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Enhancing students' interest in science and understandings of STEM careers: the role of career-based scenarios

Irene Drymiotou ^{a,b}, Costas P. Constantinou ^b and Lucy Avraamidou ^a

^aInstitute for Science Education and Communication, Faculty of Science and Engineering, University of Groningen, Groningen, Netherlands; ^bLearning in Science Group, Department of Educational Sciences, University of Cyprus, Nicosia, Cyprus

ABSTRACT

Theoretically framed within Social Cognitive Career Theory emphasising on the construct of *situational interest*, this study explores the impact of career-based scenarios, as an instructional approach, on students' interest in science and understandings of STEM careers. This case study involved 16 students aged 13–15 years old, who participated in a classroom intervention consisting of five sessions in a period of two years. Data were collected through a questionnaire and semi-structured interviews administered repeatedly after each session. The questionnaire data were analysed with the use of descriptive statistics and the interview data were analysed through content analysis. The findings illustrate that opportunities for active engagement in scientific practices and interactions with experts were important conditions for career-based scenarios to succeed in enhancing students' situational interest and understandings of STEM careers. These findings hold important implications for educational practice as they offer insights into career-oriented curriculum design for the purpose of enhancing student interest in science as well as understandings of STEM careers.

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Introduction

Students' declining interest in Science, Engineering, Technology and Engineering (STEM) studies and related careers remains an issue of concern worldwide (Organisation for Economic Co-operation and Development [OECD], 2018). The share of STEM graduates has been estimated below 26% of the total number of tertiary education graduates in Europe. This has remained unchanged for the last decade and is deemed too low to satisfy the needs for science-related personnel (Gago et al., 2005; OECD, 2019). Concurrently, societies are faced with complex challenges, such as, public health threats, climate change, and sustainable living, which demand increases in STEM labour (European Centre for the Development of Vocational Training [CEDEFOP], 2018).

CONTACT Irene Drymiotou  i.drymiotou@rug.nl  Institute for Science Education and Communication, University of Groningen, Linnaeusborg (Building 5174), Nijenborgh 7, 9747 AG Groningen, Netherlands

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In examining the reasons why students veer away from science, research in science education has shifted from solely focusing on cognitive variables to also including affective variables related to science learning, often drawing on models from the psychology of motivation (Henriksen et al., 2015). The findings of these studies reveal a number of interrelated factors, both extrinsic (i.e. science capital, socio-economic status, learning opportunities, school-related factors) and intrinsic (i.e. attitude towards science, interest linked to self-efficacy issues, gender, perceived social expectations) that influence students' science career aspirations (e.g. Holmegaard et al., 2014). More specifically, interest in science has been identified as a crucial factor in making decisions about future science-related studies and careers (Potvin & Hasni, 2014). In addition, a recent study examining the factors influencing students' STEM career choices found that their limited knowledge of STEM careers hinders STEM career aspirations (Blotnicky et al., 2018).

Drawing upon these findings and aiming to contribute towards addressing the problem of declining interest in science and STEM careers, in this study, we examined the impact of a specially designed instructional intervention, with integrated career-based scenarios on students' interest in science and understandings of STEM careers.

Theoretical framework

Social Cognitive Career Theory (SCCT) derives from Social Cognitive Theory (Bandura, 1986) and proposes a model to understand how people develop interests and make career-related choices and actions (Lent et al., 1999). This process is understood as an outcome of two levels of interaction: (a) the interaction between the person and the variables of self-efficacy beliefs, outcome expectations, and personal goals; and (b) the interaction of these three key variables with other people and environment variables (e.g. learning environment) that may impede or facilitate the development of interest and thereby goal-setting and actions related to career choices (Lent et al., 1999).

SCCT has been used to frame several studies investigating the factors that predict students' interest in pursuing future science study and STEM careers (Lent et al., 2010). Researchers focused extensively on examining self-efficacy in relation to outcome expectations, gender and socio-economic background (e.g. Chachashvili-Bolotin et al., 2016); background contextual affordances such as exposure to school and extra-curricular STEM activities (e.g. Wang, 2013); and learning experiences in secondary and tertiary education classrooms (e.g. Carpi et al., 2017).

Despite the usefulness of these studies, we still lack an understanding of how specially-designed instructional interventions might support students' interest in science and understandings of STEM careers. In order to contribute towards bridging this knowledge gap, we address the second level of interaction proposed by SCCT, in which a career-oriented learning environment as a set of background contextual affordances might establish a positive influence and potentially impact students' career decision processes. Specifically, we examined the impact of background contextual affordances (i.e. career-oriented learning environment) on students' learning experiences (i.e. the outcome of students' interaction with the career-based scenarios) providing support in the instructional activities.

In a systematic review of 228 peer-reviewed research articles over a 12-year period (2000–2012) examining interest/motivation/attitude towards science and technology at

K-12 levels, Potvin and Hasni (2014) found that interest is considered to be the main driver and the key factor in students' career decisions and that interest in science declines with school years. As the researchers argued, this finding calls for more longitudinal pedagogical efforts in order to better understand the long-term evolution of interest in the learning environment.

