2018

Career-related instruction promoting þÿstudents career awareness a interest towards science learning

Salonen, Anssi

Royal Society of Chemistry (RSC)

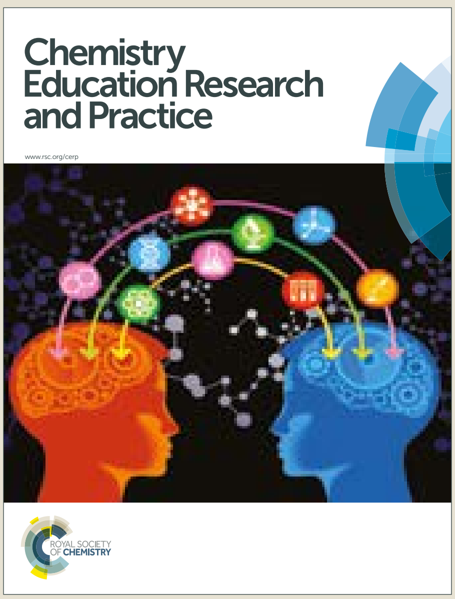
article
info:eu-repo/semantics/acceptedVersion

http://dx.doi.org/10.1039/C7RP00221A

Chemistry Education Research and Practice

Accepted Manuscript

This article can be cited before page numbers have been issued, to do this please use: A. Salonen, S. Kärkkäinen and T. Keinonen, *Chem. Educ. Res. Pract.*, 2018, DOI: 10.1039/C7RP00221A.



View Article Online
DOI: 10.1039/C7RP00221A

Chemistry Education Research and Practice

PAPER

Career-related instruction promoting students' career awareness and interest towards science learning

Anssi Salonen[a], Sirpa Kärkkäinen[b] and Tuula Keinonen[b]

The aim of this study was to investigate how the career-related instruction implemented in secondary school chemistry education concerning water issues influence students' career awareness and interest towards science learning. This case study is part of a larger design-based research of the EU-MultiCO project that focuses on promoting students' scientific career awareness and attractiveness by introducing them career-based scenarios at the beginning of the instruction unit. The participants in this study were three eight-grade classes with 46 students in total, and 2 science teachers. Data consisted of observations through the intervention and a questionnaire the students answered afterwards. Descriptive statistics of the questionnaire were used together with the content analysis of open questions and observation notes. The results reveal that students acquired knowledge about science, science-related careers and working life skills and they enjoyed studying chemistry and engaged in learning during the intervention. The students recognized the need for professionals and their responsibilities as well as the importance of water-related issues as global and local problems, but the issue was not personally important or valuable for students. The type of career-related instruction discussed in this paper can give guidelines for how to develop teaching to promote students' science career awareness, trigger students' interest and engage them in science learning.

Introduction

Without promoting students' interest and engagement towards science topics, studies and careers related to the major global, national and local science topics such as problems with clean and safe water (European Environment Agency, 2012; World Health Organization, 2017), we are likely to have problems lacking scientists to solve these issues (Bybee & McCrae, 2011). The problem starts with the students' career awareness or more specifically, the unawareness of the diversity and nature of science-related careers (Maltese & Tai, 2011; Goodrum, Druhan & Abbs, 2012). Cleaves (2005) found that two factors influence students' future science-related career choices; the first being a lack of student awareness about science occupations, scientific work and the required skills and the second, students' perception that underestimates their science abilities. Cohen and Patterson (2012) included two more influencing factors: engagement and relevance. However, the expected difficulty of science-related studies is not a reason for students not to choose those studies and later careers (Korpershoek *el al.,* 2012). Furthermore, students with early awareness and personal connections to science-related careers can develop informed decisions about these careers (Osborne & Collins, 2001; Tai *et al*., 2006; Aspden *et. al.,* 2015).

Science education should also focus on the low visibility of many science occupations in everyday life; low visibility may lead to misunderstanding and false expectations of those occupations (Schütte & Köller, 2015). Students' perceptions of the needed working life skills in science-related careers have indeed been found to be stereotyped (Salonen, Hartikainen-Ahia, Hense, Scheersoi & Keinonen 2017). Therefore, students need accurate information about science, technology, engineering and mathematics (STEM) careers and this information needs to be part of science curricula (Andersen & Ward, 2014; Holmegaard, Madsen & Ulriksen, 2014)

An effective method to provide career counselling is using advanced technology such as promotional videos (Harris-Bowlsbey & Sampson, 2005) and implementing career-related examples in teaching core curriculum (Orthner, Jones-Sanpei, Akos & Rose, 2012). In addition to career counselling, informing students about the STEM occupations and preventing stereotypes, schools can support students' choices for STEM careers by offering them science lessons that support understanding for all students and focus on everyday contexts (Korpershoek *el al.,* 2012; Potvin & Hasni, 2014). Moreover, students should be actively involved in the learning processes (Barron & Darling-Hammond, 2008). In the Finnish national core curriculum (The Finnish National Board of Education [FNBE], 2014) the aims in chemistry instruction is that students will understand: the role of chemistry in everyday life, society, environment and technology; chemistry is needed to develop new solutions; and the importance of chemistry in their future

[a] Philosophical Faculty, School of Applied Educational Science and Teacher Education, University of Eastern Finland, Joensuu, Finland
E-mail: anssi.salonen@uef.fi
[b] Philosophical Faculty, School of Applied Educational Science and Teacher Education, University of Eastern Finland, Joensuu, Finland

working life. Instruction should also support students' choices how to use their knowledge and skills appropriately. Based on these aims, chemistry education is context-based and introduces careers in which chemistry knowledge is needed. Other science subjects have similar principles (FNBE, 2014) to enhance the use of STEM careers and everyday contexts in promoting students' interest towards studying science and choosing science-related careers.

