Science Education International
Vol.27, Issue 2, 2016, 194-216

Identifying Characteristics of Science Teaching/Learning Materials Promoting Students' Intrinsic Relevance

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ABSTRACT: This article focuses on concerns related to a lack of students' perception of relevance in school science seen as differing from educators' perception of relevance. In order to determine how relevance is portrayed in teaching and learning materials (TLMs), the titles and introductory texts (scenarios) from 77 TLMs, aiming to induce students' intrinsic relevance, were analysed using conventional content analysis. The content analysis resulted in the identification of three categories, with altogether nine subcategories, which could induce perceptions of intrinsic relevance among students and therefore could be used by TLM developers to help induce intrinsic relevance among students. The results showed that although authors of these TLMs had undertaken a course on developing student relevant TLMs, there was diversity in the approach to intrinsic relevance and less than half of the TLMs were identified, based on expert opinion, as being seen to be intrinsically relevant for students. Although most introductory texts were seen somewhat familiar to students, promoting relevance in the context of students' perceptions remains a question.

KEY WORDS: science education, intrinsic relevance, teaching/learning materials, contemporary content analysis.

INTRODUCTION

Learning science in school is seen as key in enabling future adults to cope with societal developments in the face of constant, especially technological, change (Holbrook & Rannikmäe, 2007). Unfortunately school students do not consider learning in science classes relevant for them (Sjoberg & Schreiner, 2010) and their interest in school science tends to decline with progression in school years (Potvin & Hasni, 2014). Yet, without students who consider science worthy of study and showing a willingness to reflect on a career in science-related fields, problems linked to a lack of specialists are likely to continue to be recognized (EC, 2004; Bybee & McCrae, 2011).

Relevance is considered an important element in the focusing and promoting of students' learning. However, science content focusing on the acquisition of

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knowledge and conceptual learning does not possess familiarity for students (Osborne & Dillon, 2008). Also, such content does not lend itself to students' constructing their learning, based on prior learning. The setting is unfamiliar, often void of meaning and not perceived by students as useful (Kintsch, 1980). In short, students do not perceive science education as relevant (EC, 2007).

Students' active involvement in constructing their own ideas is shown to promote meaningful learning (Frymier & Shulman, 1995). This has led to strong support for inquiry-based learning, providing students with scientific challenges (Holbrook & Rannikmäe, 2010). However, the need to base learning on prior constructs limits a science approach and favors an educational, constructivist approach, based on a familiar setting or meaningful context. It has thus been claimed that an education through science focus has merit in promoting relevant learning in science classes (Holbrook & Rannikmäe, 2007). The "education through science" perception not only focuses on a relevant context for the gaining of scientific knowledge, but also enables a focus on skills such as problem solving in a scientific situation and decision-making about scientific issues in a social context (SSI- socio-scientific issues) (Holbrook & Rannikmäe, 2009; Zeidler & Keefer, 2003; Sadler, 2004). Taking this into account, a SSI component could serve as a relevant context for students in linking school science with everyday life, which has been recognized by chemistry students as a meaningful area of importance (Broman & Simon, 2015). As shown by Frymier and Shulman (1995) and Hulleman and Harakiewicz (2009), a student-valued study context results in higher motivation to study.

The way, socio-scientific issues, as student-valued study contexts, should be incorporated into developing TLMs is uncertain, which makes it difficult for TLM developers to implement in a relevant manner. Gilbert, Bulte and Pilot (2006) present four models indicating how context-based courses are designed in science education: These are:

(1) context as the direct application of concepts;
(2) context as reciprocity between concepts and applications;
(3) context as provided by personal mental activity;
(4) context as social circumstances." (p. 822).

