Grade nine students' learning interests towards science topics presented in different contexts and their motivation to learn science

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Summary

Introduction

Today's society needs active citizens who appreciate education, especially learning at school. If students feel that subjects such as science are valuable and meaningful for them, they are more likely to use their acquired knowledge and skills in deciding their future career choices. The PISA 2006 international comparative study, in which the main area tested is science, shows that only 16% of Estonian 15-year-old students wish to relate their future career with science-related disciplines (OECD, 2007). When comparing the PISA 2006 and 2015 results, it is evident that there is a statistically significant increase (7.8%) in students who are interested in choosing science-related future careers (OECD, 2016; PISA 2015 Eesti tulemused, 2016).

The investigation of students' interest and motivation towards science learning is an important issue in science education, as well as at the political level. Findings from the last decade (2000-2009) indicate that learning science at school is irrelevant and less related to students' everyday life and social environment (OECD, 2007; Osborne & Collins, 2001). While recent studies, such as PISA 2015, show a tendency for Estonian 15-year-old students' interest towards learning science to have increased, the PISA 2015 survey also indicated that 37% of respondents (more girls than boys) are not interested in studying science. Based on this, it is suggested still necessary to find ways to increase students' interest and motivation towards science learning, especially where students have minimal or no interest. Furthermore, despite these contradictory results, little has been studied about how science content, presented in different contexts, affects students'

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curriculum-related science interest within four science subjects (biology, earth science, chemistry, and physics).

The main purpose of the current study is to determine contexts in which grade nine students have greater interest and motivation to learn within the four science subjects.

More specifically the following research questions are put forward:

1. What type of contexts invokes a wider cross-section of students to be interested in learning science subjects with respect to an individual topic?
2. To what degree are there gender differences in students' interests and motivation to learn towards science topics when presented in different contexts?
3. What kind of students' motivational profiles can be identified?

Methodology

The research data were collected as part of a larger-scale study, conducted in spring 2016. The sample for the study was composed of 848 ninth grade students, of whom 446 were girls and 402 boys, from 46 schools all over Estonia. Students completed a questionnaire electronically, either in a school computer class, or with tablets.

This study used two components of a larger, more complex instrument, which were associated with interest towards various science contexts and motivation towards science subjects. The interest part of the instrument consisted of 36 science topics, presented in different contexts so that within every science subject (biology, earth science/geography, chemistry and physics) there were nine topics put forward in 3 contexts – content-related, scientific applications related and a socio-scientific problem as the context. The subject areas chosen were plants (in biology); Earth, internal structure and relief (in geography); atomic structure, organic compounds and inorganic compounds (in chemistry); and optics, mechanics and electricity (in physics) – all based both on the content indicated in the Estonian basic school science curricula (2010) and previous research results (Teppo, 2004; Teppo & Rannikmäe, 2008).

Students' motivation to science learning was measured using a modified Intrinsic Motivation Inventory Instrument (Deci & Ryan, 2015), with the following five out of seven sub-scales: interest/enjoyment, self-efficacy, perceived autonomy, effort/importance and value/ usefulness. All statements within the interest part were presented using a 4-point Likert scale (1-not

interested ... 4-very interested) and for the motivation part a 5-point Likert scale (1-not agree … 5-agree) was used. The instrument was piloted before use and validated by experts.

Statistical analysis was carried out using SPSS 23.0. Means (*M*) and standard deviations (SD) were calculated for each item, or group of items (latent variables). The Independent Samples *t*-test was used to determine statistically significant differences between boys and girls. To describe students' interests and motivation, Principal Component Analysis with Varimax Rotation was performed. *K*-means cluster analysis was carried out for identifying students' motivational profiles.

Results and discussion

Students' interests and motivation in learning science

Within the interest part, principal component analysis resulted in five components (future used interest dimensions), describing the contextual nature of interest in science learning. The interest, (H)-dimensions, described altogether 66.1% of the variance of the sample, which were identified as: technological applications, relief, plants, abstract topics and natural phenomena.