Students' possible stereotypes, lack of career awareness, self-efficacy beliefs, outcome expectations and learning experiences are the key variables influencing their career choices. However, in addition to promoting students' career awareness, this study evaluates both students' interest towards science learning and science-related careers, not particularly their career choices. Therefore, theories related to interest itself, considered together with science educational approaches, are particularly relevant to the current study.

Theoretical background

Interest can be defined as a state when the individual is engaging or has a predisposition or intention to engage with the content (Hidi & Renninger, 2006). The interest in science has a role in the paths linking personal value and current science activities to intentions for engagement in science (Ainley & Ainley, 2011a). Krapp, Hidi and Renninger (1992) introduce two types of interest: individual interest and situational interest. Individual interest is a deeper interest developed over time or referred sometimes as a characteristic of a person, including person's knowledge and values. Situational interest is something individuals share in the moment within their environment. It usually has only short-term effect on knowledge, feelings and values (Schraw & Lehman, 2001).

Person-Object approach to Interest (POI) (Schiefele *et al.,* 1983; Krapp, 1999) postulates that interest is a relational concept between individual and the aspects of the environment providing objects of interest. Interest represents this interaction between a person and an object (Krapp, 2002). Such objects can be concrete things, topics, activities, subject-matters or ideas. While in science education the situation and topic are usually related with school science subjects, it seems that students' interest might be something more detailed (Ainley & Ainley, 2011b). Different types of activities engage interaction between person and objects: hands-on engagement, cognitive work and occupying with ideas without conscious control (Krapp, Hidi & Renninger, 1992). Under certain conditions, repeated engagement may stabilize the disposition to re-engage with some of the objects, maintain situational interest and further develop individual interest (Hidi & Renninger, 2006).

Interest differs from other motivational concepts by its content-specificity. Moreover, specific features of interest include *cognitive aspects*, *emotional or feeling characterizations*, *value components* and *intrinsic quality of activities* (Krapp, 2002). Krapp introduces two major *cognitive aspects*. First, developed interest always differs from the earlier stages, especially with the amount of knowledge individual stores. Secondly, person needs metacognitive knowledge about the missing knowledge and skills. Moreover, an interested person is eager to learn such new knowledge and skills, building on the knowledge already acquired, being independent and being alert about the problems and topics (Levitt, 2001). Furthermore, moderate prior knowledge, potential to learn more and gaining new information together seems to increase interest (Kintsch, 1980; Tobias, 1994; Schraw & Lehman, 2001). In the case of careers, students need more detailed information about science-related careers; to relate their prior knowledge, skills and interests (Salonen *et al.,* 2017). However, Ainley and Ainley (2011a) found that the level of knowledge students have or acquire is not particularly effecting their enjoyment of science.

Enjoyment and other *emotional and feeling characterizations*, even negative ones, can have a role in interest development in science learning (Ainley, Corrigan, Richardson*,* 2005). In addition, students experiencing enjoyment with the science topic and situation are more likely to engage with the topic and continue to do so (Ainley & Ainley, 2011b). Nevertheless, students feel that learning chemistry is irrelevant for their everyday life outside school and future role in society (Childs, Hayes & O'Dwyer, 2015) and the environment (Hutchinson, 2000). Cigdemogly and Geban (2015) found that one way to close this gap is by designing chemistry education including real-world contextual issues involving science and technology discussions with students. Education for Sustainable Development (ESD) and its implications has also been found to increase students' perceived relevance with chemistry and environment (Burmeister, Rauch &Eilks, 2012).

In POI, the *value component* refers to how the person's goals and intentions relate with the attitudes, expectations and values (Krapp, 2002). Students will study science subjects if they need those for their career or future study goals but the importance of science for their everyday life may not be as important (Palmer, Burke & Aubusson, 2017). In addition, individual interest has major influence on students' career choices (Aspden *et al,* 2015). However, students who think that science is not for them still acknowledge the necessity of others choosing those studies and careers (Goodrum *et al.,* 2012). Moreover, information and advice about science-related career options and educational requirements increase the utility value of school science (Andersen & Ward, 2014). Students working as citizen scientists can see that the science research or society can benefit from their work and contribution enhancing the perception of valuing the scientific work and engaging learners (Dickinson *et al.,* 2012). Students should be engaged with science-related issues that are likely to be interesting and concerning to them (Jenkins, 1999). In addition, citizen-science instructions in education should be framed in a way that students are aware of the scientific processes they are involved in (Brossard, Lewenstein & Bonney, 2005).

Intrinsic quality of the activities is the most obvious feature of interest and from the POI perspective; interest-based actions have the quality of intrinsic motivation (Krapp, 2002). There is no difference between what the individual likes and has to do. However, the content and the object of the activity need to be

View Article Online
DOI: 10.1039/C7RP00221A

taken into account when exploring interest instead of motivation (Krapp, 2002). To most students and their teachers, chemistry means activities such as inquiries and laboratory tests (Borrows, 2004). These activities are also perceived as interesting and motivating part of chemistry learning. Hofstein (2004) reminds that appropriate laboratory activities are effective in promoting cognitive, metacognitive and practical skills, and attitude and interest towards chemistry. However, this perception of chemistry being remote needs to be changed to show that chemistry is instead all around us. Further, Braund and Reiss (2007) propose that laboratory-based school science teaching needs to be complemented with outside of school science activities.

What is found considering these criteria is that students engaging with different interest features including cognitive, emotional, value and intrinsic quality features in science education can perceive the importance of the contents enhancing engagement and interest with the topic and activities, and further science-related studies and careers.

The research question

Through career-related instruction using also career-based scenario, this study seeks to understand the relationships between presenting science-related careers to students, their interest in science and engagement and enjoyment in science learning. Therefore, this study examines how career-related instruction can effect on students' career awareness and interest towards science topics and science learning.

