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INCREASING THE RELEVANCE OF SCIENCE EDUCATION – STUDENT PREFERENCES FOR DIFFERENT TYPES OF TEACHING SCENARIOS

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Abstract

Research has shown that teaching based on social issues makes science more relevant to students. Students are motivated to learn, if the science content is understandable, interesting and connected with their everyday life.

The goal of this study was to determine which issues were relevant to students and the reasons for this. Issues were presented in the form of scenarios – as a story that leads students into learning science by considering the wider goals of education. Three different categories of scenarios were defined: subject oriented, social issue-based focused on student personal experience and social issue-based, focused on global societal problems. All scenarios were developed by science teachers during a STL training course.

Two hundred and seventy two grade seven to nine students from two schools (suburban town and city) were asked to choose and evaluate the three most interesting scenarios from nine. The results of the study showed gender based differences. Girls were interested in issues that were connected with their health and outlook. Boys liked to study more about the things, which happen in society.
Keywords: relevance, science education, STL teaching scenarios, issue-based teaching.

Introduction

A key factor in improving science education in schools must be making it more relevant. And by relevant here must mean school science being seen as relevant by students (Sjøberg, 2001a). Holbrook (2003) suggested that this could be achieved through meeting one, or all, of the following criteria:

- It directly relates to concerns in the students' immediate environment or area of interest;
- It is a perceived need for the society;
- It is shown to be an interesting and useful component of the curriculum, especially for the more able students.

The importance of relevance by different groups of society initiating public debate has been highlighted by European Union Ministries of Education and research summits (Sjøberg, 2001b) and has been the subject of a number of conferences. One of the latest developments on the importance of relevance in science and technology education was a world conferences convened by ICASE and held in Penang, Malaysia (ICASE, 2003). The sub-themes of the conference recognised that relevance to students, relevance to society and relevance to industry were three important directions to consider. Presentations were made in each of these areas.

It is unclear whether relevance is important for student interest or whether student interest is the primary factor and once students are interested they perceive the science as relevant. The

European wide survey (Candidate Countries Eurobarometer on Science & Technology, 2002) highlighted the fact that interest in following science studies at school is low when related to three main factors: courses unattractiveness, course material being too hard, careers unattractiveness. A USA Indicators Report (2002) highlighted gender issues with regard to public attitudes towards science related issues and it seems that male and female citizens have interpreted most social issues differently. These gender differences were larger among those who had been more educated. It would seem that developing relevance across different genders is difficult from an interesting perspective.

Science curricula have been criticised for ignoring the relevance of science to the health, wealth, happiness, security and curiosity of humanity and neglecting all accounts of the numerous ways in which science based technologies contribute to society (Sjøberg, 2000a). Also Sjøberg (2002a) criticised the so called textbook science for its lack of relevance and lack of deeper meaning for the learners related to their daily life - the content is frequently presented without being related to social and human needs, either present or past, and the historical context of discoveries is reduced to biographical anecdotes.

What research has found about relevance?

Student interest in science has been investigated from different perspectives. In many studies, interest has been associated mostly with student motivation (Osborne *et al*., 2003; Kawachi, 2003; Harlen & Crick, 2003; Hancock, 2002; Hong, Shim & Chang, 1988) and/or relevance (Sjøberg, 2002b; Osborne & Collins, 2001; Hanrahan, 1998; Arena, 1996; Gardner & Tamir, 1989). Relevance is used as a catchword in science education. Johnson (1995) defined relevance as "anything that motivates a student to learn simply for the sake and joy of learning". Yager (1989) defined personal relevance as "the orientation for the curriculum for schools responsibility to develop programs that focus upon the learner, his/her interest and personal experience." Relevance is seen as the key to raising student interests by making it more useful in the eyes of students (Za`rour, 2001).

