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Students' Perceptions of an Intervention Course Designed to Raise Science-Related Career Awareness

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Abstract: This longitudinal study focuses on evaluating grade 7-9 school students' perceptions of intervention modules intended to be relevant, as well as promoting learning attributes to raise awareness of science-related careers. Students are taught through six purposely developed and designed career-related teaching–learning modules (C-TLMs). Each module is initiated by means of a career-related scenario, followed up by promoting conceptual science learning plus drawing attention to careers to which each module intends to relate. Student perceptions are obtained by means of a questionnaire after each module with respect to its relevance and also the mean by which the learning environment raise interest, enjoyment and motivation associated with career awareness. Outcomes show that, in general, students participating in this study agree that the developed C-TLMs are relevant and students value the learning experienced through the different module contexts. Nevertheless, student appreciation of the specific inclusion of career awareness components in the modules is mixed.

Keywords: *Career-based teaching-learning module (C-TLM), learning environment attributes, relevance, science-related career awareness.*

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Introduction

Within science education, paradigm shifts have been suggested (Holbrook et al., 2008) that seek to broaden the focus of science education contexts (Gilbert, 2006), include socio-scientific issues (Sadler & Ziedler, 2005), a focus on an 'education through science' approach (Holbrook & Rannikmae, 2007) and more recently, the inclusion of 21st century skills (National Research Council [NRC], 2013). Other concerns have focused on the suitability of science education for everyday life, seeing science education as an important springboard for innovation in the economy and recognising the major developments in science and technology, the latter placing a need for increasing future manpower in science-related careers (European Commission, 2015).

As a preparation for careers in the traditional subject of biology, earth science, chemistry and physics, as well as the science–related fields, such as technology, engineering and mathematics, many of which are viewed as fast growing areas, attention is shifting away from a specific subject education towards a wider competence approach, embodying conceptual learning, as well as attitudes and values towards such careers. Nevertheless, concerns have arisen within science disciplines, even when encompassing an interdisciplinary orientation, pointing to insufficient students to take up science-related careers (European Commission, 2015; The Organisation for Economic Co-operation and Development [OECD], 2018).

In general, it seems students do not see school science-related provisions as useful for their lives and future careers (Tytler & Osborne, 2012). Although students may initially show an interest in science (Cermik & Fenli-Aktan, 2020), research suggests such interest does not remain stable over time (Ardies et al., 2015). Students are not being made aware of career options during science classes (Maltese & Tai, 2011; Margot & Kettler, 2019) and research indicates that the impact of science-related teaching on career decisions by students tends to be negative (Subotnik et al., 2010). Cohen and Patterson (2012) suggest that the omission of career awareness in science classes relates to a low teacher self-efficacy in this area, insufficient teaching-learning materials available to science teachers, plus a perceived pressure

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to emphasise the curriculum in terms of content knowledge. Furthermore, student interest in undertaking science-related careers has been declining for decades internationally (Archer et al., 2014; Aschbacher et al., 2010; Salonen et al., 2018).

Concerns about an awareness of science-related careers apply to Estonia. A research study (Soobard, 2015) has shown that students lack an introduction to science-related 'modern' careers and are insufficiently aware of possible science-related career options suitable for them. Although, based on the Programme for International Student Assessment [PISA] 2015 and 2018 results, more than 25% of grade 9 Estonian students see their future career in science-related fields, the majority of these actually indicate a career interest in information and communication technology (ICT) (OECD, 2016; 2018). Also, previous research has shown that Estonian teachers do not recognise the need to introduce science-related careers to students (Soobard, 2015).

An extensive literature review by Potvin and Hasni (2014) indicates that society oriented, context-based science education increases students' interest, relevance and motivation towards science studies. Furthermore, Salonen et al. (2018) show that it is important to carefully choose the context for developing career awareness, as well as giving careful consideration to the links between the usefulness of a topic, the scientific viewpoint, and its social and personal importance. Gilbert et al. (2011) point out that the meaningfulness of the context is enhanced when it is within a real-world situation, especially if it also has familiarity for students.

Career-related, context-based teaching can be suggested as one science education approach raising awareness of science-related careers, especially if associated with a social constructivist approach (Kukla, 2000) and ensuring relevance of the learning is projected in a motivational format (Levitt, 2001). An initial teaching scenario, built around a motivational context intended to set the scene, can be followed-up within a learning module to facilitate inquiry-based learning (Holbrook & Rannikmae, 2010), introducing a rationale for linking with science-related careers and forming a focus on student career awareness, as well as the conceptual science to be promoted.

This study, undertaken as part of the MultiCo Horizon 2020 study (Horizon2020, Grant Agreement no. 665100) focuses on raising student's science-related career awareness, using context-based scenarios introducing science-related career teaching-learning modules, the modules forming an intervention programme. The aim of this study is to evaluate the Estonian intervention programme, meaningfully seeking to promote relevance and science-related career awareness within motivational contexts. This is seen to relate to aspects of social and personal importance, and which can later be used as a prototype for developing a science-related orientation within a science curriculum involving career awareness.

The following research questions are put forward:

RQ1 How do students perceive the relevance of teaching/learning modules, developed to promote science-related career awareness?

RQ2 Which learning environment attributes do students appreciate as meaningful for the development of science-related career awareness teaching/learning modules?

Literature Review

A core idea of social constructionism, placing emphasis on learning through social interaction (Kukla, 2000) in the process of constructing knowledge, is that the environment plays an important role. Vygotsky's notion of learning through social development (Vygotsky, 1978), indicates that the context for understanding developments within the society can be suggested as playing a major role in students` cognitive development. This leads to the assumption that knowledge, including that science-related, is a product of social interaction, influenced by the environment. This is supported by a focus on situated learning.

Situated learning and context-based teaching

In situated cognition, the environment is the context. This environment can be viewed in a social, or cultural context and thus situated learning relates to the social situation in which it occurs. Lave and Wenger (1991) indicate that situated learning is a form of social co-participation and they see learning as a socio-cultural phenomenon, rather than the action of the individual acquiring general information from a de-contextualised body of knowledge. They state:

> "*A person's intentions to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a social-cultural practice. This social process, includes, indeed it subsumes, the learning of knowledgeable skills*" (Lave & Wenger, 1991, p.29).

Context-based teaching can be seen as situated learning, which relates to a familiar, or at least a social environment, making connections between the real world and the content to be learned (Duranti & Goodwin, 1992). Learners with more self-interest, or engagement can be expected to appreciate the utility of the content to be learned and to recognise its appropriateness. Gilbert (2006) recognised that context-based teaching can be considered from 4 perspectives:

- perspective 1: Context as the direct application of concepts;
- perspective 2: Context as reciprocity between concepts and applications;
- perspective 3: Context as provided by personal mental activity;
- perspective 4: Context as the social circumstances.

