/individual work in future career	yes	3.46	0.399	5.287	0.022	0.004	other	3.42	0.416	3.063	0.080	0.002
	no	3.40	0.436				Tbilisi	3.38	0.442			
Preferring teamwork in future career	yes	3.39	0.509	12.295	0.000	0.008	other	3.35	0.524	16.169	0.000	0.011
	no	3.27	0.560				Tbilisi	3.24	0.573			
preferring a high income/high position career	yes	3.03	0.575	3.021	0.082	0.002	other	3.03	0.601	8.810	0.003	0.006
	no	2.97	0.599				Tbilisi	2.94	0.578			
Delegating environmental responsibility to others	yes	2.51	0.593	4.792	0.029	0.003	other	2.49	0.578	13.828	0.000	0.009
	no	2.43	0.541				Tbilisi	2.39	0.510			
Taking personal environmental responsibility	yes	3.44	0.507	8.816	0.003	0.006	other	3.41	0.509	11.580	0.001	0.008
	no	3.35	0.511				Tbilisi	3.32	0.514			
Having a positive attitude to science classes	yes	3.10	0.727	25.007	0.000	0.016	other	3.03	0.710	43.915	0.000	0.028
	no	2.86	0.756				Tbilisi	2.77	0.783			
Having a positive attitude to science and technology	yes	2.94	0.576	7.497	0.006	0.005	other	2.90	0.569	8.205	0.004	0.005
	no	2.84	0.557				Tbilisi	2.81	0.551			
Having informal science experience through visiting relevant institutions	yes	2.49	0.791	32.282	0.000	0.021	other	2.29	0.782	0.127	0.722	0.000
	no	2.22	0.754				Tbilisi	2.27	0.749			
Having informal science experience through using social media	yes	2.74	0.686	1.048	0.306	0.001	other	2.77	0.680	0.019	0.891	0.000
	no	2.78	0.673				Tbilisi	2.77	0.671			
Using social media in my science classes	yes	2.28	0.672	3.789	0.052	0.003	other	2.24	0.641	2.928	0.087	0.002
	no	2.20	0.627				other	2.19	0.622			

Appendix 2: Correlations among scales and individual items

	1	2	3	4	5	6	7	8	9	10	11
1. Interested in environment and sustainable development		.702**	.656**	.392**	.717**	.514**	.371**	.567**	.422**	.392**	.292**
2. Interested in space and physical phenomena	.702**		.720**	.486**	.686**	.489**	.452**	.545**	.476**	.382**	.297**
3. Interested in plants, animals, nature	.656**	.720**		.452**	.614**	.472**	.404**	.548**	.452**	458**	.289**
4. Interested in unexplained phenomena	.392**	.486**	.452**		.506**	.432**	.409**	.423**	.400**	.326**	.358**
5. Interested in science inventions and discoveries	.717**	.686**	.614**	.506**		.513**	.376**	.588**	.505**	.389**	.316**
6. Interested in issues related to sex and reproduction	.514**	.489**	.472**	.432**	.513**		.495**	.572**	.360**	.310**	.270**
7. Interested in eating disorders and skin care issues	.371**	.452**	.404**	.409**	.376**	.495**		.503**	.301**	.260**	.318**
8. Interested in factors affecting health and healthcare	.567**	.545**	.548**	.423**	.588**	.572**	.503**		.413**	.419**	.295**
9. Preferring independent/individual work career	.422**	.476**	.452**	.400**	.505**	.360**	.301**	.413**		.526**	.484**
10. Preferring teamwork career	.392**	.382**	.458**	.326**	.389**	.310**	.260**	.419**	.526**		.327**
11. Preferring a high income/ high status career	.292**	.297**	.289**	.358**	.316**	.270**	.318**	.295**	.484**	.327**	
12. Delegating environmental responsibility	.344**	.254**	.253**	.166**	.211**	.195**	.132**	.160**	.153**	.221**	.292**
13.Taking personal environmental responsibility	.423**	.410**	.427**	.333**	.494**	.311**	.268**	.436**	.479**	.436**	.215**
14. Having a positive attitude to science classes	.571**	.565**	.535**	.340**	.603**	.425**	.338	.485	.368	.355	.212
15. Having a positive attitude to science and technology	.557**	.510**	.457**	.275**	.600**	.386**	.286**	.371**	.358**	.295**	.242**
16. Having informal science experience through visiting relevant institutions	.329**	.321**	.313**	.207**	.311**	.236**	.253**	.192**	.196**	.147**	.158**
17. Having informal science experience through using social media	.155**	.164**	.147**	.117**	.173**	.095**		.104**	.149**	.144**	.221**
18. Using social media in my science classes	.196**	.156**	.138**		.084**	.072**		.052*	.063*	.119**	.170**
19. G9. Science and technology are the cause of the environmental problems	.301**	.211**	.188**	.127**	.205**	.172**	.114**	.113**	.133**	.135**	.150**
20. G11. Science and technology benefit mainly the developed countries	.220**	.218**	.181**	.157**	.277**	.162**	.079**	.141**	.213**	.122**	.168**
21. H1. In school I am using social and digital media in my schoolwork											.054*
22. H2. I am using social and digital media at home	-.170**	-.123**	-.146**	.060*	-.091**			-.112**		-.114**	
23. H13. Is reliable	.152**	.175**	.154**	.088**	.206**	.079**	.059*	.121**	.144**	.136**	.108**
24. H14. Is better than my science textbook in school	.059*	.057*		.062*	.067**						.098**
25. H15. Is encouraged by the school	.239**	.209**	.196**	.165**	.196**	.133**	.122**	.157**	.107**	.166**	.156**
26. H16. Could be better used for learning in school	.147**	.182**	.161**	.147**	.247**	.161**	.081**	.140**	.197**	.104**	.085**
27. F1. School science is a difficult subject				.097**			.052*			.079**	.074**
28. F2. School science is interesting	.388**	.433**	.406**	.244**	.425**	.311**	.219**	.358**	.272**	.247**	.108**
29. F4. I like school science better than most of the other subjects	.381**	.388**	.312**	.166**	.349**	.264**	.189**	.244**	.164**	.140**	.106**
30. F10. I would like to become a scientist	.339**	.323**	.190**	.119**	.279**	.168**	.124**	.084**	.115**	.059*	.208**
31. F11. I would like to get a job in technology	.242**	.252**	.114**		.180**	.051*			.126**	.064*	.126**