Another facet of relevance in science education, a more recent thrust, builds on the notion of scientific literacy, or rather the interpretations of scientific literacy that see educational goals as the major thrust for science teaching, rather than science teaching being solely the promotion of science knowledge acquisition (Holbrook & Rannikmäe, 2002). International studies have shown that the relevance of current science education is suspect because it seems that students do not find the knowledge taught to be useful in their future and everyday life (Holbrook, 1998; Osborne & Collins, 2001). Furthermore, research has also shown that students and teachers perception of relevance differ. This has been the case in many post socialist countries, where science has been taught traditional as a body of knowledge and the teaching has not followed rapid changes in society - this has created gaps between students needs and teachers teaching (Rannikmäe, 2001a). Based on research carried out in Western countries, Osborne (*Osborne et al*., 2003) has shown that there were also common aspects of teaching that were perceived to be relevant by both teachers and pupils. These were related to contextualizing content in terms of the students' own experiences and knowledge, as well as being supportive of social contexts designed by teachers. Students do not have extensive background that will enable them to appreciate patterns and how the fundamental building blocks from a basis for making sense of scientific world. However students do have knowledge about the society in which they live. They have had experiences from prior situations. And they are aware of issues and concerns relevant to that society (Lutz, 1996). Those relevant concerns drive students interest. This article looks at the manner in which relevance drives interest.

Issue-based teaching has received much attention

Several studies (Schneider *et al*., 2002) have shown that a from of issue based science, called project-based science (PBS) raised student interest. The PBS approach is built on five features used to design activities that:

- engage students in investigating real-life questions or problems that drive activities and organize concepts and principles;
- result in students developing a series of artefacts, or products, that address the question or problem;
- enable students to engage in investigations;
- involve students in a community of inquiry as they collaborate about the problem;
- promote students' use of cognitive tools (Krajcik *et al*., 1994).

In the PBS approach (Scheider *et al*., 2002), the real-life issue is framed as a question, which organizes and drives students' investigations. The question has also to be meaningful to students and this is achieved by being connected to their own lives or their community. It became evident that issue-based approaches gave good results and students liked to learn through these approaches (Marx *et al*., 1994).

Studies (Rannikmäe, 2001a) have shown that the STL teaching approach has made science learning enjoyable and meaningful for students and is a successful tool in teaching. STL teaching derives from a social constructivist perspective in which it is assumed that students like to find solutions to real problems by asking and refining questions, designing and conducting investigations, analyzing information and data, making decisions and conclusions (Holbrook & Rannikmäe, 1999).

Both these approaches - presenting science conceptual learning through a social issue - focus on the importance of relevance in the eyes of the learners. But there are no studies carried out to illustrate whether relevance is linked with the structure or type of issue. This study addresses this need.

In this article, the main question is does relevance make science education interesting for students? One possibility for increasing relevance in science education is to follow the STL teaching approach. Teaching materials developed under the STL philosophy start with social issue based scenarios - (short stories), which should be created by teachers and used as the focus of science lessons. These scenarios are an essential part of teaching based on the STL philosophy and described by the following criteria (Holbrook & Rannikmäe, 1996; 1997):

- starts from social issue what should be interesting and enjoyable for students;
- ensures relevance of science content – directs students to learn scientific concepts and theories;
- promoting either problem solving and decision making skills including value components and socio-scientific reasoning skills;
- have strong connection with the science curriculum.

Scenarios used in the current study were developed by 45 science teachers as part of their assignments for an in-service program, where all teachers were introduced to a philosophy of STL, trained to write teaching materials against the philosophy (Rannikmäe, 2002) and later asked to use them in their teaching. Research findings, as described in the Journal of Baltic Science Education (Rannikmäe, 2002), showed that only one third of science teachers attain ownership of STL and accepted a social issue based teaching approach. Most teachers adapted new ideas into their teaching, but created scenarios for teaching materials which often included science related issues without a social context, or were presented as add-on examples to subject oriented teaching. Approximately 60% of teachers held subject content driven approaches for

teaching scenarios and thought those to be relevant for students. The current article examines grade 7 to 9 students' choices among the teacher created scenarios and explores whether teachers' and students' opinions on relevant scenarios differ.