For the purpose of this study, we adopt Renninger and Hidi's definition (2011) of interest which refers to: 'a psychological state and a predisposition to re-engage particular disciplinary content over time that develops through the interaction of the person and his or her environment' (p. 170). In doing so, we use Hidi and Renninger's (2006) four-phase interest development model to frame the design of the study: (a) triggered situational interest, a short-term form of interest sparked by environmental stimuli; (b) maintained situational interest, a persistent form of interest over an extended period of time; (c) emerging individual interest, the beginning of a more stable dispositional form of interest; and, (d) well-developed individual interest, a psychological state and a relatively enduring dispositional form of interest to repeatedly re-engage with a particular content. Situational interest (SI) is defined as a short-term form of motivation elicited by aspects in a specific situation that stimulates focused attention and consists of affect and value components (Hidi & Renninger, 2006). According to this model, SI is initially triggered and maintained (phases a & b) and then individual interest emerges and develops (phases c & d). The length of each phase depends on the individual and environmental support.

In this study, we aimed to instantly trigger SI (phase a) and support this triggering by environmental stimuli in the classroom environment that could facilitate the students to form a connection and succeed in maintaining the initial elicitation (phase b). Triggered SI specifically refers to an attentional reaction setting up the potential for individual interest to be developed especially when repeated stimulations occur (Hidi & Renninger, 2006; Palmer, 2009).

Maintained SI denotes an affective reaction toward a situation with which the individual initiates forming a meaningful and relevant connection (Hidi, 2001). In this study, we aimed to provide this connection using a personally-relevant context and story content for the instructional activities as described later on. Triggered SI consists of feeling-related components expressing enjoyment or excitement, whereas maintained SI consists of both feeling and value-related components derived from identification of meaningfulness or personal relevance in the situation confronting the individual.

Building upon these theoretical underpinnings, we targeted SI instead of raising aspirations because SI can be used as an approach to repeatedly enhance students' interest in science and understandings of STEM careers whereas raising aspirations, is a more complex and dynamic process which cannot be controlled in a formal learning environment.

Literature review

In the past two decades, researchers in science education have investigated the reasons behind the decline of students' interest in science from primary school until school completion and then tertiary education (e.g. Bennett et al., 2013; Lykkegaard & Ulriksen, 2019). Reinhold et al. (2018), in their systematic review, examined

the reasons for the low number of STEM graduates. The researchers focused on the effect of secondary schools on students' STEM career orientation putting forward the argument that school factors play a crucial role in shaping STEM study and career aspirations. They reviewed 28 studies carried out in the US. The findings indicated that there was a lack of structured career exploration support from advisers and absence of detailed information on specific professional paths prompting the students to 'go for breadth', choosing a mix of subjects from science, arts, and humanities in order to keep their options open. Moreover, the findings showed that STEM teaching and learning that emphasises practical applications, showcases science topics of relevance to everyday life, connects with practising scientists and is supplemented with extra-curricular STEM activities is more likely to strengthen students' STEM orientation.

Similar findings were reported in the longitudinal study by Blustein et al. (2013) aiming to support high school students in considering STEM fields as viable career options. Following their participation in a two-week STEM/Career Development summer programme, the students were interviewed at two different times within a period of 18 months. The summer programme was found to have had a positive impact on making science more meaningful to students, increasing their content knowledge and motivation to explore STEM careers.

Regarding career exploration opportunities, Kudenko et al. (2017) examined existing initiatives aiming to foster students' aspirations towards STEM careers. Quantitative and qualitative data were collected on 79 school-industry initiatives across 14 EU and EU partner countries. The findings revealed that the majority of such initiatives were short-term or one-off activities with a minimal contribution from industry representatives and discussions about STEM careers. According to the teachers, the students were not able to connect school STEM subjects with their everyday lives and only a small percentage was found to have a good understanding of STEM careers. The teachers expressed the need for more support in using contextual and career information and increased opportunities for networking with industry partners. These findings provide evidence that supports offered to teachers in implementing school-industry collaborative activities are needed. Our study builds upon these findings by exploring the conditions under which we can enhance students' interest in science and STEM careers through a career-oriented learning environment that fosters school-industry collaborations.

Similarly, recent studies provide evidence on the need for interventions that explicitly support students in developing their interest in science and acquiring more realistic understandings about STEM careers (van den Hurk et al., 2019). Providing teachers with educational resources to engage in school-industry collaboration activities and fostering students' interaction with role models in STEM fields are recognised as important processes. Prior research illustrates that triggering situational interest in the classroom can be used as an approach to initiating a process of developing student interest (Palmer et al., 2017). Researchers have recommended introducing changes to the curriculum and enriching formal and non-formal educational activities in order to provide engaging and personally relevant experiences in the context of school science and technology, also highlighting the role of school-industry collaboration (e.g. Reinhold et al., 2018).

Responding to this need, our aim was to provide teachers with curriculum resources in the form of scenarios referring to socio-scientific issues with career-related aspects. In doing so, the following research questions are addressed:

- (a) How does the integration of career-based scenarios in science classrooms influence students' situational interest in science?
- (b) How does the integration of career-based scenarios in science classrooms influence students' understandings of STEM careers?

Methodology

This study employed a case study approach with the case being defined as a group of secondary school students (Merriam, 2009). A case study design provides the opportunity to gain in-depth understanding of a situation by collecting evidence over a long period of time with which we can provide insights for practice and further research. This case study offers a detailed description of the integration and enactment of career-based scenarios in science class over a two-year period and focuses on students' interest in science and understandings of STEM careers. Data were collected from participating students during the two-year intervention. Through a mixed-methods approach, quantitative and qualitative data were collected using a questionnaire and semi-structured interviews with the students. The combination enabled us to draw interpretations, triangulate our findings, and provide understandings that influence theory and practice (Creswell, 2015).