	12	13	14	15	16	17	18	19	20	21	22
1. Interested in environment and sustainable development	.344**	.423**	.571**	.557**	.329**	.155**	.196**	.301**	.220**		-.170**
2. Interested in space and physical phenomena	.254**	.410**	.565**	.510**	.321**	.164**	.156**	.211**	.218**		-123**
3. Interested in plants, animals, nature	.253**	.427**	.535**	.547**	.313**	.147**	.138**	.188**	.181**		-.146**
4. Interested in unexplained phenomena	.166**	.333**	.340**	.275**	.207**	.117**		.127**	.157**		.060*
5. Interested in science inventions and discoveries	.211**	.494**	.603**	.600**	.311**	.173**	.084**	.205**	.277**		-.091**
6. Interested in issues related to sex and reproduction	.195**	.311**	.425**	.386**	.236**	.095**	.072**	.172**	.162**		
7. Interested in eating disorders and skin care issues	.132**	.268**	.338**	.286**	.253**			.114**	.079**		
8. Interested in factors affecting health and healthcare	.160**	.436**	.485**	.371**	.192**	.104**	.052*	.113**	.141**		-.112**

Appendix 2: *(Continued)*

	12	13	14	15	16	17	18	19	20	21	22
9. Preferring independent/individual work career	.153**	.479**	.368**	.358**	.196**	.149**	.063*	.133**	.213**		
10. Preferring teamwork career	.221**	.436**	.335**	.295**	.147**	.144**	.119**	.135**	.122**		-.114**
11. Preferring a high income/ high status career	.292**	.215**	.212**	.242**	.158**	.221**	.170**	.150**	.168**	.054*	
12. Delegating environmental responsibility		.184**	.202**	.316**	.168**	.216**	.293**	.337**	.252**	.062**	-.070**
13.Taking personal environmental responsibility	. 184**		.488**	.428**	.230**	.079**		.128**	.174**		-.067**
14. Having a positive attitude to science classes	.202	.488		.651	.370	.128	.118	.258	.236		-.143
15. Having a positive attitude to science and technology	.316**	.428**	.651**		.390**	.222**	.169**	.354**	.420**		-.078**
16. Having informal science experience through visiting relevant institutions	.168**	.230**	.370**	.390**		.105**	.136**	.214**	.154**		-.063*
17. Having informal science experience through using social media	.216**	.079**	.128**	.222**	.105**		.411**	.147**	.157**	.085**	.105**
18. Using social media in my science classes	.293**		.118**	.169**	.136**	.411**		.216**	.097**	.109**	
19. G9. Science and technology are the cause of the environmental problems	.337**	.128**	.258**	.354**	.214**	.147**	.216**		.296**		
20. G11. Science and technology benefit mainly the developed countries	.252**	.174**	.236**	.420**	.154**	.157**	.097**	.296**			
21. H1. In school I am using social and digital media in my schoolwork	.062*					.085**	.109**				-.060*
22. H2. I am using social and digital media at home	-.070**	-.067**	-.143**	-.078**	-.063*	.105**				-.060*	
23. H13. Is reliable	.161**	.144**	.189**	.281**	.173**	.198**	.214**	.131**	.149**		-.138**
24. H14. Is better than my science textbook in school	.234**		-.093**	.098**	.106**	.229**	.224**	.143**	.145**		-.092**
25. H15. Is encouraged by the school	.289**	.131**	.235**	.273**	.174**	.234**	.337**	.244**	.167**		
26. H16. Could be better used for learning in school	.065**	.207**	.177**	.266**	.157**	.195**	.115**	.101**	.216**		.206**
27. F1. School science is a difficult subject	.163**		-.105**			.059*	.062*	.127**	.059**	.206**	
28. F2. School science is interesting	.092**	.369**	.657**	.425**	.258**			.128**	.148**		
29. F4. I like school science better than most of the other subjects	.218**	.243**	.596**	.447**	.287**	.114**	.130**	.211**	.150**	.095**	.064*
30. F10. I would like to become a scientist	.283**	.054*	.327**	.385**	.260**	.117**	.243**	.251**	.173**	.080**	-.072**
31. F11. I would like to get a job in technology	.209**		.180**	.283**	.098**	.229**	.274**	.182**	.156**		.086**

