USING LEARNING MODULES TO RAISE STUDENTS SCIENCE-RELATED CAREER AWARENESS

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Abstract

The current study focused on evaluating the use of a career-based scenario and a follow-up teaching-learning module for establishing student science-related career awareness. In this study, two groups of students participated, one evaluating only the scenario (N=67), the other evaluating the scenario after involvement in the follow-up intervention (N=85). Findings indicated that students in both groups agreed they gained new knowledge, useful in their future lives and in problem solving situations, based on the scenario. Students who undertook the intervention agreed more than the scenario only group that the scenario gave knowledge needed in school subjects and that they learned general and science-related skills needed in their future career. At the same time, it was found that tendencies related to interest, value (relevance), likeness and motivation remained similar in both groups (interest and likeness were more recognised compared with the value and a motivation to learn more about the topic).

Keywords: Career awareness, Career-based learning module, Science education.

1 INTRODUCTION

Education systems worldwide strive to prepare citizens possessing a range of competences (knowledge, skills, attitudes and values) [1], enabling a capable workforce. However, concerns within science education, even including interdisciplinary aspects such as associated with STEM (science, technology, engineering and mathematics) education, not only relate to a lack of a sufficient workforce in the STEM field, but insufficient students are taking up STEM careers [2] [1]. Although specific indicators are lacking [3] [4], research on STEM career motivation indicates students’ negative impressions of the impact of STEM teaching on career decisions [5]. In general, students do not see the school science-related provision as useful for their lives and future career developments [1] [6]. Furthermore, student motivation towards science-related learning tends to decline as grade level increases [7]. In addition, it seems that students are not being made aware of career options [8] and research has shown that introducing STEM careers as an add-on to learning is not enough, because, although students may have shown interest in this, such interest does not remain stable over time [9].

Nevertheless, a literature review has shown that society oriented, context-based science education increases students’ orientation towards science studies and science-related careers [10]. Context-based education is meaningful when the context, or application, is within a real world situation, having some familiarity for the students [11].

Suitable contexts, positively affecting student interest, motivation or attitudes can be initiated by means of a scenario which can provide an initiation into science and technology career orientations. Such a scenario is defined as “a motivational, student-relevant, initial teaching construct, which can be presented as a story, slide presentation, video etc., and can initiate students’ thinking and willingness to start asking questions and make comments [12]. The most likely scenario context is connected to students’ personal life, either now, or in the future (personal relevance), which can be further expected to have a social relevance orientation and/or connection with an updated global or local problem/issue (media relevance) [13]. Nevertheless, the scenario is not expected to be a standalone, but initiating a sequence of lessons, leading to learning that is related to the intended science curriculum. In this manner, a scenario, accompanied by a subject-related teaching approach, forms a teaching – learning module.

In this research, a 3 stage teaching approach is used [14], the scenario being stage 1, the science conceptual learning as stage 2 and the socio-scientific consolation as stage 3. The research focuses on a scenario, which is built around an industry visit within which students are encouraged to ask career-related questions to various employees. The scenario is created as a co-operative endeavor between students and science educators. The teaching approach is based on social constructivism at
both levels: learning (students construct their initial ideas) and teaching e.g. enhancing progress from
the scenario into actual science cognition [15], which in this case is conducted via several practical
involved activities, modelling work in an industry-related frame.

The following research questions are put forward:

RQ1: In what ways do students evaluate social constructivist scenarios built on industry visits?

RQ2: Which aspects in the scenario evaluation form characteristics for classroom intervention
involving industrial visits?

2 METHODOLOGY

2.1 Design

This study was part of European Union funded research project ‘Promoting Youth Scientific Career
Awareness and its Attractiveness through Multi-Stakeholder Co-operation’ (MultiCO). In this project
each participating country carried out an intervention study to raise student’s science-related career
awareness (from grade 7-9) using a student relevant scenario within a teaching-learning module. In
Estonia, five modules were developed and used over a three year period. Teachers using the
modules in school were provided with an in-service course guiding their use of the context-based
career awareness modules.