Methodology

Sample

The research was carried out in October 2002 involving 272 students, 136 boys and 136 girls (from grades 7 to 9) from two schools. The study was conducted in a public high school (Tartu Tamme Gymnasium) from an urban university town and in Otepää Gymnasium situated in a suburban environment. Both schools are district schools. The schools are considered as alternative high schools and students throughout the appropriate district can elect to attend. The student populations have wide backgrounds and abilities: the schools were not magnet schools for science, nor were they considered among the top schools in the district on student achievement. Science is taught in both schools as separate subjects (biology, chemistry, physics, geography, science) by different teachers.

Instrument

The instrument for this study consists of two parts – scenarios (Appendix 1) and a questionnaire (Appendix 2). Scenarios were chosen from the set developed by 45 science teachers during STL in-service courses. Table 1 illustrates the criteria developed for contracting the set of comparable scenarios for this study. The 9 scenarios were taken from different categories – subject oriented, social issue-based focused on student personal experience and social issue-based focused on global societal problems. A subject-based scenario does not require students' initiative to solve the problem which has already been defined, hence all depends on the teacher whether students will be involved in higher order thinking in the lesson or not. This kind of scenario reflects science textbooks and traditional teaching. The other types of scenarios – connected with students and with the society – require students to think actively, solve problems and make decisions. Such scenarios engage students in investigating real-life questions, or problems, (which are not defined) that drive the activities and organize concepts and principles. Differences between those scenarios depend on the type of issue: the issue might be connected with the student (for example with health) or express global, sometime hot problems (topics) in the society (technology related for example). Categories are also comparable by complexity: the number of the scientific concepts unfamiliar for students (don't know) and the interdisciplinary connections between the science subject (taught separately at school). The title of the scenario was given in question form and did contain words linked to scientific concepts.

Table 1. Comparison of three different categories of scenarios.

Typical quality of scenario	**Subject oriented scenarios** (No II, VI, VII)	**Social issue based focus on student** (No I, III, IX)	**Social issue based focus on societal problems** (No IV, V, VIII)
1. Title of scenario.	Doesn't contain scientific concepts. Question form.	Doesn't contain scientific concepts. Question form.	Doesn't contain scientific concepts. Question form.
2. Scientific key concepts, which students don't yet know.	4-5	4-5	4-5
3. Connections between science subjects.	Connections are interdisciplinary.	Connections are interdisciplinary.	Connections are interdisciplinary.
4. Quality of issue.	Well-defined issue as an application of theory.	Ill-defined issue.	Ill-defined issue.
5. Inquiry skills.	Don't need students' initiative for problem solving.	Problem solving activity depends heavily on students' inputs. Decision-making is an essential component, but shouldn't assume socio-scientific decision-making.	Problem solving activity depends heavily on students' inputs. Socio-scientific decision-making is needed.

Results and discussion

1. Students choices between the most interesting scenarios

In the current study, we identified relevance for students as the leading force to learn science (Osborne *et al*., 2003). The questionnaire was constructed, based on two aspects – students' interests and motivation (willingness to learn - know about) to learn. Before data collection the questionnaire was validated and piloted. Students were asked to read through all 9 scenarios and select from these, the three most interesting ones based on what they wanted to study and to justify their choice by *yes*, *no* or *don't know* using 9 factors (Appendix 2). Students were also asked to show the most uninteresting scenario if there was any and give reason why they didn't like this. The tasks took approximately 40 minutes to complete.