Gilbert favoured perspective 4 and most strongly criticised perspective 1, even though it is common in science-related teaching. This is because perspective 1 basically relates to putting forward uses of the conceptual learning and does not:

- introduce students to the social, spatial and temporal framework of a community of practice;
- provide a high-quality learning task, as the behavioural environment is sketchy, almost to the point of invisibility;
- provide a vehicle for students to acquire the coherent use of specific language;
- invoke background knowledge in any significant manner.

Holbrook and Rannikmae (2014) show that the suitability of contexts, positively affecting student interest and motivation, can be initiated by means of a carefully devised scenario, even when providing an initiation into science and technology career orientations. This is an example of model 4 in Gilbert's context-based teaching. Such a scenario can be described as an initial teaching construct, presented by the teacher in a social setting having familiarity to students and which both 'sets the scene' for identifying prior learning. It strives to establish the educational base from which to determine the desired conceptual learning to be developed. The scenario approach is based on social constructivism and self-determination theory (Ryan & Deci, 2002) and seeks to highlight the importance of relevance and interest in driving human behaviour (students' learning).

This scenario viewpoint is seen as being in line with an 'education through science', as opposed to a curriculum science content approach, described as 'science through education' (Holbrook & Rannikmae, 2007). The scenario is seen as a major teaching focus, which can be based on a social issue, or on elements of students' intrigue and interest so as to raise awareness of ways in which science is involved, or impinges on the society. Such an approach pays careful attention to the development of students' personal and social attributes, recognised as part of the overall goals of education. Anchoring the relevance of the instruction, by utilising approaches promoting the situational interest of students, is seen as a further step in creating social constructivist learning. Within the learning process, the scenario is socially contextualised and, with help of the teacher, can be used to stimulate science ideas, initiating science learning through a student-perceived, collaborative learning need. Research has shown that the crucial part of the scenario stage is its relevance to the learners, even if in a sophisticated science-related, multi- or interdisciplinary aspect (Kotkas et al., 2017). Principles, based on Bruner (1966), applicable to the development of a scenario, are:

- instruction is concerned with the experiences and contexts that make the student willing and able to learn (readiness);
- relating to a real-life issue and seeking to trigger motivation to learn;
- instruction is structured (spiral arrangement) so that it can be easily followed by students;
- the scenario presentation, guided by the teacher, is a collaboration between teacher and students.

The scenario is intended to be an introduction, setting the scene for the development of a teaching-learning module (TLM) (Bolte et al., 2012; Holbrook, 2008). Such TLMs have been developed encompassing an initial scenario, based on a contextualised introduction, before engaging in conceptual science learning in a de-contextualised manner, only to re-contextualise to interrelate the conceptual science with the initial scenario setting. This has been termed a 3- stage model approach (Holbrook & Rannikmae, 2010). The implementation of a career-awareness related scenario – conceptual science learning – situational career-awareness consolidation model (Kotkas et al., 2017) can be a pedagogical approach and tool for promoting career-related relevance, social situational interest, science competence development and career associated awareness, valued by society. Scenarios can be derived from a focus on industries related to science themes.

Relevance of Learning

Relevance has been interpreted as importance, usefulness, or meaningfulness to the needs of the student (Levitt, 2001). A more personal interpretation of relevance put forward by Keller (1983) defines relevance as a student's perception as to whether the content, or instruction, satisfied his/her personal needs, personal goals and career goals. The relevance of science education, in the eyes of students, is multi-dimensional (Teppo & Rannikmae, 2008). In reviewing the literature, van Aalsvoort (2004) concludes that there are four aspects of relevance related to the study of science in school: personal relevance (science lessons need to be relevant from a student's perspective); professional relevance (science lessons need to give insights into possible professions); social relevance (provide insights into the role of science in human and social issues); personal and social relevance (science lessons need to help students develop into responsible citizens).

From a teaching perspective, relevance can be divided into:

- Relevance associated with the *initial impact* of the learning on the students i.e. trying to justify an answer to the question 'why study this?'. In this way, relevance is a *perception by students* of usefulness, meaningfulness, being helpful and important, or impact on the area of learning before the learning starts to take place (Holbrook & Rannikmae, 2009).
- Relevance related to the learning to show that the learning has relevance to students i.e. *relevance of the learning,* or answering the question 'why learn these science components?'. Such relevance is triggered by the teaching (towards creating a professional, social or personal need by students) and, as such, is satisfying a need, rather than being perceived as having the potential to satisfy the need. This relevance may be called the *relevance of the subject matter* presented for study. Relevance in this situation precedes interest and *triggers motivation of* students (Holbrook & Rannikmae, 2009).

In applying these two components of relevance, the learning environment being established by the teacher also plays an important role (ibid).

A further meaning of relevance leads *to satisfying a need.* This sufficiently motivates students to participate in the learning and, if other factors promoting motivation also function well, the students want to, and do, learn. Here student *motivation drives relevance* and the science teaching is satisfying the learning needs of students. Such relevance may be dependent on the classroom situation, the comprehensiveness of the science and how the learning may help with the career or further studies (Holbrook & Rannikmae, 2009).

Learning environment attributes associated with interest, enjoyment/like and motivation

Often interest is thought of as a process that contributes to learning and achievement - that is, being interested in the subject matter is a mental resource that enhances learning (Hidi, 1990). One way to enhance student interest is by creating an engaging, meaningful environment, whereby students are able to recognise the value of their learning (Brophy, 1999; Stipek, 2002; Wigfield et al., 2012). Student interest can be divided into individual interest and situational interest (Hidi & Baird, 1988; Renninger, 2000). Individual interest is more trait-like and endures over time. It can be considered a disposition that individuals take with them from one context to the next. Situational interest, by way of contrast, is more momentary and situationally bound; in other words, it can be a specific reaction to something in a situation, such as a funny video clip, humorous conversation, or slide presentation on a concern of relevance. Situational interest can be described as an interactive or relational construct, because it `flows from a person's relationship with a particular activity' (Reeve, 1996). In stimulating the learning, educational researchers have focused on situations, which can be expected to encompass situational interest in an effort to explore its potential for motivating students to learn, both short and long terms (Renninger et al., 1992). Such situation in a science-related context can be considered a scenario, which can not only link the science to the situation or context but stimulate interest in wider aspects such as career orientations.