In the current study, the focus is on the scenario “Should there be a sugar tax?” and on its follow-up
teaching-learning module related to chemistry, as well as biology, components of the curriculum.
The purpose of the study is to investigate the relevance of the student initiated, teacher modified,
and career-based, scenario in two settings: a) the scenario (as a PowerPoint slide presentation) as
a standalone without the follow-up learning module, and b) the use of the scenario when associated
with the post-intervention learning within a science curriculum associated with the model indicated in
figure 1.

Figure 1 illustrates the model that is designed to promote STEM career awareness, initiated by the
use of a motivational and realistic STEM career scenario, associated with curriculum-driven STEM
learning that includes socio-scientific decision making in a real life context. In the decision making
process, students are guided to appreciate the usefulness of the work and life skills introduced in the
scenario as a real life situation. It is expected that this approach raises student interest in science-
related studies and influences, through personal relevance, their appreciation of STEM careers.

The motivational concern, to which the STEM career scenario in the current study relates, is about a
sugar tax added price of soft drinks and how this can influence future lemonade production as well as
have an impact on human health-related issues. A visit to the industry (a regionally famous beer and
lemonade factory) following the scenario introduction provides students with an opportunity to see
different industry departments (laboratory, R&D department, logistics, etc.) during which students can
ask questions from employees so as to gain a better impression of the operational competences
required. Later, back in the classroom, students can discuss the questions asked and the responses
received. Following the discussion, students undertake a set of practical activities, in an open-inquiry
format modelling real life career competencies. The activities are similar to those seen by students during the visit (degustation of soft drinks as organised with public involvement, designing of new soft drinks and their marketing such as in a R&D department, quality check of different soft drinks (pH, sugar content, gas solubility, etc.).

2.2 Instrument

In the MultiCo project, a questionnaire for evaluating student's perceptions about the developed scenarios was administered before the intervention phase took place [16]. But for evaluating the scenario after the teaching of the whole module, within this study, (so as to determine differences in students' perceptions before and after the intervention), the earlier questionnaire was modified, with changing of items dependent on the nature of the actual teaching [17]. Nevertheless, questionnaire items, in both cases, were related to the scenario topic, the acquired knowledge, the usefulness of the knowledge, career awareness, and through open-ended explanations, students’ interest, relevance, liking and motivation towards science studies. In both questionnaires, responses were requested using a 4-point likert scale (3-point scale for the last 4 items). Student responses were analysed using descriptive statistics (means and standard deviations) to recognise the perception tendencies related to the developed scenario. In the open ended responses, students initially indicated their level of agreement with the statement (on a 3-point scale), which were analysed using descriptive statistics and then the accompanying written responses were analysed based on the arising themes and validated by interviews.

In this article, examples of students’ responses are presented to recognise which justifications students used for their evaluation.

2.3 Sample

In this study, two groups of grade 8 students evaluated the developed scenario and its usefulness for raising STEM career-awareness. The first group (N=67), was used to determine students’ perceptions about the type of scenarios without any extra explanation or activities from the teacher and only evaluated the scenario presented by 10 PowerPoint slides with no follow-up intervention. The time for undertaking the evaluation task was not limited but, in general, took about 20 minutes. The second group (N=85) of students evaluated the scenario after the whole 4-lesson module was carried out, which included the multiple practical activities and the industry visit.

Both groups of students were taught by experienced science teachers who initially had gone through an in-service course on context-based teaching and hence a context-based approach was not new for them.