Students' choices of the most interesting scenarios (Figure 1) showed that the most popular scenarios among all students were the so-called student-oriented scenarios. Those scenarios allowed students to relate to familiar or experienced situations (number 1 and 9). This confirmed that certain issues - linked with students' health and outlook, motivate most students to know more about science and to be able to understand the issue. Similar findings have been shown by Sjøberg (2002a). The fact that subject oriented scenarios (2 and 4) were less popular reinforced other research findings which emphasised the gap between student needs and science taught in schools (textbook oriented) and showed how essential it is to change the teacher. Some differences were found between students grade levels and the actual scenario that was preferred whereas grade 7 students liked scenario 9, grade 8 and 9 students preferred number 6, which was an example of a social - related issue.

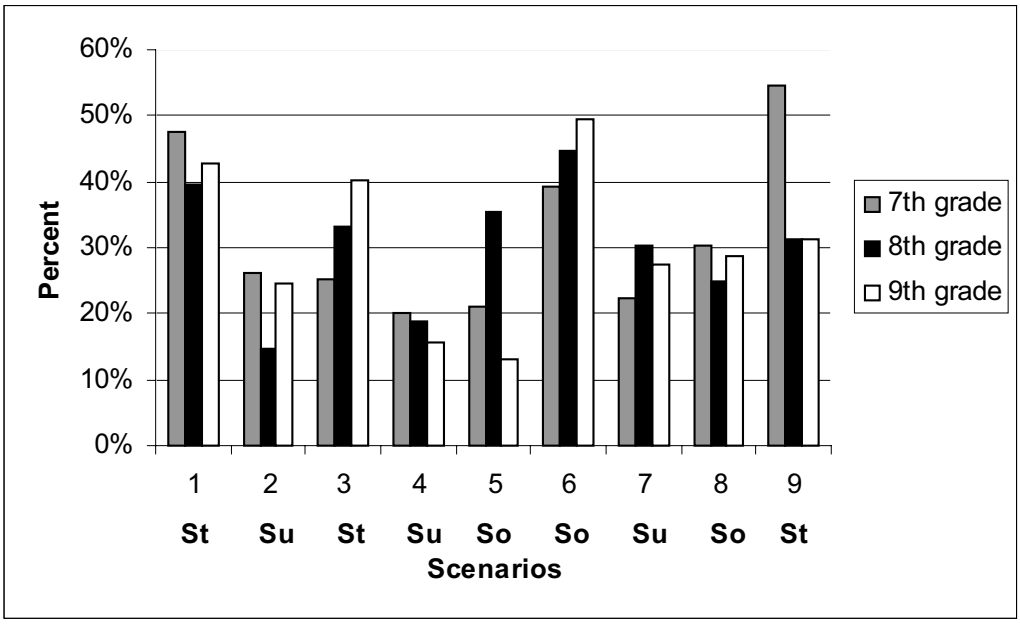

Figure 1. 7th, 8th and 9th grade students' choices between the most interesting scenarios.

St – Social issue based focus on student
Su – Subject oriented scenarios
So – Social issue based focus on societal problems

Table 2 summarises all students' opinions against three categories of scenarios. The tendency shows that students (girls more than boys) like to learn about the problems, which are connected with themselves and their everyday life. Outcomes showed the gender differences are stronger in grades - 7 and 8, where boys liked social based issue focused on societal problems more than girls.

Sjøberg (2002b; 2000b) studies have shown similar tendency among students from developed countries, where boys and girls were interested in different phenomena and issues. Therefore it seems extremely important for younger students that teachers pay attention to gender differences and design teaching to be more relevant for students using a variety of issues. Table 3 shows that boys and girls are not only interested in different issues, but also put forward different justifications.

Table 2. Students' scenario choices in the three categories.

Grade	Gender (N)	Subject oriented scenarios (%)	Social issue based focus on student (%)	Social issue based focus on societal problems (%)
7	Boys (52)	20.6	39.0	40.4
	Girls (47)	27.9	48.6	23.5
8	Boys (50)	27.2	30.1	42.7
	Girls (46)	17.6	43.4	39.0
9	Boys (34)	27.9	38.5	33.6
	Girls (43)	22.4	44.9	32.7

2. Reasons given by students for choosing their most preferable scenarios

The title for a scenario seems to be essential for decision-making – especially for girls (see Table 3). It becomes evident that girls' justifications are similar – they keep pointing out the first three factors – interesting title, everyday life problem and content. Boys' opinions are more diverse - they exhibited larger differences between grades and among factors. Boys also considered meaningful factors – essential in the society and scientific problems. And interestingly content and title were as important as for girls.