The first two identify with contexts, where teaching concepts has a great emphasis, the third provides the context by the students' own mental activity. The fourth model serves as a form of representation of a small community inside society (Gilbert et al., 2011). Nonetheless, none of the above provides practical suggestions, how to make science intrinsically relevant for students. TLMs have gained in popularity among several European Commission FP6 and FP7 projects like PARSEL (Rannikmäe, Teppo, & Holbrook, 2010)and PROFILES (Bolte, Holbrook, & Rauch, 2012),which aim to develop TLMs, focusing on inquiry-based science education and student relevance i.e. reacting to an EC document (EC, 2007), which points out science in school is uninteresting, boring, irrelevant and abstract. A key feature of such TLMs is the initial context chosen.

The current article addresses the problem of a lack of intrinsic relevance approaches to the study of science by students and more specifically, how TLMs for science education can be made more intrinsically relevant. The contexts, initial indicated by the title, are usually elaborated in a form of short written texts. In order to motivate and engage students in science learning, the students' perception of relevance of the title and introductory scenario within the TLM is seen as crucial. Unfortunately, when developing learning materials, educators (teachers, teacher educators, curriculum developers) tend to pursue their own perception of relevance rather than the perception of what may be considered relevant to the student. This, in turn, can reduce students´ perception of intrinsic relevance, which in turn can impact on students´ motivation to learn science.

THE PURPOSE AND RESEARCH QUESTIONS

The current article aims to investigate how student intrinsic relevance is promoted in teaching/learning materials (TLMs) and more specifically, in the title and introductory texts, which are designed for this purpose. Three research questions guided the analysis process.

1. What characteristics can be identified in TLM titles, which are intended to be intrinsically relevant to students?
2. What characteristics can be identified in introductory texts (scenarios), which are intending to be intrinsically relevant to students?
3. How well do titles, which are intended to be intrinsically relevant to students, interrelate with introductory scenarios, which also intend to be relevant to students?

THEORETICAL BACKGROUND

Teaching/learning materials

The philosophy behind developed TLMs, on which this research is based, is that activity theory, based on taking action to meet a need (Engeström *et al.*, 1999) and self- determination theory, recognising the importance of students' intrinsic motivation (Deci & Ryan, 2000), are key components related to the creation of student learning environments.

Holbrook and Rannikmäe, (2010) have suggested that TLMs, in meeting student needs, can follow a 3-stage approach described as:

1) an interactive scenario seeking students´ perception of relevance and motivation, which sets the scene and also enables teachers to determine students' prior science learning;

2) stage 2 promotes the gaining new scientific competences through an inquiry-based approach;

3) further explores the initial scenario from the first stage, but now utilising the newly gained science learning and focuses on decision making in a socio-scientific environment.

Relevance

There is no one specific definition of relevance, although the question *"What makes the learning in school relevant to the students' life and their future?"* has been under educators' focus from the beginning of the twentieth century (Stuckey *et al.*, 2013). Several interpretations exist, taking into account different aspects of relevance. Levitt (2002) interpreted relevance with respect to students through the use of words such as importance, usefulness or meaningfulness. Keller (1983) defined relevance through personal perceptions, whether the content or instruction satisfied students´ personal and career goals. This means that in order to make learning materials personally relevant, educators not only need to know students' aspirations, but how learning materials need to address what is considered useful, meaningful and important in the eyes of students.

Van Aalsvoort (2004) suggested 4 different aspects associated with relevance: personal, professional, social and personal/social. The first is also referred to as intrinsic relevance (Stuckey *et al*., 2013, referring to Holbrook, 2008), while the latter three aspects represent different perspectives of external relevance, referring to a career focus, being a responsible citizen and relevance from a society aspect.

It is suggested that *intrinsic relevance, as a term, describes the possibility of an object/activity being considered as important to specific persons for a specific reason and the evaluation of intrinsic relevance is carried out through their cognitive processes.* There could be several reasons why something is considered intrinsically relevant, but the more persons perceive object/activity as connected to themselves, their relationships, interests, future goals and aspirations, the bigger the possibility of perceiving it as intrinsically relevant. Relevance can be perceived before the learning starts to take place. It is very much from the perspective of whether the learning is likely to meet the need perceived by students. It may be initiated by reference to the media, debates taking place in the society, relationships with perspective employment, peer pressure and possibly society pressure related to issues within the society (Kember & McNaught, 2011).