	23	24	25	26	27	28	29	30	31
1. Interested in environment and sustainable development	.152**	.059*	.239**	.147**		.388**	.381**	.339**	.242**
2. Interested in space and physical phenomena	.175**	.057*	.209**	.182**		.433**	.388**	.323**	.252**
3. Interested in plants, animals, nature	.154**		.196**	.161**		.406**	.312**	.190**	.114**
4. Interested in unexplained phenomena	.088**	.062*	.165**	.147**	.097**	.244**	.166**	.119**	
5. Interested in science inventions and discoveries	.206**	.067**	.196**	.247**		.425**	.349**	.279**	.180**
6. Interested in issues related to sex and reproduction	.079**		.133**	.161**		.311**	.264**	.168**	.051*
7. Interested in eating disorders and skin care issues	.059*		.122**	.081**	.052*	.219**	.189**	.124**	
8. Interested in factors affecting health and healthcare	.121**		.157**	.140**		.358**	.144**	.084**	
9. Preferring independent/individual work career	.144**		.107**	.197**		.272**	.164**	.115**	.126**
10. Preferring teamwork career	.136**		.166**	.104**	.079**	.247**	.140**	.059*	.064*
11. Preferring a high income/ high status career	.108**	.098**	.156**	.085**	.074**	.108**	.106**	.208**	.126**
12. Delegating environmental responsibility	.161**	.234**	.289**	.065*	.163**	.092**	.218**	.283**	.209**
13.Taking personal environmental responsibility	.144**		.131**	.207**		.369**	.243**	.054*	
14. Having a positive attitude to science classes	.189	-.093	.235	.177	-.105	.657	.596	.327**	.180**
15. Having a positive attitude to science and technology	.281**	.098**	.273**	.266**		.425**	.447**	.385**	.283**
16. Having informal science experience through visiting relevant institutions	.173**	.106**	.174**	.157**		.258**	.287**	.260**	.098**

Appendix 2: *(Continued)*

	23	24	25	26	27	28	29	30	31
17. Having informal science experience through using social media	.198**	.229**	.234**	.195**	.059*		.114**	.117**	.229**
18. Using social media in my science classes	.214**	.224**	.337**	.115**	.062*		.130**	.243**	.274**
19. G9. Science and technology are the cause of the environmental problems	.131**	.143**	.244**	.101**	.127**	.128**	.211**	.251**	.182**
20. G11. Science and technology benefit mainly the developed countries	.149**	.145**	.167**	.216**	.059*	.148**	.150**	.173**	.156**
21. H1. In school I am using social and digital media in my schoolwork					.206**		.095**	.080**	
22. H2. I am using social and digital media at home	-.138**	-.092**		.206**			.064*	-.072**	.086**
23. H13. Is reliable		.306**	.266**	.264**		.118**	.151**	.101**	.109**
24. H14. Is better than my science textbook in school	.306**		.246**	.311**	.141**	-.155**		.096**	.104**
25. H15. Is encouraged by the school	.266**	.246**		.189**	.084**	.114**	.156**	.208**	.129**
26. H16. Could be better used for learning in school	.264**	.311**	.189**			.101**	.120**	.072**	.108**
27. F1. School science is a difficult subject		.141**	.084**			-.155**	-.127**		
28. F2. School science is interesting	.118**	-.155**	.114**	.101**	-.155**		.494**	.215**	.093**
29. F4. I like school science better than most of the other subjects	.151**		.156**	.120**	-.127**	.494**		.426**	.225**
30. F10. I would like to become a scientist	.101**	.096**	.208**	.072**		.215**	.426**		.478**
31. F11. I would like to get a job in technology	.109**	.104**	.129**	.108**		.093**	.225**	.478**	

Spearman's ρ is calculated for the ordinal data ("In school I am using social and digital media in my schoolwork"; "I am using social and digital media at home"), **. is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Pearson's r for the rest of the data. **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).