3 RESULTS

3.1 Scenario evaluation without intervention

Data analysis indicate that students agree that the scenario presented through a PowerPoint slide presentation, allows them to gain new knowledge about the topic (the mean value indicating agreement is taken to be above 2.50), the knowledge can be useful for the future and probably can be helpful for problem solving in the future. They also agree that the scenario is easy to understand. At the same time, they don’t see this topic as being important personally, in a family setting, in a local community, nor at a world level. They don’t associate the usefulness of the scenario topic in learning school subjects, in using skills, nor see the science-related skills, introduced in the scenario, important for them in their future careers. Table 1 shows students’ evaluation responses for the scenario before involvement in further intervention. Standard deviations indicate the wide spread of students’ answers.
Table 1. Evaluation results of scenario “Should there be a sugar tax?” (N=67).

<table>
<thead>
<tr>
<th>Item</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>This scenario enables me to gain new knowledge about the scenario topic</td>
<td>3.03</td>
<td>0.74</td>
</tr>
<tr>
<td>The knowledge I gain from the scenario may be useful in the future</td>
<td>2.79</td>
<td>0.73</td>
</tr>
<tr>
<td>I can put knowledge, gained from the scenario into practice, to solve problems</td>
<td>2.60</td>
<td>0.82</td>
</tr>
<tr>
<td>I find this scenario topic important for me personally</td>
<td>2.15</td>
<td>0.78</td>
</tr>
<tr>
<td>I find this scenario topic important for my family</td>
<td>2.06</td>
<td>0.77</td>
</tr>
<tr>
<td>I find this scenario topic important for appreciating the work of our local community (town, village)</td>
<td>2.37</td>
<td>0.74</td>
</tr>
<tr>
<td>I find this scenario topic important for learning school subjects</td>
<td>2.16</td>
<td>0.74</td>
</tr>
<tr>
<td>I find this scenario topic important for the whole world</td>
<td>2.45</td>
<td>0.79</td>
</tr>
<tr>
<td>I predict I will need to perform skills, described in the scenario, in my future career</td>
<td>2.00</td>
<td>0.72</td>
</tr>
<tr>
<td>I predict I need to perform science-related skills, described in the scenario, in my future career</td>
<td>1.99</td>
<td>0.71</td>
</tr>
<tr>
<td>The scenario is easy to understand</td>
<td>3.06</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Based on the four open ended items (see Table 2), students liked the scenario and found it interesting, but even so they did not appreciate its value (relevance) and did not want to learn more about this topic.

Table 2 presents themes arising from the qualitative analysis, based on students’ open-ended responses. The themes indicate that students’ perceptions about scenario are more positive when they personally feel it has novelty and usefulness for them, includes career awareness aspect and they perceive the learning environment to be attractive. On the contrary, students with more negative perceptions towards the scenario associate the scenario with a particular science subject and have a fixed attitude to career choices based on their own preferences. Students giving responses in the middle range are not confident in their perception about the scenario.

Table 2. Open ended responses to the scenario “Should there be a sugar tax?” (example in brackets).

<table>
<thead>
<tr>
<th>Item</th>
<th>M</th>
<th>SD</th>
<th>1 (more negative)</th>
<th>2 (neutral)</th>
<th>3 (more positive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find this scenario interesting</td>
<td>2.16</td>
<td>0.81</td>
<td>1. Subject related perceptions (<em>not interested in Biology</em>)</td>
<td>1. Dual attitude (<em>new knowledge was interesting, but topic was boring</em>)</td>
<td>1. Novelty (<em>new topic for me</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Career perceptions (<em>this job is not for me</em>)</td>
<td>2. Career perceptions (<em>possible jobs in industry</em>)</td>
<td>2. Learning environment (<em>good life related examples</em>)</td>
</tr>
<tr>
<td>I find the information in the scenario valuable</td>
<td>1.70</td>
<td>0.74</td>
<td>1. Personal interest (<em>not interesting for me</em>)</td>
<td>1. Dual attitude (<em>not sure I need this in future; good information, but not for me</em>)</td>
<td>1. Learning environment (<em>new activities in science lesson</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Personal importance (<em>I don’t drink lemonade</em>)</td>
<td></td>
<td>2. Usefulness (<em>I need this information in future</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Subject related perceptions (<em>I don’t like Biology</em>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Career perceptions (<em>this job is not for me</em>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. Familiarity with the situation (<em>topic was familiar to me</em>)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I like the scenario  2.12  0.79  1. Subject related perceptions (I don't like Biology)  
  2. Personal interest (not interesting for me)  
  1. Dual attitude (I got knowledge, but perhaps I don't need it)  
  1. Career awareness (I saw people working in laboratory)  
  2. Learning environment (understandable scenario)  
  3. Personal interest (this scenario was interesting for me)  