Relevance is triggered by the teaching (towards creating a professional, social or personal need by the student) and as such is *satisfying* a need, rather than being perceived as *having the potential to satisfy* the need. As concluded by Holbrook and Rannikmäe (2009), relevance can be expected to influence student motivation and in particular intrinsic motivation.

In the current article, the terms` personal relevance`, `intrinsic relevance` and `extrinsic relevance` are used. Nonetheless, personal relevance is not seen as a synonym for intrinsic relevance. Intrinsic relevance is seen to have the meaning

of perceiving something as relevant to oneself, but the reason behind that includes personal aspects like future goals, including future studies or career plans, goals in personal life, etc. Also perceiving something as intrinsically relevant can be introduced by internalisation of the need to consider something as important to oneself. In this case, extrinsic relevance can become intrinsic relevance.
Interlinking these ideas, a model of how extrinsic relevance and intrinsic relevance can drive students' intrinsic motivation via TLMs, can be suggested (Figure 1).

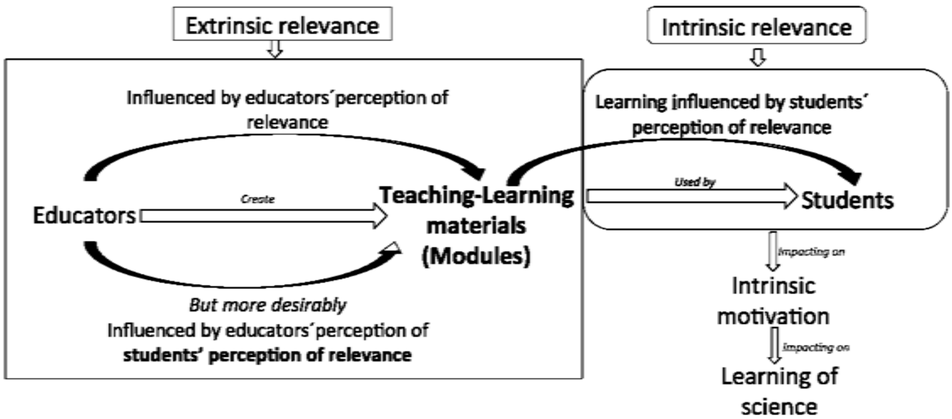

Figure 1. Extrinsic and intrinsic relevance connections with science teaching and students' intrinsic motivation for learning.

While developing TLMs for science education, it is usual for educators to consider the curriculum, societal needs, employability or industrial needs and the needs of the science community, as these influence educators' perception of relevance. Additionally, the model needs to take into consideration that educators try to implement their understanding of what is considered relevant in the eyes of students.
The model presented in the current article suggests that in order for teaching/learning material to be intrinsically motivating for students to learn science, student needs to perceive it as intrinsically relevant and as an extrinsic component, imposed on the students. In order to do that, there is a need to know the effectiveness of developed learning materials that induces the students' perception of relevance without teacher interference.
It has been shown by Hulleman and Harakiewicz (2009) that implementing tasks enabled students to see the connection of science course materials to their daily life, had a positive impact on low achieving students' interest and performances. Positive results in terms of enjoying the task, importance of doing well on a given task, usefulness of the task in connection with short and long-term goals, were also achieved by Gaspard *et al.* (2015) when

implementing relevance interventions in Math classes. Nonetheless, the authors have not detected any research in the science education literature that addresses the problem of which characteristics are able to trigger perceptions of intrinsic relevance in a student. This article thus strives to focus on determining the characteristics of intrinsically relevant science TLMs.