Design: problem-based learning

The design of the intervention was framed around Problem-based Learning (PBL), defined as a model in which instruction initiates with a problem that needs to be solved and the students are actively engaged in activities and tasks considered authentic to their learning environment (Savery & Duffy, 1995). A PBL approach to the design of the intervention was deemed appropriate given research evidence suggesting that the development of individual interest using this model can occur upon repeated arousal of situational interest (Rotgans & Schmidt, 2017). The PBL approach was introduced in science teaching units in the form of career-based scenarios and included of personally-relevant content, tasks promoting participation, collaborative group-work, and interaction with experts in STEM fields.

Procedures

The study involved 16 secondary school students (6 females, 10 males) of similar socio-economic status (middle class) attending the same class in an urban middle school in Cyprus. The students formed a homogeneous group in terms of societal culture and access to science resources outside of school. The students participated in an intervention consisting of five scenario enactments (sessions), which were incorporated into the curriculum through a context-based approach to relate school science content to students' daily life (Kang et al., 2019). The sessions took place over two consecutive years in the

8th and 9th grades with students aged 13–15 years old (Table A1). At these age levels the school adopts an integrated science curriculum that incorporates units which can be identified with different disciplines. The sessions, in which all students took part were offered within the subject *Science* and extended over 3–12 teaching periods (35–50' each). The study evolved in three phases: (a) design and development of the career-based scenarios and the teaching-learning sequence by the first author in collaboration with the school science teacher, and the development of evaluation tools; (b) scenario implementation in science class by the school science teacher; and (c) data collection and analysis.

Career-based scenarios are stories referring to socio-scientific issues (e.g. climate change) that create a need for connecting with STEM experts (e.g. energy efficiency consultant). The stories are framed within a personally relevant context, a prevalent feature of the scenarios, which is linked to students' everyday life, school, and community (Table A1). For example, in session B the students interact with a local recycling company known for its plastic bottle caps campaign to raise money for wheelchairs and discuss worldwide campaigns to reduce plastic which has dominated the media. As a topic, this was deemed potentially personally-relevant because it was aligned with contemporary media discourse and the introduction of re-cycling policies in the context of the study. Likewise, in session C, the students addressed another contemporary issue, that of noise pollution that has been estimated to have a large impact on both quality of life and mental health, with many people being unaware of these effects. It is important to note that career-related goals and interaction with experts from STEM fields are missing from the curriculum and such interventions have not been studied previously in this country. Hence, the integration of such scenarios in science teaching units is considered to be an innovation for the science curriculum, both because of their content and due to the involvement of experts.

Instruments

We collected both quantitative and qualitative data at the end of each session using: (a) the Scenario Evaluation with Relevance and Interest (SERI) questionnaire (Kang et al., 2019); and (b) interviews with students on the added value of their learning experience, in terms of triggering interest and raising awareness about STEM careers. The qualitative data served a secondary role in supplementing and enriching the interpretation of the quantitative data.

SERI questionnaire

The SERI questionnaire is a validated instrument consisting of 21 questions related to relevance (individual, societal and vocational dimensions) and interest (affect, value and knowledge) used to measure students' perspectives on the career-based scenarios (Kang et al., 2019). We used an adapted version of the questionnaire consisting of items related to the interest domain as conceptualised by Hidi and Renninger (2006) and Krapp and Prenzel (2011) reflecting affect (3 items), value (4 items), and career-related information presented in the scenario (3 items) (Appendix B). All items were presented on a four-point Likert scale from *totally disagree* to *totally agree* except for the item 'I find the topic of the scenario interesting' which was on a three-point Likert

scale. The questionnaire also included three open-ended questions asking what the students liked best, what they liked least, and the reasons they found the scenario topic interesting (or not). In total, we collected 74 questionnaires during the intervention. Six questionnaires were missing from four different students due to absence and two students who left the school. Cronbach's alpha was calculated as a reliability measure for each subscale in order to test for internal consistency, which was found to be acceptable in all the sessions (0.8 in sessions A, B, and C; 0.9 in session D and 0.6 in session E).

Individual interviews

The interviews were semi-structured and were conducted by the first author with 10 out of 16 students (3 females, 7 males). The interviews were conducted within ten days following the end of each session and before the beginning of the next teaching unit. In total, we recorded and transcribed 41 interviews. Each of the ten participants engaged in 2–5 interviews. The purpose of the interviews was to obtain a deeper understanding of students' interest and their understandings of the careers presented in each scenario. The interviews were semi-structured and used the research questions as a guide (Appendix B). The selection of the participants was based on their scores on a validated questionnaire that was administered prior to the intervention. The purpose of this selection was to increase the diversity of interest levels among the participants and also to safeguard some representation of both female and male students in order to address the gender aspect.

Data analysis

The quantitative data collected were analysed using descriptive statistics (Table 1) to examine the central tendency for each item (median and mode values) using SPSS (version 25.00). This analysis provided an overall representation of students' interest

Table 1. Students' scenario evaluation on the Affect and Value component of SI and their understandings of STEM Careers.