This scenario makes me want to learn more about the topic  1.33  0.56  1. Personal interest (not interesting for me)  
  2. Career perceptions (I have different ideas for my job)  
  3. Subject related perceptions (I don't like Biology)  
  1. Dual attitude (good information, but not sure I need this in future)  
  2. Career perceptions (I want to get other job; good new knowledge, but job is not for me)  
  1. Career awareness (I learned about new interesting professions)  

### 3.2 Scenario evaluation after intervention

Students, who evaluated the scenario after the whole intervention, were more positive towards the scenario in some aspects. Students in this group also agreed that they gained new knowledge about the topic, knowledge which could be useful in the future, possibly was helpful for problem solving in the future and was easy to understand (Table 3). In all the other items, students’ level of agreement was higher compared to the previous group, not involved in the intervention. This was especially so for items related to the importance of the topic in the community and at a world level, plus usefulness of the scenario topic while learning school subjects and using both general skills, plus seeing science-related skills, introduced in the scenario, important for them in their future careers (the mean value above 2.50).

<table>
<thead>
<tr>
<th>Item</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>This scenario enables me to gain new knowledge about the scenarios topic</td>
<td>3.39</td>
<td>0.54</td>
</tr>
<tr>
<td>The knowledge I gain from the scenario may be useful in the future</td>
<td>3.00</td>
<td>0.64</td>
</tr>
<tr>
<td>I can put knowledge gained from the scenario into practice, to solve problems</td>
<td>2.83</td>
<td>0.62</td>
</tr>
<tr>
<td>I find this scenario topic important for me personally</td>
<td>2.48</td>
<td>0.67</td>
</tr>
<tr>
<td>I find this scenario topic important to my family</td>
<td>2.08</td>
<td>0.66</td>
</tr>
<tr>
<td>I find this scenario topic important for appreciating the work of our local community (town, village)</td>
<td>2.80</td>
<td>0.69</td>
</tr>
<tr>
<td>I find this scenario topic important for learning school subjects</td>
<td>2.91</td>
<td>0.67</td>
</tr>
<tr>
<td>I find this scenario topic important for the whole world</td>
<td>2.85</td>
<td>0.78</td>
</tr>
<tr>
<td>I predict I will need to perform skills, described in the scenario, in my future career</td>
<td>2.67</td>
<td>0.82</td>
</tr>
<tr>
<td>I predict I need to perform science-related skills, described in the scenario, in my future career</td>
<td>2.14</td>
<td>0.77</td>
</tr>
<tr>
<td>The scenario is easy to understand</td>
<td>3.07</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Although the tendency of responses for the last four items remained the same as for the previous group (i.e. the scenario was more interesting, students liked it more compared to the value (relevance) they recognised and were motivation to learn more about this topic), their responses were more positive.

Table 4 presents emerging themes, derived from the qualitative analysis based on students open-ended responses. Themes indicate that students’ perceptions about scenario were more positive when they personally felt an appreciation towards the knowledge gained, or the scenario was novel, practical, important and useful for them, included a career awareness aspect and they perceived the learning environment to be attractive. In this group, students also mentioned the science teacher’s
important role in handling the teaching. On the contrary, students with more negative perceptions towards the scenario associated the scenario with a particular science subject, their familiarity with the topic, personal importance, and usefulness and had a fixed attitude to career choices based on their own preferences. Students giving responses in the middle range were not confident in their perception about the scenario.