Situational interest, from meaningful context-based learning, results from students being associated with a specific learning task (Mitchell, 1993) and is considered a powerful motivator guiding learners to participate in further learning (Deci, 1992). Chen et al. (2014), building on a general theoretical model by Deci, put forward five situated learning dimensions:

(1) *novelty which infers information deficiency between information known and unknown. Novelty can be associated with* ***liking the activity;***

(2) *challenge****,*** *defined as the level of difficulty relative to one's ability; challenge can be associated with a desire to learn more and hence an appropriate challenge can be related to a degree of* ***motivation;***

(3) *attention demand is the concentrated cognition and mental energy willing to expend in learning an activity; at a simple level, attention demand can also be associated with* ***like;***

(4) *exploration is conceptualized as the learning aspects that drive the learner to explore and discover; this can be associated with* ***interest****;*

(5) *instant enjoyment refers to the characteristics that lead the learner to an instant positive feeling of being satisfied;* ***enjoyment and like*** *can be seen as interconnected.*

Research has demonstrated that both situational and individual interest promote attention, recall, task persistence, and effort (Ainley et al., 2002; Hidi, 1990; Hidi & Renninger, 2006).

Career awareness

As employment demand, over the past decades, has shifted in favour of skilled needs, this being seen as requiring more extensive and wider education, particularly associated with science and science-related professional areas, such as technology, engineering and ICT. In many cases, these new areas, occurring outside the experiences of many teachers, draw on a teacher's readiness and competence to teach (Julia et al., 2020). It is thus not surprising that concerns have arisen, associated within science-related, or STEM education (Hasanah, 2020), even when interdisciplinary, relating to insufficient students opting, in the future, to take up science-related careers (European Commission, 2015; OECD, 2018).

A number of reasons for the decline in students taking up post-education, science-related careers have been put forward, indicating students:

- lack interest in science learning and thus not considering the potential of important science-related career possibilities (Krapp & Prenzel, 2011);
- don't recognise the relevance of science learning in being meaningful for new science-related careers dealing with socially and globally important problems (Bybee & McCrae, 2011);
- perceive their self-efficacy in science as low and thus not willing to put effort into cognitive advancement in science learning (Potvin & Hasni, 2014; Sjoberg & Schneider, 2010);
- are unaware of the plethora of new careers, so much so that students are not sufficiently aware of possible science-related career options suitable for them (Soobard, 2015);
- are taught by science teachers who are not able to perceive suitable teaching-learning materials to use and thus tend to avoid inclusion of science-related careers in class (Maltese & Tai, 2011; Margot & Kettler, 2019);
- don't recognise a science contextual-related approach stimulated by a scenario can promote skills associated with science-related careers, which are often transferable to other situations (Peasland et al., 2019).

In some cases, a problem can be that students hold barriers (e.g. gender-based) in stating their own awareness about their competences for science-related careers (Dinh & Nguyen, 2020). In fact, there are number of females who do well in jobs, according to their opinion, where society feels these belong to males (ibid). This points out that while developing context-based teaching-learning materials, learning environment attributes need to be attractive for both female and male students. Even more, science-related careers, with the associated knowledge and skills, can be used as context for teaching science (Kotkas et al., 2016). In this way, students get an impression about the daily work of a particular profession and learn science content through solving (perhaps complex) problems in real life situations (Changtong et al., 2020), thus imitating professionals who work daily with such given problems (Kotkas et al., 2016). In this type of learning, the role and attitude of the teacher is important, as research has shown that science teachers tend to avoid including science-related careers in class due to lack of confidence and teaching-learning materials (Maltese & Tai, 2011; Margot & Kettler, 2019; Soobard, 2015). At the same time, students do expect teachers to be entertaining and funny while teaching science and having a wide range of teaching methods for activating students learning (Ucak, 2019).

Methodology

Research Goal

This study seeks, as a part of the Multico project (Horizon2020, Grant Agreement no. 665100), to evaluate an intervention programme, composed of 6 career-awareness oriented, teaching-learning modules (C-TLMs), with respect to promoting relevance and science-related career awareness within motivational science learning environments. The C-TLMs in this study were designed, based on a scenario driven, 3-stage teaching model, adapted from Holbrook & Rannikmae (2010), each focusing on specific science-related careers.

Sample and Data Collection

The sample was formed from students and their science teacher in three schools. This enabled the involvement of 104 students across grades 7 to 9 (44% girls, 56% boys), from three Estonian language-speaking classes. School participation in the intervention was voluntary and each school principal received an introduction letter explaining the purpose of the Multico project, its procedures and how the data would be managed, organised and published.

Diversity considerations in sampling, such as ethnic minorities, different language speaking students were not considered as the overwhelming majority of students in Estonian schools were Estonian with, in general, a similar socio-economic background. Participation in the study was voluntary for students and permission from parents was asked. The purpose of the study and the use of the outcomes were explained to students, parents, teachers and school principals in written letter format by the project manager in Estonia. All data was stored keeping in mind the principles of confidentiality.

Data was collected by the science teachers immediately after each C-TLM had been implemented. For this, each student completed a paper-and pencil questionnaire and where appropriate, gave open-ended responses on the same sheet. Completing the questionnaire took approximately 20 minutes.

Intervention

The modules were taught as a longitudinal, intervention programme over 3 years (1 module in grade 7 and 2 modules per year in grades 8 and 9) with the same students. In grade 7, only one module was taught, as this was the starting year and the whole intervention programme was prepared. Each module was designed in 3 stages. Stage 1, referred to as the scenario, initiated the teaching, leading to learning related to the intended science curriculum, both in terms of subject matter and general (cross-curricular) competences. The second stage provided new science-related knowledge and competences, as outlined in the curriculum, and was thus anticipated to have a positive impact on students' learning. The third stage was consolidation.

The intervention was organised as given in Figure 1.

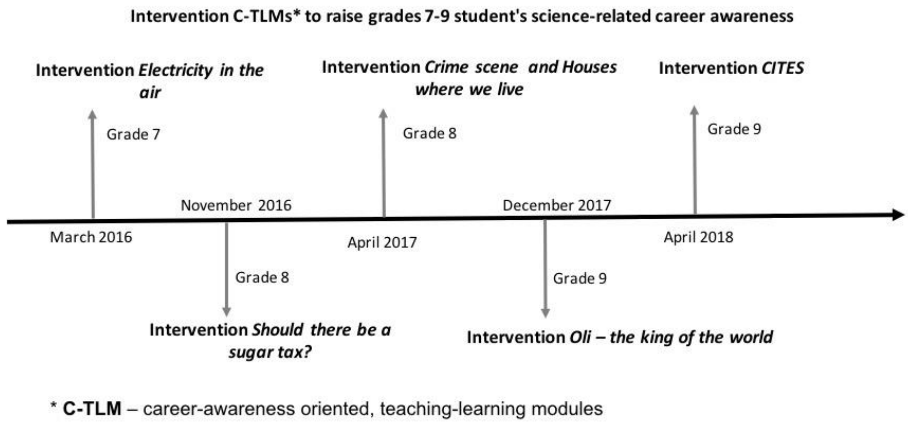

Figure 1. The design of the intervention programme

An overview of the 6 C-TLMs, with the specific focus within each of the 3 stages, was as indicated in Table 1.