Items ^a	Session A <i>n</i> = 14		Session B <i>n</i> = 15		Session C <i>n</i> = 16		Session D <i>n</i> = 15		Session E <i>n</i> = 14	
	<i>Mdn</i>	<i>Mo</i>	<i>Mdn</i>	<i>Mo</i>	<i>Mdn</i>	<i>Mo</i>	<i>Mdn</i>	<i>Mo</i>	<i>Mdn</i>	<i>Mo</i>
SI/Affect										
The scenario was fun	3.00	3	4.00	4	3.00	3	3.00	2	3.00	3
I like the format of the scenario	3.00	3	3.50	3.5	3.50	3.5	3.00	3.5	3.50	4
I find the topic of the scenario interesting ^b	2.00	2	2.00	2	2.00	2	2.00	2	2.00	2
SI/Value										
The topic has something to do with me	3.00	3	3.00	3	2.00	2	3.00	3	3.00	3
I find this topic important for me personally	3.00	2	3.00	3	2.00	2	2.50	3	3.00	3
I find this topic important for learning at school	3.00	3	3.00	4	3.00	3	3.00	3	4.00	4
I find this topic important for society	3.00	3	4.00	4	3.50	4	4.00	4	4.00	4
Career-related information										
I gained new knowledge about jobs and career opportunities	3.00	4	4.00	4	4.00	4	3.00	3	3.00	3
I developed an understanding about the skills that are necessary in this job	3.00	2	3.00	3	3.00	3	3.00	3	3.00	3
This job/career might be an option for me	2.00	2	3.00	3	2.00	2	2.00	1	2.00	2

^a1 = totally disagree to 4 = totally agree. The findings are discussed with respect to the two extremes (median = 2.5).

^b0 = no, 1 = cannot decide, 2 = yes.

in the scenario experience focusing on the dimensions of interest affect and value. The collated data from the open-ended questions as part of the same questionnaire and the interview transcripts were analysed using content analysis for the purpose of attaining more insights on the sources of the development of SI and students' understandings of STEM careers. In order to ensure trustworthiness, the first author coded all qualitative data and a second rater independently coded a random 20% of the data set which they then discussed until they reached consensus (Merriam, 2009).

In order to carry out the qualitative analysis of the data about SI, a coding tool was drafted first based on the sources of SI identified from the literature. Following that, the data were analysed using a combination of deductive and inductive approaches in two rounds of coding (Creswell, 2015). In the first-round, a deductive approach was used having the two components of SI, affect and value, as an a priori system of coding corresponding to the main two categories. From this round, six sub-categories were formed and 15 codes. In the second round of coding, the definitions of the sub-categories and codes were refined using an inductive approach and some new codes were discovered that were merged in the categories. Hence, from the content analysis we derived seven sub-categories and 17 codes (Tables 2 and C1).

Furthermore, the qualitative data about students' understandings of STEM careers were initially analysed using established codes to supplement the quantitative data on information about jobs, career opportunities, and skills, as well as choosing the career presented as a future option. The data were analysed based on the operational definition of understandings of STEM careers as follows: students' familiarity with any career or occupation that requires a high degree of knowledge in at least one STEM discipline, emphasising on background, duties and responsibilities and required skills (Blotnick et al., 2018) (Table C2).

Limitations

The study is limited in different ways. First, the case study approach does not allow for generalisations beyond the context of the study, especially given its small size. Another limitation resides in the sampling method employed. The participants of the study were selected through convenience sampling. Hence, the sample cannot be considered representative of the wider population but served only in addressing the research questions of this study. However, the participants of the study were typical of the wider student population in this country that the study, in terms of age, cultural experiences, and background scientific knowledge. Moreover, the limited sample size restricted further statistical analysis, which we tried to address with the use of qualitative data. Last, we acknowledge the complexity and dynamic nature of forming STEM career aspirations, which is why we focused on understandings instead.

Findings

Career-based scenarios supported students' development of SI

The first research question addresses the components of interest: 'affect' and 'value'. The affective component focuses on students' emotions towards the scenario and the teaching

sequence. The value component is about students' evaluation of the scenario and the teaching sequence as important, meaningful, and relevant to themselves.

Overall, the findings from the quantitative analysis as shown in Table 1 below indicate students' general enjoyment of the learning process. This was expressed through positive feelings towards the scenario ($mdn \geq 3.00$, out of a maximum of 4) and interest to the highest degree in the scenario topic ($mdn = 2.00$, out of a maximum of 2) in all the sessions. Regarding the value component, the students agreed that the topics of the scenarios in the five sessions were important for people to know in general and to learn at school ($mdn \geq 3.00$). Overall, the topics were perceived as personally relevant in all the sessions ($mdn \geq 2.50$) except in 'Waves and Sound: Acoustics Club' ($mdn = 2.00$) which was also evaluated as not personally important ($mdn = 2.00$).

Sources of SI

Content analysis of written responses to the open-ended questions and the transcribed oral interviews provided insights for the sources of SI. Specifically, they shed light on: what the students liked more, found more interesting, important, and relevant to themselves. Table 2 shows the frequencies of the sources of SI classified in the components of interest: 'affect' and 'value'. The frequencies were calculated based on the content analysis of students' responses to the open-ended questions in the questionnaire ($n = 76$) and the interviews ($n = 41$). The category 'affect' is organised into five sub-categories and the sub-

Table 2. Affect and Value-related sources of SI.