Method

The context of this case study is the EU project 'Promoting Youth Scientific Career Awareness and its Attractiveness through Multi-stakeholder Co-operation' (MultiCO). MultiCO project aims to promote the students' awareness and interest in science studies and career paths. The overall methodology of the MultiCO project follows the design-based research (DBR) approach (Wang & Hannafin, 2005). This study with mixed methods; quantitative and qualitative, provides deeper information and understanding related to the impact of career-related instruction on the students' interest towards science studies and science-related careers in the intervention's context. It is not possible and not the intention to generalise the results of this case study (Cohen, Manion & Morrison, 2007).

Participants

The participants in this study were three 8th grade science groups, total of 46 students, aged 14-15 years and their 2 woman science teachers from a secondary school in Eastern Finland. The students had already participated in an intervention with career-related instruction. The teachers are experienced in implementing scenario-based instruction.

Intervention

Intervention (Table 1) consisted of seven lessons and three phases: career-based scenario, inquiries and discussion panel. Based on a theoretical framework and the requirements of the school's curriculum, career-based scenario was planned collaboratively with teachers, researchers and other stakeholders. Teachers planned the inquiry and consolidation phases to link the intervention with curriculum topics.

Table 1. Intervention description

Lesson	Content and aims of lesson
Lesson 1 (45 min)	*Scenario stage in the science classroom:* The students watched a film about the lake Mertajärvi, located near the school. Slideshow presentation continued with information about the lake. The presentation ended with research questions: • In what condition is the water in the lake Mertajärvi? • Is the water quality of the lake Mertajärvi suitable for swimming? • Examine and find the facts and make a decision.
Lesson 2 (90min)	*Scenario stage at the lake Mertajärvi:* The students observed the surrounding of the lake Mertajärvi. The environmental health officer introduced herself, her career path and current work. She also took samples together with the students. *Inquiry stage at the lake Mertajärvi:* The students took their own water samples from the lake Mertajärvi and examined the temperature of air and water, conductivity and pH at the lake.
Lessons 3-5 (6x45 min)	*Inquiry stage in the science classroom:* The students examined their water samples with following inquiries with step-by-step instructions available: • A sensory examination: smell, colour, cloudiness • Oxygen content • Phosphate and nitrate content • Iron content The students' results were compared with the results analysed by a chemist.
Lesson 6 (45 min)	*Discussion panel*: The students discussed about the results of their inquiries. The teachers picked one student of each class as a chairman of the panel to lead the discussion of the following questions: • In what condition is the water in the lake Mertajärvi? • What needs to be done to the lake Mertajärvi? • How can we make better use of the lake and its surroundings for recreation?
Lesson 7 (45 min)	*Finnish language class*: The students wrote an essay about the condition of the lake Mertajärvi and what can, and needs to, be done to it. The students used their gathered results and the ideas from discussion panel to validate their arguments.

Most of the career information was provided during the career-based scenario, particularly during the lesson 2 with the professional, and later in the discussion panel. The first part of the scenario stage included information about the lake and the problem. In addition, the students and teachers discussed shortly about what had already been done to the lake and who are the responsible professionals. A woman environmental

View Article Online
DOI: 10.1039/C7RP00211A

health officer was asked to participate in the career-based scenario to promote women in science-related careers. The inquiry working sheets did not include any career information. However, the teachers did remind the students during the inquiry stage about the earlier scenario stage including the career and introduced working life skills.

Data collection

Data was collected during and after the intervention (Table 2). During the intervention, the first author observed students' interactions with the career-based scenario, educational material, other students, teachers and other adults. Observations focused on whole classroom, groups of students and individual levels. Researcher used observation sheets with foregoing variables listed to help gathering the data. Intervention was also video recorded with one camera. The observations acted as the primary data. Video recordings were not analysed and they were used only as optional data to clarify statements and actions e.g. teachers' choices of instruction. Notes were taken of discussions between researcher and teachers during the intervention.

After the intervention, the students answered an intervention evaluation questionnaire including 21 Likert items, 19 items were asked in 4-point scale, but questions 22 and 23 were in 3-point scale offering the students a neutral choice. These two questions had a following open-ended question asking about the reasons. In addition, two open questions were also included: "20. What was best in the unit?" and "21. What was worst in the unit?" We modified a scenario evaluation questionnaire (Kotkas, Holbrook & Rannikmäe, 2017) to study how the following factors (and corresponding items in questionnaire) triggered students' interest during the intervention.

- Knowledge (1-3, 23)
- Module attributes, enjoyment and feelings (12-15, 20-21)
- Vocational value (6, 8-10, 18)
- Personal and social value (4, 5, 7, 11)
- Career awareness (16,17,19)
- Interest of topic (22)

Data analysis

Observation data was analysed using content analysis (cf. Elo & Kyngäs, 2008). The analysis included two main phases: the preparation phase and the organizing phase. The preparation phase included transcribing the data and reading it through to make sense of the whole data. In the organization phase, the categories were freely generated and grouped. After using this inductive approach, a deductive approach with an unconstrained analysis matrix based on Krapp (2002) interest criteria was used to rearrange the categories. Descriptive statistics from the questionnaire are presented in the results. No statistically significant differences were found between girls and boys using chi-square test with 2 or 3 degrees of freedom according to item and $p<0.05$. Collapsing categories for items 1-19 did not increase the significance.

Validity, reliability and ethical consideration

Each data source has strengths and weaknesses. Therefore, in this study observations and notes from teacher discussions complemented the questionnaire data. Observation data reliability was enhanced with analysis triangulation (Patton, 1999); two researchers analysed the data separately, ending up with a similar categorization and analysis of the data. Combining different instruments and data collection methods ensures also the method triangulation (Patton, 1999). Greene (2015) notes that a combination of methods has a clear advantage over the use of a single method studying student engagement. Schiefele (1999) found that questionnaires usually measure interest that is more personal as that situation is over and it is challenging to remember the feelings individual had, ending with answers mainly about their individual interest. Even though observations eliminate the problem of retrospection, there is the possibility of observer's bias affecting in the results (Minner, Levy, & Century, 2010).