Table 1. Descriptions of the 6 developed science-related, career awareness modules

C-TLM Title	Career oriented, scenario stage (*A contextual, relevant science-related career scenario*)	Career oriented, situated learning stage (*Conceptual science learning associated with raising career awareness*)	Career Awareness, consolidation stage (*Career focus, building on the initial contextualisation*)
Electricity in the air	**Slide presentation**: discussion around electricity production, consumption ending up with imitating engineer's work for building a solar panel.	**Focus:** building a solar panel (group work) using guidelines, learning physics behind this activity.	**Outcome:** presenting solar panels built in groups to other students, the careers considered were electrical engineer and environmental specialist.
Should there be a sugar tax?	**Visiting industry**: visiting departments, asking questions from employees ending up with imitating the work of the industry in the classroom.	**Focus:** developing soft drink (group work) using experiments (measuring pH, tasting, checking quality and gas solubility), learning biology and chemistry behind this activity.	**Outcome:** students presenting created soft drink designed in groups, to other students, the careers being considered were chemist and biochemist.
Crime scene	**Expert visitor:** expert from the career field talks about his/her career in classroom ending up with crime investigation.	**Focus:** investigating crime scene (group work) using available evidences and descriptions of events, learning biology and chemistry behind this activity.	**Outcome:** presenting crime investigation outcomes in groups to other students, the careers considered were criminologist and investigator.

Table 1. Continued

C-TLM Title	**Career oriented, scenario stage (*A contextual, relevant science-related career scenario*)**	**Career oriented, situated learning stage (*Conceptual science learning associated with raising career awareness*)**	**Career Awareness, consolidation stage (*Career focus, building on the initial contextualisation*)**
Houses where we live	**Expert visitor:** expert from the career field talks about his/her career in classroom ending up with imitating the work of city planner with walk around city.	**Focus:** planning city (group work) using data set including pros and cons for smart and regular houses, learning geography behind this activity.	**Outcome:** presenting city planning outcomes in groups to other students; the careers considered were city planner and architect.
Oil - the king of the World	**Slide presentation**: discussion around oil production, disaster ending up with imitating the work of rescuer helping birds.	**Focus:** cleaning birds and water from oil (group work) using guidelines, learning biology and chemistry behind this activity.	**Outcome:** presenting birds and water cleaning outcomes in groups to other students; the careers considered were biologist and environmental specialist.
CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)	**Slide presentation:** discussion around endangered species ending up with reflections on the value of the work of customs officers.	**Focus:** investigating and classifying confiscated items from travellers (group work) using guideline, learning biological aspects behind this activity.	**Outcome:** presenting plants and animal products being confiscated in groups to other students; the careers considered were customs officer and biologist (botanist and zoologist).

Instrument design

A questionnaire, presented in two parts, was devised to be administered to students after each C-TLM intervention (Kotkas et al., 2017), exploring

(a) student perceptions of the relevance of each module, (4-point scale), and

(b) student views on attributes associated with the learning environment (Agree/Disagree plus reasoning).

In part (a), nine items (taken from Kotkas et al., 2017 and given in Table 2) were included to determine the relevance of the learning experience developed within each C-TLM. The items covered:

- relevance towards knowledge (whether students recognised the gaining of new relevant information);
- career orientation;
- relatedness (whether students felt related with the described situation), and
- impact (whether students recognised the described problem/situation as relevant at a school, personal, local, or global level).

Part (b) included three items regarding interest, liking and motivation, giving students the opportunity to elaborate on their perceptions developed within each C-TLM, using a 2-point scale (agree/disagree). In addition, students gave open-ended explanations. The open-ended explanations were analysed separately.

Table 2. Questionnaire items included within the instrument

Theoretical category	**Item**	**Scale**	**Focus area in current study**
Role of knowledge	I appreciate that this module enabled me to gain new knowledge.	4-point scale (totally disagree, disagree, agree, totally agree).	Relevance of the learning through career-awareness focused, teaching-learning modules, as appreciated by students.
Career orientation	I predict that my future career will require me to perform skills, which were developed in the module.		
	I predict that my future career will require me to perform science skills, which were developed in the module.		
Relatedness	The module activities made it easy for me to relate with the situation described.		

Table 2. Continued

Theoretical category	Item	Scale	Focus area in current study
Impact	I found the module topic important for me personally. I found the module topic important for my family. I found the module topic important for the local community (town/country). I found the module topic important for learning school subjects. I found the module topic important for the whole world.		
Interest Like Motivation	I found this module interesting to me. I liked the module. The module made me want to learn more about the topic.	Open-ended explanations associated with agree and disagree responses.	Learning environment attributes.

Data Analysis

Quantitative data analysis consisted of descriptive statistics (mean, standard deviations) exploring students' perceptions of relevance. Student responses were interpreted as 'in agreement' when the mean value exceeded 2.50 and 'disagreement' for mean values below 2.50.

Qualitative data analysis consisted analysis of the open-ended items using inductive (data driven) thematic content analysis procedures, seen as:

a) familiarisation and coding (step 1);
b) generating/reviewing themes (step 2);
c) defining and naming themes (step 3).

This procedure was undertaken to determine student's perceptions, views and experiences following that suggested by Vaismoradi and Snelgrove (2019).

The themes identified were:

- "Agreement" with respect to: (1) career related, (2) subject matter, (3) interest, (4) importance, (5) usefulness, (6) novelty, (7) emotional feeling, (8) knowledge gained, (9) learning environment, (10) teacher, (11) ambition, (12) complexity and (13) instructions provided.
  (Depending on the C-TLM, not all categories emerged from students' responses).

  Example descriptors: (1) I am interested in this career, (2) I like chemistry, (3) module is interesting, (4) important to the whole world, (5) this learning is useful for me, (6) novelty different from usual school lessons, (7) I feel this is good, (8) I learned new knowledge (9) inclusion of practical and group work, (10) teacher was very supportive, (11) I now want to learn more about this, (12) complexity complex, but made me learn more to understand, (13) instructions are clear and easy to follow.

- "Disagreement" with respect to: (1) career, (2) subject matter, (3) interest, (4) importance, (5) usefulness 6) instruction, (7) complexity, (8) emotional feeling, and (9) familiarity.
  (Depending on C-TLMs, not all categories emerged from students' responses).