Affect	Frequencies	
Novelty	+54	-4
'Be the expert' activity	23	
Interaction with expert	17	-2
ICT tools	14	-2
Scientific practices	+37	
Problem-based activities	37	
Interest	+25	-11
Interest in the topic	15	-5
Interest in science in general	6	
Interest in the career	3	-6
Interest in school science	1	
Social relatedness	+17	-1
Group-work	14	-1
Division of labour	2	
Self-regulated learning	1	
Complexity	+2	-9
Level of difficulty	2	-7
Total	+135	-25
Value	Frequencies	
Knowledge	+59	0
Learning about science topics	31	
Learning about careers	16	
Learning in general	12	
Relevance	+34	-3
Social/Global relevance	21	
Personal relevance	13	-3
Total	+93	-3

Note: Positive numbers refer to number of times a positive influence on student interest was mentioned. Negative numbers refer to reports of negative influence.

categories include 12 codes. The category ‘value’ is divided into two sub-categories and the sub-categories include five codes. The numbers presented in Table 2 refer to the number of times the students mentioned these sources in each code, sub-category, and total in each category.

Affect-related sources

As can be derived from Table 2, ‘affect’ ($n = 135$) was found to have influenced students’ SI remarkably. Within this category, ‘novelty’ ($n = 54$) was perceived as significantly important by the students ($n = 59$) in terms of triggering their interest. Indicatively, ‘be the expert’ activity/mission’ ($n = 23$), ‘interacting with an expert’ ($n = 17$) and the use of ‘ICT tools’ ($n = 14$) were reported amongst the greater sources of SI. It was indicated that taking on the role of an expert to accomplish a mission and using software programmes were perceived as something new, not commonly used in the teaching practices in this classroom. The excerpts below from the interviews with three different students are indicative of the supporting evidence:

I like it because before when we had the first lesson of a new chapter, we just started learning about it without knowing what it was. Now we had a task to figure it out. (Novelty/‘Be the expert’ activity/mission: session A; Interview with S6)

[..] the man came here, it was live and we could see him, and he was showing us everything with his hands, so this was probably the most interesting and the most interactive. (Novelty/ Interacting with an expert: session C; Interview with S3)

It was interesting to see with the computer how fast certain materials heat up. (Novelty/ICT tools: session E; Interview with S8)

At this point, it is worth noting the actions taken to develop a friendly and informal environment during the experts’ visits and avoid the risk of positioning the expert as a ‘genius scientist’. Before the visits, we collaborated closely with the experts to ensure that they would discuss their work-life as well as their everyday routine, the reasons for pursuing the specific career, and any difficulties they encountered emphasising cognitive abilities and skills during their studies and their career trajectory. Respectively, before the visits, the teacher advised the students to prepare a set of questions about the experts’ jobs and in particular their personal life. During the visits, the teacher prompted the students to pose the questions and find out information about experts’ personal lives. Even though the ‘interaction with an expert’ was amongst the most common sources in the novelty sub-category, the findings presented in Table 2 include two instances of a negative influence on student interest. Both of these comments contradicting the broader trend are from interviews following the session ‘Heat transfer: Save the Polar Bears’. Two students found the experts’ visit to be not particularly engaging because of the absence of connections to scientific practices, such as the use of lab experiments (e.g. [..] *perhaps they could have done more hands-on things to become more engaging*). This implies that non-engaging interaction with experts can have a negative impact on students’ interest. On the other hand, it became clear that the experimentation that took place after the experts’ visit in the same session, served to regenerate their interest ‘providing balance’ in the session. The following are some representative examples from the interviews with two students:

I think we had a balance, for example, we had work to do but there was also the experiment in the middle and it was really nice. (Interview with S7)

The actual boxes and the experimentation side of things were like a much better way that we were able to really have a hands-on experience. (Interview with S17)

Of interest in the above is that students' engagement in scientific practices with or without the presence of an expert seemed to have been deemed as stimulating. Consistent with this indication, 'scientific practices' ($n = 37$) was the second most frequently reported source of SI. The students shared that the problem-based activities such as the lab experiments (sessions A & E), the poster design (session B), and modelling (session C) aroused their interest. This view is exemplified in the excerpt that follows from an interview with another student:

Researcher: What was the most interesting part?

S8: Definitely what we were doing in the last lesson, designing the club actually, drawing out and showing what it is.

Responses placed under the sub-category of 'interest' indicated that the students were more 'interested in the topic' ($n = 15$) and less 'in science in general' ($n = 6$). An indicative example of being interested in the topic is presented next:

Yeah, it was ... let's say, special. I don't think that anybody had ever thought of how the roads are built. It was the first time I thought about it and that there are people who are responsible for this, so it was interesting. (Interview with S7)

The excerpt above implies that the use of science topics perceived as interesting by the students can trigger their SI. Nevertheless, the fact that only a few students found the careers interesting ($n = 3$) may be an indication that presenting unattractive careers to the students can influence negatively their interest in the entire session. This is better illustrated in the words of two students below from an interview and the questionnaire, showing both positive and negative reactions.