Table 4. Open ended responses for scenario “Should there be a sugar tax?” (example in brackets).

<table>
<thead>
<tr>
<th>Item</th>
<th>Descriptive</th>
<th>Themes from open ended responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>I find this scenario interesting to me</td>
<td>2.66</td>
<td>0.57</td>
</tr>
<tr>
<td>I find the information in the scenario valuable to me</td>
<td>2.27</td>
<td>0.61</td>
</tr>
<tr>
<td>I liked the scenario makes me want to learn more about the topic</td>
<td>2.66</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>1.66</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Open ended responses for scenario “Should there be a sugar tax?” (example in brackets).
Among the students with more positive perceptions (students who marked 3 on the 3-point Likert scale), the change in students’ perceptions based on the emerging themes can be explained with reference to the following aspects during the implementation of the module in the intervention phase:

- Novelty of the industry visit.
- Attractiveness of the learning environment.
- Undertaking practical work related to real life problems.
- The learning of new knowledge and skills seen as useful for the future.
- An introduction to STEM professions.

These aspects pointed to the relevance of the learning through student involvement at a personal, social and even at a global level.

- The corresponding change in students’ perceptions based on negative perceptions (students who marked 1 on 3-point Likert scale) can be explained by the following aspects:
  - Lack of liking of a particular subject.
  - Lack of familiarity with the topic.
  - Not perceived as useful.
  - Lack of perceived personal importance.
  - Lack of personal interest.
  - Little perception about future career choices.

Students were asked also to name the skills they learned from participating in the module and name the professions they know where those skills were needed. Outcomes are indicated in Figure 2, the size of type indicating the degree of student agreement.

**Figure 2. Skills obtained from the module and professions mentioned by the students.**

Results indicated that students heavily mentioned collaboration (49), degustation (42), measuring (35), communication (25), analytical skills (19), listening (12), reading (11), calculation skills (7) and management (5). They also recognised that the module is suitable for developing thinking (logical, critical), creativity, ICT, reporting and discussion skills. Students recognised that many of these skills were useful for following professions: taster (judging quality of the product by taste) (33), chemist (22), biochemist (20), lab. technician (15), manager (10), cook (10), doctor (9), teacher (7), food technician (6) and scientist (6). They also mentioned ICT specialist, public official, programmer, product developer and biologist. This indicates that students do recognise that skills learned in science classes are transferable to many professions, which are more or STEM professions and going beyond those mentioned in the module.

### 4 CONCLUSIONS

This study was conducted to evaluate the use of a career-based scenario and a follow-up teaching-learning module for establishing student science-related (STEM) career awareness. Two groups of students participated, one evaluating only the scenario for raising students’ career awareness and the other evaluating the scenario after involvement in the follow-up intervention.

It was found in response to first research questions that students’ opinions related to the scenario were diverse. Results from the group without undertaking the intervention tend to imply that it is
insufficient for students only to read scenario about science-related careers. Students did recognise from scenario new knowledge, its usefulness in problem solving situations, but they felt lack of relatedness with future career skills and choices. The group with follow-up module had a more positive influence on students’ career awareness and they also recognised that they can use the knowledge and skills they gained in their later studies.

In response to the second research question, students mentioned the following characteristics as playing a meaningful role within the intervention:
- Teacher positive role for making this module interesting for them.
- Visiting the lemonade industry and learning in an attractive out of school environment.
- The follow-up industry-related practical work reinforced student relevance.
- The learning of new knowledge and skills seen as useful for the future.
- An introduction to STEM professions.

These aspects of relevance shown through the intervention pointed to the relevance being enhanced through student involvement at a personal, social and even at a global relevance level. Nevertheless, this study illustrated that a third component could also be a factor associated with student relevance. That factor was career awareness.

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REFERENCES