The questionnaire items were translated into Finnish so the students could answer it in their native language. Open-ended question answers were then translated into English and the original questionnaire items in English are used in this study. Translation in both ways was done with care not to lose the meaning of the sentences. The teachers were experienced and the way of teaching was familiar to them. The researcher also worked in close and working cooperation with the teachers. The students were familiar with the researcher and the style of instruction, making possible for them to be relaxed and participate in a normal way. The number of participants in this study was rather small. Therefore, generalization of the results is difficult or impossible. However, 3 groups and 46 students in a case study and in the context of the research problem is adequate to draw conclusions about the influence of career-related instruction.

Table 2. Data collection methods

Phase	Data collection	Data analysis	Aim of the data
During intervention	Observations: whole class, groups of students, individual students, teachers	Content analysis, quantitative analysis	Students' interactions with material, teachers and other adults; Students engagement and situational interest in science learning; Students awareness and interest in introduced science topics, working life skills and careers
	Notes: discussions between researchers and teachers	Content analysis	Teachers' perceptions of using career-based scenarios; Teachers' choices on carrying out career-related instruction
After intervention	Questionnaire: students	Quantitative analysis, content analysis	Students' interest, motivation, relevance and attitudes learning science; Students' awareness and interest in introduced science topics, working life skills and careers

The autonomy of the participant was respected; participation was voluntary, based on consent given by the students themselves. Consent was also asked from students' parents or guardians, teachers, schools and school administrators. No additional ethical review was needed from the Ethical Council, as the study was part of the school's normal activities. Privacy and data protection was taken into account; anonymity of the participants was secured by collecting questionnaire data anonymously and no names were marked on observation sheets; the data was then made available only for the use of the research group.

Results

The observations were firstly grouped into 19 categories and then into 5 main categories: Students' working methods and skills; Interaction; Working life skills, careers and society; Emotions, feelings and experiences and Interest and engagement (Table 3).

Table 2. Categorization of observations

Category	Number of observations
Students' working methods and skills	*60*
Reasoning and argumentation	21
Technology and instruments	13
Precision and caution	12
Instructions and time management	8
Notes and observations	6
Interaction	*49*
Collaboration and teamwork	18
Teacher-student	15
Student-student	11
Leading and guiding	5
Working life skills, careers and society	*48*
Working life skills	22
Careers	19
Society and public participation	7
Emotions, feelings and experiences	*41*
Frustration	16
Positive emotions	12
Negative emotions	8
Own experiences and empathy	5
Interest and engagement	*32*
Interest during inquiries and discussion panel	17
Interest during scenario	15
Engagement	13
Total	*243*

When comparing individual questionnaire items between girls and boys, girls perceived slightly more their future career connected with the topic than boys ($\chi2 = 5.460$; df = 2; p=0.065). In all of the other items the difference between genders were far from significant with p-values ranging from item 13 ($\chi2 = 5.478$; df = 3; p=0.140 to item 16 ($\chi2 = 0.763$; df = 3; p=0.858). The results of the intervention evaluation questionnaire are presented in the Table 4. Furthermore, we present these findings from the questionnaire with the support of observations.

Interest: enjoyment and engagement

The majority of the students perceived that they acquired new knowledge about the intervention's science topic (M=3.03; SD=0.49) and considered the gained knowledge more or less valuable for them and useful for future practical problem-solving. However, the topic hardly raised the students' interest to study science subjects. Discussions between teachers and researchers revealed that during the intervention teachers realized that some of the inquiries and assignments were too complex for the majority of the students to understand and therefore keep up with the phases of the intervention.

The students showed positive and negative emotions during the intervention. Positive emotions were mainly using humour and laughing during the lessons: *"Get those mega gloves" "This is so precious water" "Of course I could drink this water".* Negative emotions were associated with the condition of the lake: *"Ugh! It smells like dead in here."* The students, especially girls, showed only few feelings or expressed their own experiences throughout the intervention towards the science topics or career introduced. However, they showed some empathy towards the condition of the lake such as: *"Fortunately the lake Saimaa is not in that condition".*

The students perceived that working and learning methods were pleasant (M=2.74; SD=0.55) and studying was easy (M=2.87; SD=0.57) during the intervention. In addition, majority of the students were actively participating. The observations validate the students' enjoyment and engagement. The students were mainly positively interested (24/32 of observations related to interest) in scenario and inquiry stages. In scenario stage, students showed interest on observing the nature outside the classroom: *"Are we going out already?"* During the inquiry stage, students were interested in new equipment and surprising reactions. The students showed indifference or frustration mainly in inquiry stage, mostly with the use of computers and electronic learning material and because of the workload. Only few of the students were actively participating during the scenario stage in class but most of the students worked actively during the inquiries and perceived the free working style easy and enjoyable.

The students' reasons for their neutral or slightly negative interest about the topic (M=1.86; SD=0.67) and future interest to learn more about the topic (M=1.70; SD=0.66) had some variation. Positive reasons about the topic included: *"It was nice to learn something new about the lake"; "Because I like to do science inquiries and calculations, even though I don't understand all the time".* Most of the negative reasons towards interest about the topic had no reason, but if there was, it was such as: *"I just did not like it"; "It just was not for me"; "Ugh, such a dirty pond".* The students' willingness to learn more about the topic was reasoned with positive answers such as: *"The topic is important"; "Some details might have been missed".* Negative reasons were linked with the perception of already learning enough or the future career aspiration: *"I think I learned enough"; "I don't think my future career needs skills and knowledge like this".*