  Example descriptors: (1) I don't want to have a career in this area, (2) I don't like chemistry, (3) I am not interested in this content, (4) the learning is not important for me, (5) I don't see how this is useful for me, (6) instructions given were not understandable, (7) it is too complicated to understand, (8) I find the module boring, (9) I have already learned this.

Validity and reliability

For this study the questionnaire items were administered in Estonian. Initially items were created in the Estonian language, translated into English (for use by other partners in the MultiCo project) and then re-translated into Estonian (where modifications had occurred) to ensure a common meaning across partners.

In the analysis of the open-ended items, the initial coding and the forming of themes, with descriptions, was conducted in English. The process of creating themes for the open-ended responses in all C-TLMs was discussed within the expert group (four members) formed by scientist educators within the MultiCo project until a consensus was reached for themes in all C-TLM open-ended responses (across all partners).

Prior to implementing the first C-TLM, an initial in-service introduction and guidance session was organised for teachers involved in the study. Follow-up meetings were held before each new intervention and teachers were allowed to give feedback continuously throughout the three implementing years. Furthermore, throughout the project, teachers were given the opportunity of face-to-face and online consultations, where they felt a need.

For the 3rd intervention, a choice of module was offered ("Crime scene" versus "Houses where we live"). For this, the teacher, together with the students, decided which C-TLM they wished to study. The reason for the choice was because, in these two C-TLMs, expert visitors came to the classroom and to best target students' interests, the decision of which visitors was determined by teachers and students.

Results

Students' perceptions of the relevance of the teaching-learning modules

Data was collected from all students present at the end of each C-TLM in all three schools. The data was processed and means and standard deviations were determined. In addition, Cronbach's Alpha was calculated to be >.80 for all C-TLMs. Outcomes were as presented in Table 3.

Table 3. Outcomes derived from the 4-point questionnaire for each C-TLM

	Items	Electricity			Sugar tax			Crime scene			Houses			Oil			CITES		
		N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD
Role of Knowledge	I appreciate that this module enabled me to gain new knowledge	84	3.50	0.53	86	3.42	0.52	36	2.94	0.75	23	2.96	0.71	85	3.45	0.61	62	3.71	0.52
Relatedness	The module activities made it easy for me to relate with the situation described.	83	2.88	0.71		NA		36	2.86	0.80	21	2.43	0.68	83	2.90	0.79	62	3.39	0.58
Impact level	Important for me personally.	83	2.66	0.74	86	2.47	0.65	36	2.42	0.65	21	2.24	0.83	84	2.62	0.85	62	2.89	0.81
	Important for my family.	84	2.48	0.74	85	2.08	0.66	36	1.86	0.72	23	2.04	0.71	84	2.31	0.81	62	2.53	0.92
	Important for the local community, town/country.	81	3.02	0.65	86	2.84	0.67	35	2.49	0.78	23	3.48	0.59	84	2.96	0.91	61	2.98	0.74
	Important for learning school subjects.	81	2.94	0.66	87	2.91	0.66	36	2.31	0.71	23	2.00	0.80	84	3.25	0.73	62	2.52	0.78
	Important for the whole world.	84	3.20	0.71	85	2.81	0.78	36	2.81	0.82	23	3.30	0.82	85	3.68	0.62	61	3.67	0.54
Career orientation	I predict that my future career will require me to perform skills, which were developed in the module.	82	2.52	0.74	86	2.69	0.80	36	2.47	0.91	23	1.91	0.67	85	2.40	0.88	62	2.47	0.76
	I predict that my future career will require me to perform science skills, which were developed in the module.	82	2.37	0.69	86	2.16	0.75	35	2.26	0.70	23	2.17	0.65	84	2.76	0.80	62	2.35	0.68

N= number of students responding; M = mean; SD = standard deviation; NA-not applicable.

Student explanation given in the open-ended items attributed to perceptions of the learning environment

(a) Interest in science learning via the C-TLMs

For each C-TLM, students expressed their agreement or disagreement with the statement, *"I found this module interesting to me"* giving reasons in a variety of ways (Table 4). In general, responses were overwhelmingly positive.

Table 4. Reasons for indicating C-TLMs were or were not interesting

C-TLM	Grade	Agree Disagree	Reasons cited for 'I found this module interesting to me'*	Number of responses
Electricity	**7**	Agree	environment 16; interest 12; emotion 11; knowledge 10; usefulness 4; novelty 7	**60**
		Disagree	instruction 3; interest 2; emotion 1	**6**
Sugar tax	**8**	Agree	environment 27; knowledge 18; emotion 13; novelty 10; interest 7; usefulness 3; subject 1; teacher 1; career 1	**81**
		Disagree	subject 1; familiarity 1; emotion 1; importance 1	**4**
Crime scene	**8**	Agree	emotion 4; environment 3; novelty 2; interest 2 knowledge 1	**12**
		Disagree	-	**0**
Houses	**8**	Agree	interest 6; knowledge 2; environment 1; usefulness 1; emotion 1	**11**
		Disagree	subject 1	**1**
Oil	**9**	Agree	knowledge 18; emotion 9; environment 7; usefulness 7; interest 5; novelty 4	**50**
		Disagree	interest 3; emotion 2; instruction 1	**6**
CITES	**9**	Agree	knowledge 20; emotion 17; interest 8; usefulness 7; environment 6; novelty 5; career 3; teacher 2	**52**
		Disagree	emotion 4; interest 2; familiarity 1	**7**

*An explanation of the indicated reasoning terms is given in the Data Analysis section

Generalizing, based on all C-TLMs, explanations for students' agreement with the statement *"I found this module interesting to me"* were grouped into 9 categories, based on the responses given in Table 4 and illustrated in Figure 2.

Example of positive responses cited were:

"This was very exciting for me" (emotion)
"I am very interested in technology" (interest)
"I had a possibility to practice new things" (novelty)
"I had a possibility to build a solar panel by myself" (learning environment)

Students who gave negative responses, disagreeing with the statement *"I found this module interesting to me"*, explained this in 6 categories as indicated in Figure 2.