I definitely found it interesting. I enjoyed engineering and sound engineering so it could be an option when I grow up. (Interview with S8, session C)

I didn't find it interesting because transportation engineering is not my interest. (S6 in the questionnaire, session D)

'Social relatedness' ($n = 17$) was also found to be a source of SI. 'Group-work' ($n = 14$) was the most common source compared to 'division of labor' ($n = 2$) and 'self-regulated learning' ($n = 1$). An example of this view can be found in the words of one student:

It was nice that we put all the clues in a group, and we worked all together as a team to find out what might have killed Juliana. (Interview with S7, session A)

What becomes of interest in this quote is that the students enjoyed working in groups towards a common goal.

Nevertheless, it was evident that the students developed unpleasant feelings related to the 'task complexity' and specifically the 'level of difficulty'. An indicative example

follows from a student answering the questionnaire after the ‘Speed and motion: Two-wheeled mission’ session:

Questionnaire: I did not like very much about this scenario:

It was quite boring and complicated. I find the mission map confusing. (S5)

On the other hand, two students in the same session had noted that they found the task interesting because it was challenging. The following excerpts from the interviews with the two students provide evidence of that:

Researcher: What did you like the most?

S3: The map. It was the most difficult but the most important and most interesting.

S17: Maybe instead of bike tracks we could work with airplane routes [...] just maybe pump up the numbers a bit, trying to make it more challenging.

What is important to notice in the above quotes is that under some conditions challenging tasks may stimulate students and trigger their interest but this needs to be further explored in relation to self-efficacy beliefs.

The value of learning and relevance with global issues as sources of SI

As the findings of the content analysis (Table 2) showed, ‘knowledge’ was the most common source of SI ($n = 59$) in the category ‘value’. The students pointed out that ‘learning about science topics’ ($n = 31$) is meaningful for them. The extracts below from the interviews with two students represent this view:

I knew very little about sound and acoustics but now that I’ve learnt so much more it has all become very interesting. (Interview with S1, session C)

It is really interesting to see that nothing we have made of plastic is pure. It was useful to see that it’s so easy for something to become impure. (Interview with S17, session B)

It is important to notice here that learning about sound and acoustics and pure and impure substances respectively was interesting for the students. This indicates that meaningful learning about a science topic may influence their interest positively.

‘Learning about careers’ ($n = 16$) either through the interaction with the experts or using videos and text-based information was also perceived useful and interesting, as illustrated by the following excerpt from an interview with a student:

The most interesting part was when we found out what transport engineers go through every day, what their work is like ... that was really interesting [...] we got a much better understanding. (S1, session D)

Even though ‘learning in general’ ($n = 12$) was the least common source in this sub-category, the data indicated that the students valued learning because it is important in general. For example, a student stated:

I really find it interesting due to all this new knowledge. (Interview with S1, session C)

This implies that even in situations where learning might not be perceived as personally relevant, it can still be perceived as interesting.

'Relevance' ($n = 34$) consists of students' responses showing that the scenario or aspects of the teaching sequence are personally or socially/globally relevant, thus influencing their interest. Unexpectedly, 'social/global relevance' ($n = 21$) was more common than 'personal relevance' ($n = 13$) in students' comments about what triggered their interest. The excerpts below exemplify both views:

Questionnaire: I find the topic of the scenario interesting because the subject of global warming is intriguing and very important worldwide issue. (S17, session E)

I think a lot of people enjoyed it [the project to turn the squash court into a night-club]. It was definitely a lot more relatable to kids of our age. (Interview with S17, session C)

What these indicate is that the students appeared to demonstrate interest and sensitivity in societal issues. Personal relevance, on the other hand, was aligned with students' personal experiences and the extent to which they personally related to the topic of the scenario.

In summary, it becomes clear in the analysis that the integration of career-based scenarios in the science classroom showed an overall positive influence on students' SI; certain aspects of the scenario approach appear to have played a more critical role than others. The findings from the quantitative data illustrate that in all sessions the students expressed positive feelings towards the scenario and the teaching sequence and found the topic interesting and important for people to know and to learn at school. As the findings of the content analysis of the written responses to open-ended questions and the interviews with the students revealed, affect-related sources were perceived more influential in terms of triggering students' SI as compared to value-related sources.

Within the category 'affect', 'novelty' with regards to 'be the expert' activity was the most common source of SI reported by the students while the 'interaction with experts' appears not to have been always engaging (e.g. session E). On the other hand, 'scientific practices' were found to have stimulated students' SI, enabling their re-engagement with the session, where necessary. Additionally, there were some indications that triggering students' interest was facilitated through collaborative 'group-work' thus satisfying the need for social relatedness. The use of topics perceived as interesting to the students was another source of SI, directly linked to students' personal interest. Last, 'task complexity' or perceived high 'level of difficulty' initiated both positive and unpleasant feelings to the students, which presumably relates to self-efficacy beliefs that can influence students' interest.

In the category 'value', 'knowledge' and particularly 'learning about a science topic' was the most frequently reported source of SI by the students, followed by 'learning about careers' and 'learning in general'. Learning, in general, was considered useful by the students and thus interesting even though not always personally relevant. Similarly, 'social/global relevance' was found more interesting than 'personal relevance' demonstrating students' interest and sensitivity with global issues.

Career-based scenarios supported students' development of understandings about STEM careers

The analysis of the data from the questionnaire in terms of students' understandings of STEM careers, showed that they reported learning information about the STEM jobs

presented in the intervention and career opportunities, as well as developing improved understandings of the skills required in these jobs ($mdn \geq 3.00$) (Table 1). On the contrary, choosing the careers presented in the intervention as a future option was not common since the students rejected this option in all the sessions ($mdn = 2.00$) with the exception of the job of the environmental scientist ($mdn = 3.00$) in session B. The analysis of the interviews provide elaborations on the students' views about the acquired knowledge and their future career options.