View Article Online
DOI: 10.1039/C7RP00221A

Table 4. The results of the instruction unit evaluation

Item no.	Item (4-point Likert scale)	M	SD	% agree (N)	% disagree (N)
1	I gained new knowledge about the topic.	3.03	0.49	95 % (37)	5 % (2)
2	The knowledge I gained from the unit may be useful in the future.	2.54	0.72	56 % (22)	44 % (17)
3	I can use the knowledge acquired to solve problems in practice	2.49	0.60	54 % (21)	46 % (18)
4	The topic is important for me.	2.13	0.62	26 % (10)	74 % (28)
5	This unit enables me to understand local entrepreneurs and their operations	2.59	0.50	59 % (23)	41 % (16)
6	The topic raises my interest on studying science subjects (mathematics, physics, chemistry, biology and geography)	2.23	0.78	28 % (11)	72 % (28)
7	The topic is important for the world.	2.62	0.85	64 % (25)	36 % (14)
8	My future career may be connected with the topic.	1.85	0.63	13 % (5)	87 % (34)
9	I predict I will need to perform skills, learned in the unit, in my future career.	2.03	0.54	15 % (6)	85 % (33)
10	I predict I will need to perform science-related skills, learned in the unit, in my future career.	2.15	0.63	28 % (11)	72 % (28)
11	This unit described science-related problem significant to the society.	2.74	0.79	69 % (27)	31 % (12)
12	It was easy for me to relate with the situation (scenario) described in the beginning of the unit.	2.49	0.56	51 % (20)	49 % (19)
13	During the unit it was easy to study.	2.87	0.57	87 % (34)	13 % (5)
14	Working during the unit was pleasant.	2.74	0.55	74 % (29)	26 % (10)
15	I participated actively during the work.	2.85	0.54	87 % (34)	13 % (5)
16	I gained knowledge about careers new to me.	2.55	0.76	61 % (23)	39 % (15)
17	This unit helps me to understand the responsibility of the described careers.	2.67	0.66	67 % (26)	33 % (13)
18	I became interested of the described careers.	1.87	0.63	13 % (3)	87 % (20)
19	This unit helps me to understand what skills are needed in the described careers.	2.52	0.59	57 % (13)	43 % (10)

	Item (3-point Likert scale)	M	SD	% agree (N)	% neutral (N)	% disagree (N)
22	I find the topic of the unit interesting.	1.86	0.67	16 % (6)	54 % (20)	30 % (11)
23	I want to learn more about the topic	1.70	0.66	11 % (4)	48 % (18)	41 % (15)

Careers, skills and society

Students gained knowledge about the introduced careers and they understood the responsibilities and the working life skills required but their interest towards these particular careers remained low. The teachers tried to involve the careers and working life skills throughout the intervention by emphasizing accuracy, safety, precision and reminding the students about the career-based scenario at the lake and about the results chemist provided. The students usually did not react to these in any way. For example, the students posed only one question to the environmental health officer during the career-based scenario. This question was about her salary.

The students did not connect their future careers with the topic introduced in the intervention and yet they did not see the practical value of the learned skills as most of them perceived that the learned skills were irrelevant in their future career (M=2.03; SD=0.54). Science-related skills were valued a little higher in future careers (M=2.15; SD=0.63). The observations and discussion panel revealed insights of how the students used their knowledge and skills during the intervention. The most noticeable used working life skills among the students were safety and accuracy: "*I put this cork now and close the bottle so if it falls nothing happens.*" During the inquiries, students usually wrote very precisely the results in their notebooks. Even though the students reasoned and created their own analyses in cooperation, they did not write them down. At the beginning of the discussion panel, the students were not eager to show any of their results or analyses. When they finally started to list the results, they did not add their own conclusions. Moreover, students who were a little uncertain of their own analyses started immediately to rewrite their conclusions when someone presented conclusions somehow different from their own.

The students recognized the importance and value of the science topic to the surrounding society and the world but not for themselves (M=2.13; SD=0.62). The questions in the discussion panel guided students for linking their work more with the society. During the discussion panel, most of the students agreed on that the city has to take better care of the lake. One discussion including a comment with collective responsibility: *"If the lake is donated to the city in order they keep it in good condition and as a comfortable zone for all the citizens, we have not met the conditions".* Students also understood that their results differ from the public perception of the lake's condition: *"The lake Mertajärvi is chemically in better condition than people usually think*". According to the students, teachers can inform public and policy-makers about the issue; professional of water treatment can make plans for cleaning the water and its surroundings and animal experts can take care of endangered dragonfly species living at the lake.

Discussion

This study provided students with learning experience in which they first encountered a two-stage scenario including a science-related career and society-related issue, inquiries and a discussion panel related to the introduced water topic.

The results show that in this career-related instruction intervention the most important features of interest for students were *cognitive aspects, emotional and feeling characterizations* and *intrinsic quality of activities.* These were triggering the transaction between the student and the objects: topic (water), careers (environmental health officer, chemist) and inquiry activities (Krapp, 2002). Students acquired new knowledge about the topic, careers and working life skills. Even though the expected difficulty is not a reason not to choose science studies (Korpershoek *et al.,* 2012), the amount and high level of knowledge and skills may have reached the limit of the students' potential and interest to learn more (Tobias 1994; Schraw & Lehman, 2001)

The lessons when visiting the lake outside the classroom triggered the students' interest in science learning. The inquiry part at the lake seemed to carry the students' interest through the more demanding parts later in the classroom. Positive emotions such as humour dominated the early stages of scenario and inquiries, especially at the lake. Negative emotions emerged when the inquiries, reasoning and reporting needed more and more the students' attention. Putting too much pressure on reporting the inquiries can kill the enjoyment and *intrinsic quality* of these activities. These results are worrying as the inquiries are seen motivating and interesting part of chemistry education and, according to Ainley *et al.* (2005); both negative and positive emotions have effect in the situational interest development. However, these findings support the earlier studies (Hofstein, 2004; Braund & Reiss, 2007) that inquiry-based teaching should be complemented with outside classroom activities allowing students to see that chemistry is all around.