Example of negative responses were:

"I am not interested in Biology" (subject)
"Instructions were unclear and difficult to follow" (instruction)
"This was very boring" (emotion)

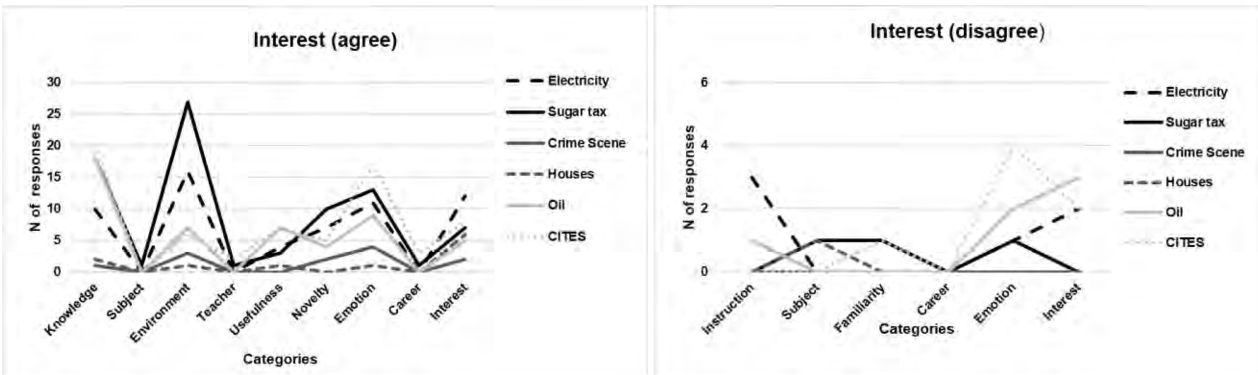

Figure 2. Explanations for agreement and disagreement in terms of Interest

(b) Liking/Enjoyment of studying via the C-TLMs

Students expressed their agreement or disagreement with the statement, *"I liked the module"* for each C-TLM in a variety of ways (Table 5). In general, responses were positive.

Table 5. Reasons for indicating C-TLMs were liked or not liked

C-TLM	Grade	Agree Disagree	Reasons cited for 'I liked the module'	No. of responses
Electricity	**7**	Agree	interest 13; environment 8; emotion 7; instructions 7; novelty 5; knowledge 4; importance 1; teacher 1	**46**
		Disagree	instructions 3; emotion 1; interest 1	**5**
Sugar tax	**8**	Agree	interest 11; emotion 8; environment 8; knowledge 7; novelty 6; instructions 4	**44**
		Disagree	interest 2; career 1	**3**
Crime scene	**8**	Agree	interest 5; environment 4; novelty 3; emotion 2	**14**
		Disagree	career 1	**1**
Houses	**8**	Agree	interest 5; environment 3; emotion 2	**10**
		Disagree	-	**0**
Oil	**9**	Agree	emotion 12; environment 15; interest 8; knowledge 4; novelty 3; instructions 1; usefulness 1;	**44**
		Disagree	emotion 3	**3**
CITES	**9**	Agree	environment 14; interest 13; emotion 12; knowledge 10; novelty 5; instructions 2; teacher 2; usefulness 1; career 1	**61**
		Disagree	interest 2; instructions 1; emotion 1	**4**

Generalizing, based on all C-TLMs, students' agreement with the statement *"I liked the module"* were grouped into 10 categories based on the data given in Table 5 and illustrated in Figure 3.

Example of responses were:

> "I liked this, because this topic is important for the whole world" (importance)
> "This content was very interesting to me" (interest)
> "This was new and I had to practice skills I never use in my everyday life" (novelty)

Students who gave negative responses, disagreeing with the statement *"I liked the module"*, explained this in one of four ways related to instructions, emotions, interest and career (Figure 3). Example of responses were:

> "I didn't like this, because instructions were very difficult to follow" (instructions)
> "I don't like this kind of content" (emotion)
> "I didn't like this, because I know my future career already" (career)

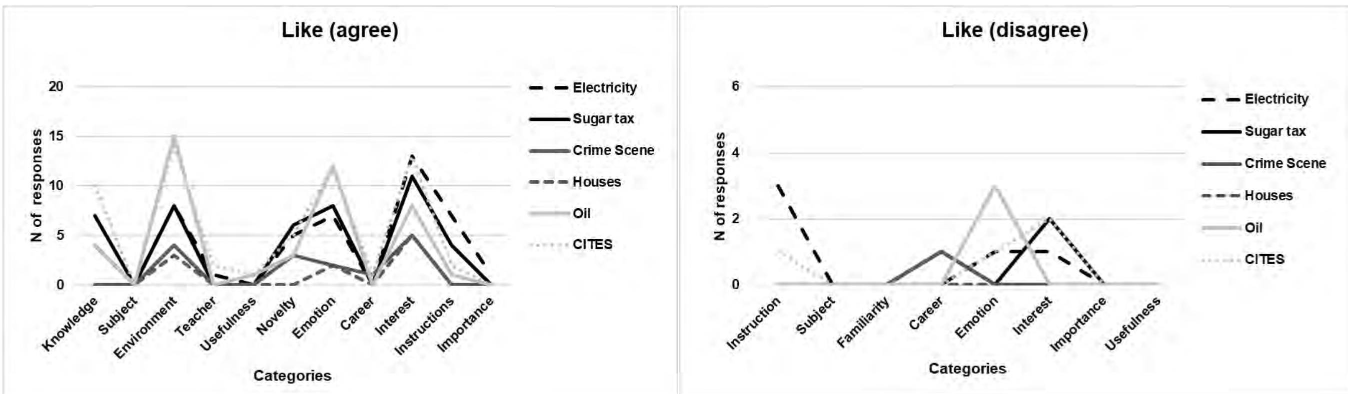

Figure 3. Explanations indicating ways of disagreement and agreement in terms of Like

(c) Motivation in studying via the C-TLMs

Students expressed their agreement or disagreement with the statement, *"The module made me want to learn about the topic"* for each C-TLM and gave reasons in the variety of ways (Table 6). In general, responses were negative.

Table 6. Explanations put forward for agreement and disagreement in terms of motivation for each C-TLM

C-TLM	Grade	Agree Disagree	Reasons cited for 'the module made me want to learn about the topic'	No. of responses
Electricity	**7**	Agree	interest 9; emotion 3; environment 3; ambition 2; usefulness 1; novelty 1; complexity 1	**20**
		Disagree	interest 14; emotion 8; career 3; complexity 3; instruction 1; subject 2	**31**
Sugar tax	**8**	Agree	emotion 2; ambition 2; usefulness 1;	**5**
		Disagree	emotion 14; interest 12; career 2; complexity 1; subject 1;	**30**
Crime scene	**8**	Agree	interest 2; ambition 1	**3**
		Disagree	interest 7; emotion 5; career 1;	**13**
Houses	**8**	Agree	emotion 2	**2**
		Disagree	emotion 6; interest 6	**12**
Oil	**9**	Agree	ambition 3; emotion 1; career 1	**5**
		Disagree	interest 13; emotion 7; career 6; subject 1	**27**
CITES	**9**	Agree	usefulness 2; interest 2; importance 1; ambition 1; environment 1	**7**
		Disagree	interest 11; emotion 7; career 6; complexity 1	**25**