Table 3. Important factors for grades 7-9 students in choosing their most preferable scenarios.

	7th grade (%)		8th grade (%)		9th grade (%)	
Factors	girls	boys	girls	boys	girls	boys
1. Interesting title	34.7	27.6	30.4	22.7	38.0	20.6
2. Everyday life problem	26.2	19.2	38.4	22.0	34.9	25.5
3. Interesting content	36.9	28.8	33.3	28.0	42.6	21.6
4. Experienced by myself	19.9	9.6	21.0	20.7	25.6	10.8
5. Essential in society	7.8	12.2	8.0	23.3	10.8	14.7
6. Important in the future	20.6	16.7	19.6	17.3	31.0	11.7
7. Connected with health	22.0	25.6	18.1	24.0	18.6	28.4
8. Scientific problem	9.9	9.6	10.1	7.3	19.3	24.5
9. Interdisciplinary	17.7	10.9	13.8	13.3	14.7	22.5

3. Uninteresting scenario.

There were many students who did not find any uninteresting scenarios. They commented that they had found all scenarios different from previous. Unfortunately there were also a few students who just left the line blank, not making it possible to draw any conclusions from that part of the questionnaire. The most uninteresting scenarios belonged to the subject-oriented category. The outcomes showed that 54% of those who answered this question didn't like the subject-oriented scenarios.

The following examples illustrate students' reasons why they did not like subject-oriented scenarios (the comments are linked with topics from biology curricula, where at these grade levels, students are studying about local plants).

> *"I don't like this problem because there must not be flowers in school. School's purpose is teaching children", "I don't like school and flowers", "About this there is too much reading and speaking".* (From scenario: "In dark or in light?")

> *"Boring text but very useful", "I don't care from which wood the bathhouse platform is made – it is important that I don't burn myself", "To whom is this problem interesting?".* (From scenario: "Why is made the bathhouse platform from the aspen tree wood?")

Social issue-based scenarios, focused on student or on societal problems, were not liked 25% and 21% respectively. Most students' explanations, related to uninteresting scenarios, were short – they used few sentences and didn't use ideas given as factors in the questionnaire. Based on their reasoning, we categorized students' explanations in to the three groups:

a) there were no reasons in the students' answer, just the title of scenario was given;
b) reason given were short and not specified in a sentence: the content of the scenario was uninteresting;
c) students' gave reasons linked with social factors.

Students' reasoning showed that - it is difficult to make learning interesting even through everyday issues when the content is too heavily linked with the science curriculum (for example, plants). Another aspect was that students didn't connect social communication with the objectives of learning.

As all the scenarios were chosen from those created by teachers', there is some evidence that teacher's and students' opinions were different concerning relevant issues. This research enriches the list of reasons why the gap between students and teachers exist.

Conclusions

This study was an attempt to discuss one possible reason to make science education more relevant to students. Issues presented in the form of scenarios were all taken from daily life and presented in slightly different formats for students.

If we use the scenario as a "model" for relevance of science education for students, the following conclusions can be highlighted:

- Boys and girls see the relevance of science education differently and this depends also on age group. It is important to consider gender differences and students age group in designing teaching scenarios for the classroom. For making teaching more relevant for students, teachers should create various types of scenarios. Girls like to study more about things, which are connected with them (with their health and how they look). Boys are more eager to learn about problems that happen in the society (economical and environmental problems);
- Students' and teacher's opinions on relevance differ. 1/3 of teacher created scenarios, were irrelevant in the eyes of students. The outcomes show that the most uninteresting scenarios belong to the subject-oriented category (54% of students who answered this question didn't like the subject oriented scenarios);
- Students free reasoning helps to develop frames for creating relevant scenarios for teaching.