The *value components* in this intervention were value for the world and local society, and value for the individual. Students considered the water topic highly relevant for the surrounding society and the world but this topic was not relevant in personal level for the majority of the students. Even though most of the students lived near the lake, they cannot yet see their role as active citizens but can see the significance of the problems surrounding them. The results support the study by Cigdemogly and Geban (2015) that engaging students with real-world issues can close the gap between students and society. Moreover, the results align with the earlier study (Child, Hayes & O'Dwyer, 2015) that students feel chemistry as irrelevant for their lives and they cannot see their role in the society. As the clean water is actually not an everyday problem in Finland or any other European country, it might not raise students' interest towards learning about the topic or the careers related to it (Korpershoek *et al.,* 2012).

Career-related instruction implemented in this study introduced students with outside of school and laboratory activities making school science (chemistry) more relevant and valuable promoting in this way STEM career awareness (Hofstein, 2004; Cohen & Patterson, 2012). However, students did not relate their future career with the introduced career or science topic and therefore, perceived only little value of the acquired knowledge and skills neither from this topic nor from further science studies (Palmer, Burke & Aubusson, 2017). The students might have had difficulties connecting their future careers with the science topics because they were not aware of the diversity of careers, especially in science (Maltese & Tai, 2011; Goodrum *et al.,* 2012) and had false expectations of science-related careers (Salonen, *et.al.,* 2017; Schütte & Köller, 2015). However, students see the topic's importance for the society and the world, recognizing the need for someone else working with such problems in future (Goodrum, *et al.,* 2012).

The students had an opportunity to plan their teamwork and the teacher gave them a lot of responsibility over their learning. These teacher decisions also align with the national core curriculum of Finland and earlier studies (FNBE, 2014; Barron & Darling-Hammond, 2008) promoting cooperation and students' active participation in learning. For some students this might have led to problems in understanding the inquiries and the whole learning process and objectives leading to a feeling of irrelevance (Hutchinson, 2000; Childs, Hayes & O'Dwyer, 2015).

During the inquiry phase, students had problems to link the acquired scientific knowledge and results with their own ideas and conclusions. Therefore, the teachers developed the discussion panel questions. These questions including future and society aspects could have guided the students learning and trigger their interest better than the original research questions in the scenario phase. As the discussion panel proceeded with student-student and student-teacher interactions, the students appreciated and became more aware of relations between their own and others' argumentation and were actively involved (Barron & Darling-Hammond, 2008). This might have led students having deeper understanding of the relations between science, society and individuals, making chemistry and science-related careers more relevant to themselves and further triggering the interest in science learning.

Even though students were interested during the intervention, it was not able to enhance students' further interest to learn about the topic. The intervention included positive triggers to interest but it might have included too many difficult phases for the students. This can be a reason for the students' enjoyment and engagement during the intervention yet not re-engaging with the topic (Krapp, 2002) and promoting further interest towards science studies and careers.

Further research and implications

Further research and interventions are needed to evaluate the results in more complete understanding of the design and use of career-related instruction as well as in relation to other key variables in career choosing such as self-efficacy, career stereotypes, and learning outcome expectations. The MultiCO-project continues the design process and evaluation of career-related scenarios and instruction in further design cycles. No significant differences between girls and boys were found in the analysis but the small number of students have effect on the results and further studies with larger cohorts are necessary to test the gender difference more accurately. However, this case study might give interesting and important insight and implications in closing the gender gap in science interest. In addition, this intervention and future research can give educators help and guidelines connecting science teaching with careers, society and working life skills.

Limitations

There is always a possibility of misunderstanding and/or loss of nuances in translation progress. Therefore, any translations were made with great care together with multiple researcher reviewing the translated questionnaire items and answers. The cultural context was also challenging. Finnish students are not that interested in careers in general, much less their own career opportunities so early in this age. Moreover, the students' interest in science-related careers and science learning cannot be defined with one or two case studies. It requires perseverance research with different kind of studies and throughout reporting of both successful and unsuccessful results. The small number of participants does not allow generalization yet the referred earlier studies validate some of the results. Unfortunately, a controlled comparative study design could not be implemented without changes in crucial factors such as teacher and learning environment or changing the overall design of the MultiCO project. However, with multiple data sources, precise analysis of the data and careful reporting of the results, this study gives valuable information and offers other researchers and educators the possibility to make conclusions and their own applications.

Conclusions

Water and especially clean water in Finland is not an everyday problem for secondary school students in Finland. However, local problems with water pollution and ecosystems occur. The water as a topic and the career-related instruction introduced in this study might give interesting guidelines for the Education for Sustainable Development (ESD) and Citizen Science approaches. This study shows that students' realize the local scientific problems but their interest and engagement towards these topics vary, as they do not personally regard them important or relevant and link the topic with their lives.

If we can meet the students' individual interests with the introduced science topics and careers the engagement may be more obvious. Finding a topic and a career to meet every students' interests is impossible. Career-related instruction should concentrate on emphasizing the perceived personal value and relevance of the careers for the student. Thus, it can provide links between the usefulness of the topic, science studies, society and personal life.

Professional visitor in the lessons is always a challenge and more attention is needed to make the cooperation more functional and promoting regarding science-related careers and working life skills. Moreover, career-related instruction could benefit from using the careers, in addition to the scenario phase, throughout the teaching unit. For further opportunities to develop career-related instruction, we need to listen students' and teachers' views. However, unless teachers are enthusiastic about science, they are unlikely to adopt a teaching approach such as the one presented here, as it places higher demands on them relative to regular science teaching. In future, research on what kind of effect the career-related instruction has in the situational interest and engagement after the career introduction and during the intervention might give more information about how to use careers, professionals, fieldwork and visits outside school more efficiently in chemistry and science education.

Using career-related instruction has its challenges. However, students' interest towards chemistry and science learning can be promoted with moderate amount of acquired knowledge, enjoyment during lessons, linking the career, working life skills and the society together with students' interests, and combining the outside of school activities with inquiry. In addition, introducing students to new science-related careers and working life skills enhance their career awareness and knowledge about the variety and nature of these careers. These are required if we want students to perceive science studies and science-related careers interesting and important for them instead of only for someone else.

Conflicts of interest

There are no conflicts to declare.

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 665100.