Generalizing, based on all C-TLMs, students' agreements with the statement *"The module made me want to learn about the topic"* were grouped into 8 categories, as indicated in Table 6 and illustrated in Figure 4. Example of responses were:

> "Complex content inspires me to learn more" (complexity)
> "This content is interesting to me" (interest)
> "I want to learn more, because this might be useful for me in my life" (usefulness)

Students who gave negative responses, disagreeing with the statement *"The module made me want to learn about the topic"*, explained this in 6 ways (Table 6). Although the number of response was small, the majority of students disagreed with this statement and based on the current study, the reasons put forward indicated aspects to carefully consider in promoting student's science learning and science-related career awareness. Example of responses were:

> "I didn't like this content very much" (emotion)
> "I am more interested in mathematics than science" (interest)
> "I don't need this content and skills in my future career" (career)

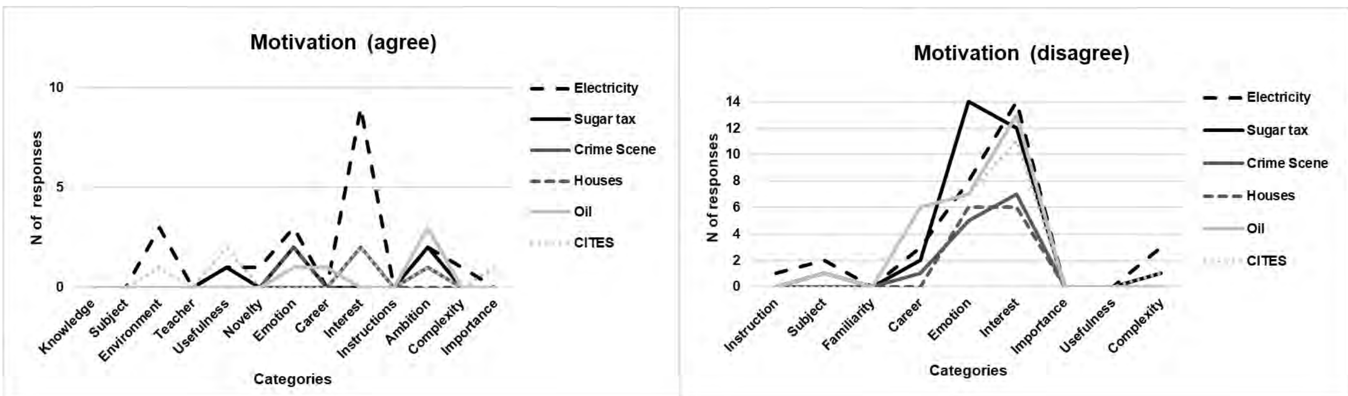

Figure 4. Explanations for agreeing or disagreeing in terms of motivation

Discussion

This research focused on an evaluation of 6 purposefully developed C-TLMs, taught over a 3-year period, with each built around a socially and/or personal relevant, real-life context and focusing on introducing science-related careers in different, but motivational formats. Data was collected seeking students' opinions on the relevance of the learning and on their perceptions of the suitability of the learning approaches, based on a 3-stage model design (Holbrook & Rannikmae, 2014).

In general, the results showed grade 7-9 students perceived the C-TLMs positively. Students appreciated the new knowledge received, which they could use later in life, especially when this related to the undertaking of practical work and presented through a situated learning focus (Lave & Wegner, 1991) and using an 'education through science'

(Holbrook & Rannikmae, 2007) inquiry, problem-solving approach (e.g. how to - build a solar panel; develop soft drinks; remove oil from polluted water and from birds; investigate and classify items confiscated from travellers). The C-TLMs in the current study enabled students to pretend to be involved in the science-related career introduced within the C-TLMs, while seeking to make the science-related provision useful for their future lives and possible careers, as recommended by other researchers (Changtong et al., 2020; Margot & Kettler, 2019; Tytler & Osborne, 2012).

Some C-TLMs were less well received e.g. the C-TLMs on “Crime scene” and “Houses”. These C-TLMs focused on inviting an expert visitor, who introduced students to their daily work. In these modules, students were involved more in hearing what the experts were doing, rather than being in the position of putting themselves in the ‘shoes of the experts’ and thus gaining an experience of the science-related careers introduced in the C-TLMs. It seemed that when students could actually experience the science-related career aspect by undertaking practical work related to this career, they perceived the knowledge they learned as more appropriate for them. Thus, besides *the relevance of the knowledge*, students recognised a need for *the relevance of the learning* approach impacting on satisfying needs (Holbrook & Rannikmae, 2009).

In general, students were able to relate with the situations and activities in the modules. For example, in the C-TLM “CITES”, the content was about travelling and handling endangered species, which students found to be very relevant. Students recognised that this C-TLM enabled them to gain knowledge and useful tips on what to keep in mind while travelling, a real-life focus to which students could strongly relate. This result confirmed that society-oriented, context-based teaching increased relevance towards science learning (Salonen et al., 2018), resulting in a student perceived useful and meaningful learning environment.

In the C-TLMs “Electricity”, “Crime scene”, “Houses” and “Oil”, the content related to building a solar panel; investigating a crime; city planning and cleaning polluted oil from birds/extracting oil from plants. All were seen as potentially related to future careers, as shown by the level of student agreement, although the knowledge gained from these C-TLMs was not so easily seen as applicable by students for their daily lives. On the other hand, students recognised that knowledge related to travelling (C-TLM “CITES”), for example, going on vacation targeted personal relevance (relevant from a student perspective) and also social relevance (role of science in human and social issues) (van Aalsvoort, 2004).

In four of the modules (“Electricity in the air”; “Should there be a sugar tax?”; “Oil- the king of the world”; “CITES”), students agreed with the statement that they would need to perform such skills in their future careers, although these were not necessarily perceived as science-related. When asked, more explicitly, about science-related skills, students tended to indicate that they could only use the skills gained from the C-TLM “Oil - the King of the world”. This C-TLM was more heavily focused on inquiry-related skills and thus students could be said to be linking inquiry skills directly with science-related skills, not recognizing, or appreciating wider science-related, ‘cross-cutting’ skills (NRC, 2013). Previous research found that students often did not recognise such skills to be science-related, nor even that such skills were being taught (Peasland et al., 2019). The need for relevance in the progression of teaching (Holbrook & Rannikmae, 2009) and the need to satisfy students’ needs to make stronger links between what was being taught and its usefulness in raising awareness of career options during science classes (Margot & Kettler, 2019), was achieved by paying attention to teaching through socially relevant situations, meaningful knowledge, career aspects, as well as importance for students.