Limitations

As the research was carried out in only two schools, it is not possible to make conclusions about all Estonian students. Thus to make wider conclusions we recommend research with representative samples.

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Appendix 1

An example of an STL teaching scenario

HOW TO GET RID OF BILBERRY BLOTS FROM CLOTHES?

One hot summer day Mary's friends asked her to come swimming with them. Mary put on her swimming suit, put a towel into her new bright bag and off they went. The day passed quickly and soon it was time to go home. While walking back along the pathway, Mary discovered that the bilberries were ripe. The girls put down their bags and began to pick the berries.

When at last Mary reached home, she saw big and horrible blots on her new bag. She began to wash her bag with soap. But soon she noticed that the blots were bright blue and would not disappear. Mary got confused. It was that Mary's mother reached home and understood what had happened. Her mother was aware of the problem and said that bilberries contain certain compounds which when in contact with soap change colour. What to do with the bilberry blots on Mary's new bag?

Instruction for the teacher:

- The title of scenario: *does not contain scientific concepts; question form*
- Scientific concepts: *indicator, acid, base, pH,*
- Connections between science subjects: *biology and chemistry*
- Quality of issue: *ill-defined issue*
- Inquiry skills: *it is necessary to figure out the problem and make socio-scientific decisions*

Appendix 2

QUESTIONNAIRE FOR STUDENT

1. Please read through all nine scenarios (short stories) and select the three most interesting ones you would like to learn about. Write the titles of these scenarios on the following lines.

1. _____
2. _____
3. _____

2. Please justify (if you agree, not agree or don't know) for each of the three scenarios using the following factors.

	Scenario no.1			**Scenario no.2**			**Scenario no.3**		
Factors	Yes	No	Don't know	Yes	No	Don't know	Yes	No	Don't know
1. Interesting title									
2. Everyday life problem									
3. Interesting content									
4. Experienced by myself									
5. Essential in society									
6. Important in the future									
7. Connected with health									
8. Scientific problem									
9. Interdisciplinary									

3. Which of the given scenarios do you not like and why? Please explain your position.

Резюме

ПОВЫШЕНИЕ РЕЛЕВАНТНОСТИ ЕСТЕСТВЕННОНАУЧНОГО ОБРАЗОВАНИЯ: ПРЕДПОЧТЕНИЯ УЧАЩИХСЯ В ВЫБОРЕ ТИПА СЦЕНАРИЯ ПРЕПОДОВАНИЯ

Мооника Теппо, Мииа Ранникмае

Исследование показало, что преподавание, основанное на обсуждении социальных тем делает естествознание более приемлемой для учащихся. Учащиеся получают мотивацию к учебе, если предмет естествознания оказывается понятным, интересным и затрагивает их повседневную жизнь.

Исследование ставило своей целью выявить, какие темы для учащихся приемлемы и почему. Темы были представлены в виде сценариев – как истории, вводящие учащихся в изучаемый предмет через рассмотрение более широких образовательных задач. Было выделено три категории сценариев: предметно-ориентированные; основанные на социальных темах и сосредоточенные на личном опыте студента; сосредоточенные на глобальных общественных проблемах. Все сценарии были разработаны преподавателями естественнонаучных дисциплин в ходе обучающего курса, проведенного STL.

Было опрошено двести семьдесят два учащихся седьмых-девятых классов из двух школ (пригородной и городской). Требовалось выбрать из девяти сценариев три самых интересных и оценить их. Результаты исследования показали гендерные различия: девочки больше интересовались темами, связанными с их здоровьем и внешним видом, тогда как мальчики предпочли изучать вещи, связанные с жизнью общества.

Ключевые слова: релевантность, естественнонаучное образование, сценарии преподавания STL, проблемно-ориентированное преподавание.

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