References

Ainley, M. & Ainley, J., (2011a), A Cultural Perspective on the Structure of Student Interest in Science, *Int. J. Sci. Educ.*, **33**, 51-71, DOI: 10.1080/09500693.2010.518640

Ainley, M. & Ainley, J., (2011b), Student engagement with science in early adolescence: The contribution of enjoyment to students' continuing interest in learning about science, *Contemp. Educ. Psychol.,* **36**, 4-12, DOI: 10.1016/j.cedpsych.2010.08.001.

Ainley, M., Corrigan, M., & Richardson, N., (2005), Students, tasks and emotions: Identifying the contribution of emotions to students' reading of popular culture and popular science texts. *Learn. Instr.*, **15**, 433–447, DOI: 10.1016/j.learninstruc.2005.07.011.

Andersen, L. & Ward, T. J. (2014), Expectancy-Value Models for the STEM Persistence Plans of Ninth-Grade, High-Ability Students: A Comparison Between Black, Hispanic, and White Students, *Sci. Educ.*, **98**, 216–242. DOI:10.1002/sce.21092

Aspden, T., Cooper, R., Liu, Y., Marowa, M., Rubio, C., Waterhouse, E.-J., & Sheridan, J., (2015), What Secondary School Career Advisors in New Zealand Know about Pharmacy and How that Knowledge Affects Student Career Choices, *Am. J. Pharm. Educ.,* **79**(1), 1-8, DOI: 10.5688/ajpe79107.

Barron B. and Darling-Hammond L., (2008), Teaching for meaningful learning: a review of research on inquiry-based and cooperative learning, in Darling-Hammond L., Barron B., Pearson D., Schoenfeld A., Stage E., Zimmerman T., Cervetti G. and Tilson J. (eds.), *Powerful learning: what we know about teaching for understanding*, San Francisco: Jossey-Bass, 11–70.

Borrows, P., (2004), Chemistry trails, in Braund, M. & Reiss, M. *Learning science outside the classroom*, London: RoutledgeFalmer, 151–168.

Braund, M. & Reiss, M. 2006. Towards a More Authentic Science Curriculum: The contribution of out-of-school learning, *Int. J. Sci. Educ.*, **28**, 1373-1388, DOI: 10.1080/09500690500498419.

Brossard, D., Lewenstein, B. & Bonney, R., (2005), Scientific knowledge and attitude change: The impact of a citizen science project, *Int. J. Sci. Educ.,* **27**, 1099-1121, DOI: 10.1080/09500690500069483.

Burmeister, M., Rauch, F. & Eilks, I., (2012), Education for Sustainable Development (ESD) and chemistry education. *Chem. Educ. Res. Pract.*, **13**, 59-68, DOI: 10.1039/c1rp90060a

Bybee, R., & McCrae, B., (2011), Scientific literacy and student attitudes: Perspectives from PISA 2006 science, *Int. J. Sci. Educ.*, **33**, 7-26, DOI: 10.1080/09500693.2010.518644.

Childs, P., Hayes, S. & O'Dwyer, A., (2015), Chemistry and everyday life: relating secondary school chemistry to the current and future lives of students, in Eilks, I. & Hofstein, A. (Eds.). *Relevant Chemistry Education – From Theory to Practice*. Sense Publishers: Rotterdam, 33-54.

Cigdemoglu, C. & Geban, O., (2015), Improving students' chemical literacy levels on thermochemical and thermodynamics concepts through a context-based approach, *Chem. Educ. Res. Pract.*, **16**, 302-317, DOI: 10.1039/C5RP00007F.

Cleaves, A., (2005), The formation of science choices in secondary school, *Int. J. Sci. Educ.*, **27**, 471-486. DOI: 10.1080/0950069042000323746

Cohen L., Manion L., and Morrison K., (2007), Research methods in education, 6th edition, New York: Routledge.

Cohen, C. & Patterson, D., (2012), Teaching Strategies that Promote Science Career Awareness., https://www.nwabr.org/sites/default/files/pagefiles/science-careers-teaching-strategies-PRINT.pdf, (accessed October 2017).

Dickinson, J., Shirk, J., Bonter, D., Bonney, R., Crain, R., Martin, J., Phillips, T. and Purcell, K., (2012), The current state of citizen science as a tool for ecological research and public engagement, *Front. Ecol. Environ.*, **10**, 291–297, DOI:10.1890/110236.

Elo, S., & Kyngäs, H., (2008), The qualitative content analysis process, *J. Adv. Nurs.,* **62**, 107–115. DOI:10.1111/j.1365-2648.2007.04569.x.

European Environment Agency, (2012), European waters – assessment of status and pressure, https://www.eea.europa.eu/publications/european-waters-assessment-2012/at_download/file, (accessed October 2017).

Finnish National Board of Education (FNBE), (2014), *National core curriculum for basic education 2014*, Finnish National Board of Education: Helsinki.

Goodrum, D., Druhan, A. & Abbs, J., (2012), *The Status and Quality of Year 11 and 12 Science in Australian School*, Australian Academy of Science: Canberra.

Greene, B., (2015), Measuring Cognitive Engagement With Self-Report Scales: Reflections From Over 20 Years of Research, *Educ. Psychol.*, **50**, 14-30, DOI: 10.1080/00461520.2014.989230.

Harris-Bowlsbey, J. & Sampson, J., (2005), Use of Technology in Delivering Career Services Worldwide, *Career. Dev. Q.*, **54**: 48–56. DOI:10.1002/j.2161-0045.2005.tb00140.x.

Hidi, S., & Renninger, K., (2006), The four-phase model of interest development, *Educ. Psychol.*, **41**, 111–127, DOI: 10.1207/s15326985ep4102_4

Hofstein, A., (2004), The laboratory in chemistry education: thirty years of experience with developments, implementation, and research, *Chem. Educ. Res. Pract.*, **5**, 247-264, DOI: 10.1039/B4RP90027H

Holmegaard, H., Madsen, L. & Ulriksen L., (2014), To Choose or Not to Choose Science: Constructions of desirable identities among young people considering a STEM higher education programme, *Int. J. Sci. Educ.*, **36**, 186-215. DOI: 10.1080/09500693.2012.749362.