'I wasn't aware of what this job is about'

The findings from the analysis of the qualitative data confirmed that the participants perceived themselves as more knowledgeable about STEM careers at the end as compared to the start of the intervention. The students reported gaining information about certain jobs and experts' responsibilities that they were not aware of. Indicative examples of such views are presented next.

I knew that there is a process of turning plastic into usable materials, but I didn't know that it is such a detailed process or that such a job exists! (S17, session B)

These words above illustrate that the student appreciated having received information about the role of an environmental scientist in recycling plastic and the scientific practices related to that. Another view, about the job of the acoustic engineer is presented below:

I knew that there must have been someone that works with sound, but I didn't know they would stare at a specific job title. I really enjoyed that we actually had him in and we were able to ask him questions and what we really needed to know, so we could get into a lot of depth with what he told us and it really really helped us that we were able to see and talk to him one on one. (S17, session C)

What is interesting here is that the student enjoyed the presence of the expert in class and the fact that they had direct access to authentic information by just questioning the expert. Likewise, the excerpt below indicates that the interaction with an expert enabled students to reconstruct their understandings of the job of transport engineer:

I knew the engineer but I didn't know what a transport engineer is. I tried to guess but I was a bit wrong because I thought that it has to do with cars, but it has to do with roads. Also when the transport engineer came in and spoke to us, we got a much better understanding and that was really interesting. (S3, session D)

This excerpt highlights that students sometimes might hold misconceptions or have inadequate understandings about specific STEM careers, which could in return influence their interest in pursuing them.

It's interesting to learn but I wouldn't choose it as a career option

As indicated in the analysis, the students were interested in learning career-related information (Table 2). However, pursuing the careers presented in the scenarios was not commonly reported, confirming the descriptive statistics (Table 1). The quote that follows represents this view:

I wouldn't like to do this job in the future because from a small age I wanted to be a doctor or marine biologist, so I don't think I will do something like this. (Interview with S3)

It is interesting to notice in the above excerpt that the main reason for rejecting these careers relates to having different career aspirations. The analysis of the data from the interviews indicated that only one student expressed choosing the careers presented as a future option, as quoted below:

That it's a good job idea which I wouldn't mind looking into. (S8, session D)

Yes, why not? I have no idea what I'm going to choose as a career so everything is an option right now. (S8, session E)

What is interesting to note here is that the reason for considering these jobs relates to 'keeping the options open' since these students have not yet formulated a specific career aspiration. The findings showed that the intervention enhanced students' understandings of STEM careers, especially in the sessions where experts were present (sessions C, D & E). The students reported shaping an overall idea about the careers presented focusing on the relevant expertise, duties, and skills mainly related to sector-specific knowledge. Learning about careers was not found interesting for the purpose of exploring future career opportunities by most students, and the intent to choose one of these careers as a future option was not a common finding. Some students rejected these careers because they were not aligned with their individual interest. Overall, students appeared to treat the decision to choose a career as an important commitment and not as something that could be arrived at merely on the basis of learning from a sequence of lessons, albeit over an extended time period and with important differences as compared to their normal educational experience.

Discussion and implications

The purpose of this study was to explore the ways in which the integration of career-based scenarios in the curriculum might enhance students' situational interest and their understandings of STEM careers. Overall, the findings of this study showed that the use of career-based scenarios could serve as a mechanism for generating students' SI and raise their awareness about STEM careers under some conditions. More specifically, certain aspects of the intervention appeared to be more critical than others in shaping students' interests and understandings of STEM careers. These are discussed next.

Novelty

Students' SI was triggered through certain teaching strategies employed in the scenario and the teaching sequence. More specifically, the interaction with experts and the opportunity to use scientific tools and related software were the most frequently reported sources of triggering and sustaining SI. These sources were perceived as novel and unusual and facilitated the students' engagement in the instructional activities. However, the data analysis showed that these interactions were not always serving the purpose of triggering and/or sustaining SI. Instead, the findings showed that these interactions were more likely to enhance students' interest if they occurred in informal settings and included more personal, informal, and unstructured conversations. The added value of the novelty effect, is consistent with findings by Chen et al. (2001),

suggesting that novelty can have positive effects, elicit instant enjoyment, and possibly enhance students' interest. The question then becomes one of whether this comes with a risk of fading away when the novelty effect is not present or under what conditions the SI generated through novel activities can be sustained through the entire teaching-learning sequence.

Scientific practices

The findings illustrated that students' SI was enhanced through their involvement in scientific practices, broadly defined as the practices that scientists engage in order to perform scientific investigations (National Research Council, 2012). In this study, we use the term scientific practices to refer primarily to problem-based activities, lab experiments, modelling, and poster design. What needs to be noted here is that students' SI seemed to have been (re)activated through these activities in situations where it was not triggered or was fading away. This confirms Rotgans and Schmidt's (2017) argument about the need for repeated arousal of SI with new instructional events as a means to enhance its strength across levels.