METHODOLOGY

Source of TLMs

In order to identify educators' perception of what is considered relevant and how it needs to be presented in students' teaching/learning materials (TLM) for science education, module title and scenario, derived from the PROFILES project database, are analyzed. Altogether 88 modules are available on the PROFILES website (http://www.profiles-project.eu/PROFILES_Modules/index.html).
The 88 modules had been constructed by 22 project partner institutions from 21 different European countries by 124 science educators participating in the project, providing substantial and diverse educators' perception of what is considered relevant and how it could be expressed. All the developers had gone through professional development on the philosophy behind the PROFILES project and the role of the title and scenario within TLMs. After eliminating duplicating modules, 77 TLM titles were analyzed, whereas 66 TLMs were used in scenario analysis and in comparative analysis of titles and scenarios, after eliminating modules, which lacked an introductory scenario.

Data Analysis

In order to determine representation of intrinsic relevance put forward by module developers, conventional content analysis (Hsieh & Shannon, 2005) was conducted. This method was used, because the source of data was in form of text passages and research literature is lacking, focusing on how text should be presented to students in order to stimulate students´ perception of intrinsic relevance. In this study, categories were formulated based on the data.

Procedure

The content analysis was conducted, based on the following steps:
1.Reading through the titles and characterizing the titles according to the form in which they are presented. As the title is the first thing that students read, when facing new learning material, it is predicted to have a major role in determining, whether students engage in the learning process from considering whether it is relevant for them.
2.Reading through the scenarios and seeking to develop categories and, if appropriate, subcategories with descriptions.

3.Categorization of scenarios within the three categories according to the descriptions of the subcategories.
4.Comparison of the titles and scenarios to find out whether the title introduces the scenario from the perspective of more than one category (“field of focus; “impact level”). The third category, “role of application,” is not considered for the categorization of titles, as it is not possible to detect by reading the title whether scientific or social concepts are presented through problem solving, or as an example of a concept application.

These steps were carried out by the first author of the current article. Then the other two authors, independently, categorized the titles according to the descriptions. The conformity percentage was calculated, resulting in the conformity of 88% among the category “field of focus” and 92% among the category “impact level.” Total conformity of categories was established by discussion.

Reliability

Intra-coder reliability (Bryman, 2001) was checked by comparing the initial categorization using the categories and their descriptions two months after the first categorization. Results showed that among the category, “field of focus,” the conformity percentage was 94% and among the category “impact level”, 97%.

RESULTS

Categorization of titles

From an initial check, titles were grouped according to the title formats (Table 1)

a. titles in form of a question.
b. titles in form of a statement.
c. titles in form of an extended question.

After that step, titles were categorized according to the context and how the titles would impact on students, when read.

Table 1. Categorization of titles by type

Category of Title	Example of a title	No of titles	% of titles
Title in form of a question: *Starts with a question word*	"How much can you drink and be able to legally drive?"	36	47
Title in form of a statement	"Brushing up on chemistry"; "Pollen exposes food fraud in honey"	21	27
Title in form of extended question: contains a *question word*, together with a partial statement.	"Traffic accident: who is to blame?"	20	26
No. of different titles		*77*	*100*

An example of one authors' categorization of titles with examples and explanations is shown within Table 2. Most titles were presented in the form of a question (56 from 77), either in a traditional manner (simple question), or in extended form (statement followed by question). Among the category 'field of focus,' most titles were presented through a socio-scientific/ mathematical context. Approximately one third of the titles implicated a scientific context and 14 titles (of 66) were categorized as social (Table 3). From categorization of the 'impact range' (Table 3), 26 titles lacked any indication of a personal impact, at a personal, local or global, level.

Categorization of the scenarios

During the reading process, certain characteristics started to emerge. More specifically, it was seen that the scenarios were either in a context, which enabled students to acquire and apply scientific concepts in practice, or the main focus of the scenario was on scientific content with the application presented as an example. This differentiation resulted in the formation of a category "role of application". The "role of application" having 2 subcategories, distinguished the role student gained when reading a scenario as: "application as an example" (scenarios under this subcategory describe scientific concepts or professions and use the application as an example.