Hutchinson J. S., (2000), Teaching introductory chemistry using concept development case studies: interactive and inductive learning, *Univ. Chem. Educ.*, **4**, 3–9.

Jenkins, E., (1999), School science, citizenship and the public understanding of science, *Int. J. Sci. Educ.*, **21**, 703-710, DOI: 10.1080/095006999290363.

Kintsch, W., (1980), Learning from text, levels of comprehension, or: why anyone would read a story anyway, *Poetics*, **9**, 87-98.

Korpershoek, H., Kuyper, H., Bosker, R. & Van der Werf, G., (2012), Students leaving the STEM pipeline: an investigation of their attitudes and the influence of significant others on their study choice, *Res. Pap. Educ.*, **28**, 1-23, DOI: 10.1080/02671522.2012.698299.

Kotkas, T., Holbrook, J. & Rannikmäe, M., (2017), A theory-based instrument to evaluate motivational triggers perceived by students in stem career-related scenarios, *J. Balt. Sci. Educ.,* **16**, 836-854.

Krapp, A., (1999), Interest, motivation and learning: An educational-psychological perspective. *Euro. J. Psychol. Educ.*, **14**, 23-40, DOI: 10.1007/BF03173109.

Krapp, A., (2002), An educational-psychological theory of interest and its relation to self-determination theory, in Deci, E. & Ryan, R. (Eds.). *The handbook of self-determination research,* University of Rochester Press: Rochester, 405-427.

Krapp, A., Hidi, S., & Renninger, K., (1992), Interest, learning and development, in Renninger, K., Krapp, A. & Hidi, S. (Eds.), *The Role of interest in learning and development*, Psychology Press: New York, 3-27.

Levitt, K. E., (2001), An analysis of elementary teachers´ beliefs regarding the teaching and learning of science, *Sci. Educ.,* **86**, 1-22, DOI: 10.1002/sce.1042.

Maltese, A.V. & Tai, R.H., (2011), Pipeline Persistence: Examining the Association of Educational Experiences with Earned Degrees in STEM Among U.S. Students, *Sci. Educ.*, **95**, 877-907, DOI: 10.1002/sce.20441.

View Article Online
DOI: 10.1039/C7RP00221A

Minner, D., Levy, A. & Century, J., (2010), Inquiry-Based Science Instruction- What Is It and Does It Matter? Results from a Research Synthesis Years 1984 to 2002, *J. Res. Sci. Teach.,* **47**, 474-496, DOI: 10.1002/tea.20347

Orthner, D., Jones-Sanpei, H., Akos, P. & Rose, R., (2013), Improving Middle School Student Engagement Through Career-Relevant Instruction in the Core Curriculum*, J. Educ. Res.,* **106**, 27-38, DOI: 10.1080/00220671.2012.658454.

Osborne, J. and Collins, S., (2001), Pupils' views of the role and value of the science curriculum: A focus group study. *Int. J. Sci. Educ*., **23**, 441-467. DOI: 10.1080/09500690010006518

Palmer, T.-A., Burke, P. F., & Aubusson, P., (2017), Why school students choose and reject science: a study of the factors that students consider when selecting subjects. *Int. J. Sci. Educ.,* **39**, 645-662. DOI: 10.1080/09500693.2017.1299949.

Patton, MQ., (1999), Enhancing the quality and credibility of qualitative analysis, *Health. Serv. Res.,* **34**, 1189-1208.

Potvin, P. & Hasni, A., (2014), Interest, motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research, *Stud. Sci. Educ.,* **50**, 85-129, DOI: 10.1080/03057267.2014.881626.

Salonen, A., Hartikainen-Ahia, A., Hense, J., Scheersoi, A. & Keinonen, T., (2017), Secondary school students' perceptions of working life skills in science-related careers. *Int. J. Sci. Educ.,* **39**, 1339-1352, DOI:10.1080/09500693.2017.1330575.

Schiefele, U., (1999), Interest and Learning From Text, *Sci. Stud. Read,* **3**, 257-279, DOI: 10.1207/s1532799xssr0303_4.

Schiefele, H., Krapp, A., Prenzel, M., Heiland, A., & Kasten, H., (1983), Principles of an educational theory of interest. (Paper presented at the 7th Meeting of the International Society for the Study of Behavioral Development in Munich), https://www.researchgate.net/publication/262560345_An_educational-psychological_theory_of_interest_and_its_relation_to_self-determination_theory, (accessed October 2017).

Schraw, G. & Lehman, S., (2011), Situational Interest: A Review of the Literature and Directions for Future Research, *Educ. Psychol. Rev.,* **13**, 23-52, DOI: 10.1023/A:1009004801455.

Schütte, K. & Köller, O., (2015), Discover, Understand, Implement, and Transfer': Effectiveness of an intervention programme to motivate students for science, *Int. J. Sci. Educ.*, **37**, 2306-2325, DOI: 10.1080/09500693.2015.1077537.

Tai, R., Liu, C., Maltese, A., & Fan, X., (2006), Planning early for 'careers in science', *Science*, **312**, 1143-1144, DOI: 10.1126/science.1128690.

Tobias, S., (1994), Interest, prior knowledge, and learning, *Rev. Ed. Res.,* **64**, 37–54.

Wang, F., & Hannafin, M., (2005), Design-based research and technology-enhanced learning environments, *ETR&D-Educ. Tech. Res.,* **53**, 5-23, DOI: 10.1007/BF02504682.

World Health Organization, (2017), Progress on Drinking water, Sanitation and Hygiene, http://apps.who.int/iris/bitstream/10665/258617/1/9789241512893-eng.pdf?ua=1, (accessed October 2017).