Interestingness

Another important finding that emerged from the analysis is that the *interestingness* of the learning situation could be a source of SI. Schraw et al. (2001) referred to the interestingness of the situation to describe the characteristics of tasks and texts that succeed in triggering interest. In this study, the interestingness of the learning situation denotes the interest in science as a discipline, in the careers presented in the sessions, in school science, and the topic of the scenarios. Overall, the topics selected for the scenarios were quite interesting for the students. Given that, in this context, general interest in science cannot be controlled, interest in school science, which was the least reported source of SI, could be enhanced using topics that the students find interesting. This outcome is consistent with the finding by Habig et al. (2018) that students' interest in activity stems from a combination of being interested in the activity and also in the content.

Furthermore, the findings illustrate that assigning challenging tasks does not always serve to trigger students' interest. Instead, triggering depends on the master experiences of students defined as sources of self-efficacy beliefs, whether they experience success or failure (Lent et al., 1999).

Regarding the careers presented in the scenarios, it became evident that those cases were not perceived as personally relevant were more likely to have a negative influence on students' interest in the particular session. Hence, this finding illustrates the value of combining more diverse sets of scenario features in order to address a broader range of students' interests.

Social relatedness

Collaborative group-work was appraised by the students to be amongst their favourite activities in the sessions. Group-work was found to facilitate triggering and even

maintaining students' situational interest. Likewise, previous studies have shown that working in small groups enhances social relatedness since it increases the feeling of belonging and might therefore result in sustaining SI (Hidi & Renninger, 2006; Palmer, 2009).

Learning with relevance

Learning was the most commonly reported value-related source of SI. The findings of this study demonstrate that the students not only appreciated learning information about global socio-scientific issues and careers but also indicated arousal of interest that stems from this learning. One possible explanation could be that this knowledge enabled students to establish useful connections between theory and practice due to the transfer of science concepts to a real-life-personally-relevant context. This finding corroborates Palmer's findings (2009) identifying learning as a source of SI and further confirms Krapp and Prenzel's (2011) argument that this occurs when the learning process is personally important.

Developing understandings of STEM careers

Considering the low visibility of STEM careers in the school curriculum, this study aimed to raise students' awareness about future opportunities in STEM, providing connections between theory and practice and careers, in science class. The findings suggest that this goal was achieved especially in the sessions where the students had opportunities to interact with the expert(s) as part of their projects. The findings showed that the students developed comprehensive understandings about the experts' background, skills, and tasks, especially in relation to the science concepts introduced in each scenario. Reflecting on this finding, there seems to be a clear argument that career-related information can be induced productively in science class, reinforcing Reiss and Mujtaba's (2017) suggestion to embed careers education in STEM lessons. Nevertheless, as the findings also revealed, solely providing career-related information, albeit in personally relevant and meaningful ways, did not result in more students interested in exploring the possibility to pursue STEM careers. One reason for this might be that effects on career aspirations are not observable within a student's school lifetime and would require a longer time interval before they can become apparent. A more likely reason is that the process of forming career aspirations is complex and can be predicted to a large extent by students' self-concept, which is considered as relatively stable by the age of the participants of this study (Rüschepöhler & Markic, 2019). Hence, if the intent is to have an impact on students' career aspirations, there is a need for more gradual interventions that start earlier in school life and are designed to provide rich information on STEM careers but also to connect with the formative processes that shape students' self-concept, including role models, family science capital, individualised learning opportunities and human relatedness.

Conclusion

This study provides empirical evidence about the ways in which the implementation of career-oriented curricula in science classrooms might enhance students' interest in

science and understandings of STEM careers. In terms of research, our findings demonstrate that the scenario features that could possibly trigger students' SI and enhance their understandings of STEM careers are: (a) promoting students' active engagement through a problem-based approach that incorporates novel scientific practices; (b) establishing connections between classroom discourse and authentic workplace environments by transferring science concepts to a real-life-personally-relevant context; and (c) integrating the STEM career component through informal interactions with experts. In terms of practice, this study provides a set of evidence-based and freely available set of curriculum materials and evaluation tools [website] for instructional designers, researchers, and educators. The intent of this study was not to influence students' career aspirations. However, there is some evidence that educational interventions adopting this goal would be more effective if they started with younger children who are still at a formative stage with respect to their self-concept.

Notwithstanding the fact that this study is the first attempt to explore effects on students' interest and understandings of STEM careers within the country context, it could set a fertile ground for further research in various other contexts. However, we acknowledge that the study is limited due to its size and hence we propose that this could serve as a pilot study for the purpose of designing a large-case study across the country. Moreover, this study is limited given its sole focus on students' formal learning experiences and not exploring other possible factors affecting their interest in science and STEM fields. Hence, we recommend that future research is carried out to examine the long-term impact of integrating career-based scenarios into the science curriculum on supporting students' interest in STEM and career decisions in relation to other intrinsic and extrinsic factors in different contexts while using larger samples targeting preferably younger children at ages when self-concept is considered still malleable. Another limitation of the study is that it has not explored the role of the teacher in the intervention, which might serve as another factor influencing the findings. The findings of such studies could be used to also further theorise about the development of situational and individual interest in science and provide practical recommendations for curriculum design and classroom practices that aim to enhance students' interest in science and understandings of STEM careers.

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ORCID

Irene Drymiotou  <http://orcid.org/0000-0001-8965-6767>

Costas P. Constantinou  <http://orcid.org/0000-0003-3183-4131>

Lucy Avraamidou  <http://orcid.org/0000-0001-9693-4438>

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