Table 2. Categories relating to titles and scenarios, with descriptions and examples of titles for each subcategory, with explanation

Category	Subcategory	Description	Example
Field of focus: Describes, how concepts are included, or how scientific concepts are framed.	Scientific	Titles/scenarios belong to this subcategory, when they focus on scientific concepts, scientific problem solving, or descriptions of a science related career. Everyday life is incorporated minimally (couple of examples of applications or everyday life is mentioned to induce familiarity in students).	"Carbon- nature of life". *Contains word carbon as a chemical element.* "Why do cans of Coca-Cola sink, while cans of Coca-Cola zero float." *Sinking and floating as physical terms scientific problem.*
	Socio-scientific/-Mathematical	These titles/scenarios cover scientific issues in social context. These titles/scenarios cover topics that are controversial and do not have one specific answer. Connect scientific concepts closely with everyday life.	"Plastics-reduce the use". *Plastics as a chemical term; the overuse of plastics is a social problem.*
	Social	Title/scenarios belong to this subcategory, if it covers a social issue/problem, which has little to do with science. Economic aspects are a key focus.	"Lara (16) is pregnant". *Teenage pregnancies as a social problem.*
Impact range: Describes on what level students are affected or how issue presented affects people.	Impersonal	Impersonal situation/issue/problem, which does not impact on students' personally, locally or globally, but can be important for some specific community (for example, scientists, doctors, product users).	"Stumbling over biodiversity- plant diversity on paving cracks". *Is important to botanists as a part of scientific community. Contains scientific words like biodiversity.*

Personal*	Impact range of a topic/issue affect students themselves, or close relationships (family; friends).	"Can you find a way to make your family happier with the electricity bill?" *Addresses student by words you and your family*.
Local	Impact range of a topic affects the local community to which students belongs; does not need to affect student personally, but can have impact on a student (i.e. school community, local at village/city/country levels).	"Toxic fish? Environmental toxins in fish from Baltic sea." *Toxins in fish of Baltic sea is a problem for the surrounding areas of Baltic sea*.
Global	Impact range of a topic has a global impact, and can have direct impact on student, but the impact can also be indirect. Environmental problems belong here.	"Stop having sex- the world is overpopulated" *Overpopulation is a global problem, causing problems with food supplies, energy, illnesses.*

*The personal impact range overlaps, in some cases, with either the local, or global range.

The student adopts a passive role while reading); or “problem solving through application of a scientific/mathematical/social concept” (scenarios under this subcategory put students into a position to learn a scientific concept by undertaking a problem solving activity to seek a scientific solution, thereby participating actively).

There were 14 (21%) scenarios, which had a great emphasis on pursuing scientific concepts while applying these concepts had a decorative role (see Appendix for scenario categorization). More than half of the scenarios (79%) were presented in such a way that students were guided towards an opportunity to solve problems and apply the concepts themselves. Almost half of the scenarios (32 out of 66, 48%) used socio-scientific issues as a focal event.

The second category “field of focus”, emerged from scenarios differing in their focus of implementation. The “field of focus” was sub-divided into 3 subcategories, representing the context around which the key ideas were built:

“Scientific”- scenarios under this subcategory focus on scientific concepts, scientific problem solving, or a description of a science related career; “Socio-scientific/mathematical”- scenarios under this subcategory covered a scientific or mathematical issue in a social context. These scenarios covered issues that were controversial with multiple solutions and were closely related to real life;

“Social”- scenarios belonging to this subcategory covered a social problem, which had little to do with science; of ten economic aspects were emphasized.

21 out of 66 (41%) scenarios focused on scientific concepts, scientific problem solving or on a science related career, where relatedness to everyday life was recognized as lacking or was just mentioned. Although 48% of the scenarios were presented through a SSI context and connected scientific/mathematics concepts with everyday life, the level of impact varied.