As indicated in Table 3, students agreed that the C-TLMs - “Electricity in the air”, “Oil- the king of the world” and “CITES” were personally important for them. For example, in the C-TLM related to electricity, students suggested that building a solar panel and using it to charge their own smart device was identified as important science-related learning. In the C-TLM related to oil, students were involved in hands-on practical work giving them the feeling that they were actually responsible for cleaning the water and the birds, while in the C-TLM “CITES”, students gained a clear understanding of acceptable souvenirs they would be permitted to bring home. This personal importance of findings confirmed that by establishing usefulness and importance through an initial relevant, context-based situation, before the conceptual science learning took place, facilitated students’ engagement in both learning and recognising the usefulness of the learning (Salonen et al., 2018).

For all C-TLMs, students agreed that the content was important for appreciating the work of their local community (town, country) and worldwide. But, at the same time, students tended to disagree that the learning was important related to their families. This suggested that, although students did recognise that all C-TLMs targeted real life concerns (e.g. energy consumption, obesity and sugar consumption, introducing novel technologies, oil production, endangered species), some situations were less seen as related at a family level. As the purpose of this intervention was to create an engaging, meaningful environment for students to appreciate the value of the learning (Brophy, 1999; Stipek, 2002; Wigfield et al., 2012), a focus on relating modules to their families could be seen as outside student perceptions.

All C-TLMs, except “Houses where we live” and “Crime scene”, introduced content that students generally perceived as having a positive impact on their further school learning. These two C-TLMs relied more on expert visitor competence and the ability to explain science content through their experience. Thus, in these C-TLMs, students did not gain direct experiences and less recognised the usefulness of the obtained knowledge.

Suitability of the learning environment in C-TLMs

Student responses tended to indicate that careful attention was needed to the way each C-TLM was presented to students. Figure 2 showed that the majority of students' responded positively regarding their interest in the C-TLMs. The positive interest towards the C-TLMs was based, in particular, on an appreciation of at least one of the following: the knowledge gained, the subject matter presented, the type of learning environment, the teaching approach employed, the novelty of the topic, emotional feelings gained, the career indicated, or simply the content or activities in the C-TLMs. These interest aspects tended to relate to the establishment of a meaningful learning environment (Brophy, 1999; Wigfield & Eccles, 2002), focusing on learning activities relevance in the eyes of students (Holbrook & Rannikmae, 2009) and developing situational interest for leading to further learning (Deci, 1992). However, where students felt a lack of interest towards a topic, C-TLM, or career presented, they tended to express negative comments towards the C-TLM. Often students indicating a lack of interest for the content or subject that had previously been taught, or they had already decided their future career orientation.

As indicated in Table 5, students generally liked learning through the C-TLMs. Students comments indicated that they 'like', when it was associated with knowledge gained, the established learning environment, the role played by the teacher, emotional feeling gained, the type of instructions provided, usefulness, related to career orientation and in some cases, the interest, importance, or novelty of the C-TLM compared with regular school science lessons (Figure 3). In these learning environments, the role of teachers was seen in a positive way compared to previous research, which indicated science teachers were not able to perceive suitable approaches to promote career awareness and tended to avoid the inclusion of science-related careers (Maltese & Tai, 2011; Margot & Kettler, 2019), or alternatively, they perceived insufficient TLMs available which included career awareness (Cohen & Patterson, 2012). This study indicated that science teachers were willing to engage with careers if provided with suitable activities, supporting the notion that students appreciated teachers with a wide range of teaching activities (Ucak, 2019). Nevertheless, not all students liked the C-TLM learning environment, citing a lack of clarity of the instructions, or a tendency to develop negative feelings towards the C-TLMs.

Interestingly, student motivation, in terms of learning more through the C-TLMs was low (Table 6). This was despite that, in general, the findings indicated all C-TLMs were evaluated positively by students. To explain the anomaly, students pointed to a number of reasons e.g.

(a) they were not that interested in this topic;
(b) the poor instructions provided gave negative feelings against the topic itself;
(c) a perception that the C-TLMs were too complex, or
(d) student valued other future career orientations.

Although previous research found that society oriented, context-based science education increased motivation towards further science studies (Potvin & Hasni, 2014), this study concluded that motivation was not enough. Students agreeing to learn more within modules pointed to the need for a rich, or novel learning environment, student perceived usefulness, positive emotions and interest, focusing on ambitions, targeting their career aspirations and perhaps surprisingly, possessing complexity. Such aspects could be associated with the value of context-based teaching (Duranti & Goodwin, 1992; Hidi & Renninger, 2006; Holbrook & Rannikmae, 2009; Gilbert, 2011) with its links to self-determination theory (Ryan & Deci, 2002) – i.e. competence in being able to handle complex tasks and the satisfaction of having autonomy in fulfilling ambitions. The positive mentioning of complexity and ambition in student comments were associated only with comments on motivation and even through the majority of students were not willing to learn more within such modules, it seemed that perceptions about one's capabilities (in terms of handling complex tasks and having ambition to find out more) could play a meaningful role in further learning aspirations. Earlier research showed that students with lower perceived self-efficacy in science were not willing to put effort into cognitive advancement in science learning (Potvin & Hasni, 2014; Sjoberg & Schneider, 2010). Thus, in supporting student satisfaction with the learning content in a manner such that they wished to learn more, student self-perceptions about their capabilities needed careful consideration during the teaching-learning process.

Conclusion

In general, grade 7-9 students indicated that the C-TLMs, developed to promote science-related career-awareness, were perceived as relevant in terms of knowledge included, its career awareness, its relatedness and impact and was in line with the intention of using a novel and varied learning environment. The open-ended responses showed that students found the manner in which the C-TLMS provided different, but meaningful contexts, as interesting, appropriate and generally fitting to the students' liking. The approach to incorporating elements of science-related careers was more appreciated when it included student involvement in activities rather than simply hearing about careers and skills involved directly through presentations.

Recommendations

As this research indicates that a purposefully designed learning environment seems to be important for raising students' science-related career awareness, it is recommended that the learning environment needs to:

- support students learning with purposefully developed and meaningful activities (e.g. practical work imitating real life content, problems and skills needed in science-related careers);
- enable students to recognise the importance of science-related careers;
- allow students to work collaboratively in groups.

In this process, it is recommended that the role of teacher needs to:

- support the development of students;
- provide a wide range of student-involved activities (e.g. industry visits, expert visitors, science centres);
- raise the relevance and interest towards the learning content.

In future research, more attention should be paid to gender issues when developing teaching materials such as C-TLMs and in finding ways to engage girls more in science-related careers.

Limitations

This study was undertaken with a small number of students in only three schools and therefore results are not generalizable to the whole population. Despite this, results give valuable insight for making learning environments linked to potential careers more relevant for students.

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