Results of the study showed that the students' interests depended both on the context and science subject. Subjects specifically appeared in two H-dimensions – relief (geography) and plants (biology). The results indicated that the students were more interested in these topics when they were presented in personal or social contexts. In contrast to previous studies (Teppo & Rannikmäe, 2008), the outcomes did not reveal students' low interest in plant-related topics, but towards reliefs. Students' high interest in plants can be explained by the curriculum reform carried out in 2010, which provided guidance for a competence-based curriculum design (Põhikooli riiklik õppekava, 2011). In comparison to all H-dimensions, students were more interested in learning about interdisciplinary natural phenomena, presented in personal and social contexts. The least interesting topics were those content-related and abstract in chemistry and physics (atom structure, electric circuits and its components). One reason for this could be the fact that within abstract dimensions we could not distinguish between different contexts and only content-related items were included. According to the context, reasons could also be related to the gender/age specificities (Potvin & Hasni, 2014; Walpner et al., 2016), or teaching science subjects within Estonian schools, separately, from grade 8. Results also showed gender differences – girls were significantly more interested

than boys in learning about plants and natural phenomena Boys were more eager to learn about atomic structure and electric circuits, but the overall interest in these topics was still low.

Within the motivation part, analysis identified five M-dimensions (intrinsic motivation, valuing science learning, effort, negative attitude and science subject), describing 73.3% of the variance. While the second (value) and the third (effort) dimensions overlapped with the subscales in the original instrument (Deci & Ryan, 2015), the first (intrinsic motivation) and the fourth (negative attitude) included items from the interest/enjoyment, perceived competence and autonomy subscales. When comparing differences between boys and girls towards M-dimensions, it became evident that statistically significant differences appeared within two dimensions – girls were perceived to value, and put more effort into science learning than boys.

Students' motivational profiles

Taken into account four M-dimensions (intrinsic motivation, valuing science learning, effort and negative attitude), omitting science subject, K-means cluster analysis identified three clusters (with low, medium and high motivation rate of students) within each science (biology, earth science, chemistry and physics) subject, altogether 12 clusters. Clusters were identified subject-wise, because students answered to all motivational items within one science subject specifically. Clusters differentiated from each other both in size (incl. the number of boys and girls), as well as interest and the motivation to learn.

Results of the study showed a tendency for students with a higher motivation than other student clusters indicated a more positive satisfaction with school science. They were also interested in all topics offered, despite the context. At the same time, students in the low motivation subject related clusters were characterised by the lack of interest in scientific topics, regardless of the context, especially in physics and chemistry abstract topics. However, the average rate of motivation of students was characterised by rather low interest. Thus, based on the results of the current study, it is important to pay more attention to students who have low interest and motivation to learn science subjects, by including more context-based and student-centred learning methods in order to arouse and maintain their interest. In general, the current study shows that students' interests are, on the one hand, subject specific and, on the other hand, students' interest are affected by their motivation level.

Conclusions

1. Students' interest towards learning science topics depended on the context, as well as the science subject. Most students were interested in technological applications and natural phenomena presented in personal and social contexts. Abstract chemistry and physics topics were the most uninteresting for grade nine students. Based on the science subject, it can be concluded that plants in biology, and relief is earth science, were the topics perceived to be within students' interest, dependent on the context.
2. Gender differences emerged, both in the interest, as well as in the motivation, towards science learning. While biology and earth science related topics (plants and various natural phenomena) were significantly more interesting for girls, physics and chemistry related topics (e.g. atomic structure and circuitry) were statistically significantly more interesting for boys than girls. The motivation of girls and boys showed gender differences in the way that the girls were perceived to value and put significantly more effort into science learning than did the boys.
3. Based on the four M-dimensions, it was possible to distinguish, within each science subject, three profiles – high, medium and low motivation students who were differentiated by their contextual interests and motivation.

Based on the current research, it is suggested that science teachers should make more courageous use of personal and social contexts in teaching abstract (content-related) topics, thus increasing and holding interest. Further studies are needed to find out the differences in students' interests and motivation between different age groups (e.g. students from grade 6 and 9) and between students' and teachers' opinions on science learning contexts.

Keywords: interest, motivation, contexts in science learning, students' motivational profiles