As the situation described in the scenarios varied, this was considered to have an impact on students. An “impact range” category was thus identified. Depending on the way the scenario was written, the impact could be either impersonal, or have an influence at different levels (personal, local, global).

“Impact range,” with 4 subcategories represented the level at which students were possibly affected, or how the issue presented in the scenario affected society:

“Impersonal”- scenario lacked connection with the issue/problem presented, but it could be important for certain communities, like scientists, doctors, product users;

“Personal”- scenario is addressing a topic/issue, that affects students themselves, or their close relationships with family/friends);

“Local”- scenario was addressing a topic/issue, that affected the local community, like school community, local village/city/country, to which the students belongs. The issue did not need to affect students personally, but need to have an impact on the students;

“Global”- scenario was addressing a topic/issue that had a global effect, like environmental issues.

Table 3. Categorization of titles among categories "field of focus" and "impact range"

Category	Subcategory	Example of a title	No of titles	% of titles
Field of focus:	Scientific	"What do plants eat?"	23	35
Field of focus: Socio-scientific/ mathematic	Socio-scientific/ mathematic	"Waist deep in waste –a necessity or an irresponsibility?"	29	44
Field of focus:	Social	"Lara is pregnant"	14	21
Impact range:	Impersonal	"Pollen exposes food fraud in honey"	25	38
Impact range:	Personal only	"Can you find a way to make your family happier with the electricity bill"	20	30
	Personal and Local	"Would you allow the cultivation of genetically modified soybeans in your country?"	2	3
	Personal and Global	"Stop having sex- the world is overpopulated!"	2	2
Impact range:	Local only	"Should Costas and Artemis proceed into assisted reproduction"	16	24
	Local and Global	"Are we overusing plastics?"	1	2
	(Local and Personal*)		(2)	
Impact range:	(Global and Local*)		(1)	
	(Global and Personal*)		(2)	
Total			*66*	*100*

*subcategories in brackets are duplicates of those given in other impact range

Scenario analysis showed that 37, out of 66, scenarios belonged to the subcategory impersonal, indicating that majority of scenarios lacked a personal effect at any level. 29 scenarios did have an indication that they had an effect on a reader at some level. It is important to notice that the scenarios, which indicated personal impact, showed simultaneous signs of impacting reader on multiple levels (see Appendix for scenario categorization).

Comparison of TLM titles and scenarios among category "field of focus"

Six titles linked with scenarios under the category "field of focus," subcategory "social". However, there were eight mismatches under the title "social" subcategory, shifting toward a "socio-scientific" scenario.

For a "socio-scientific" focus among titles and scenarios, ten mismatches were found, with the shift toward a "scientific" scenario. Six TLMs had scientific titles but there was a shift toward "socio-scientific" scenarios (Table 4.)

Table 4. Mismatches among title and scenario in the category "field of focus"

Title	Scenario	Number of mismatches among TLM title and scenario
Socio-scientific →	Scientific	10
Scientific →	Socio-scientific	6
Social→	Socio-scientific	8

The shift among the titles and scenarios could be divided into positive and negative shifts, considering whether a more or less connection with everyday life could be seen by students. Scientific titles with socio-scientific scenarios and social titles with socio-scientific scenarios were considered as positive shift. However, when the title looks attractive (socio-scientific), but the scenario was presented as a scientific problem (a socio-scientific to scientific shift), then there was little chance of s perception of intrinsic relevance among students. This was considered to be a negative shift. Unfortunately, 10 TLMs fitted this description.

Comparison of TLM titles and scenarios among category "impact level"

In the second category, "impact level," a comparison was undertaken to determine whether there was change represented by 'impersonal to personal' impact (Figure 2). As students could perceive the impact at different levels, personal impact was considered to be either impacting on students or their families at a local, or a global, level.

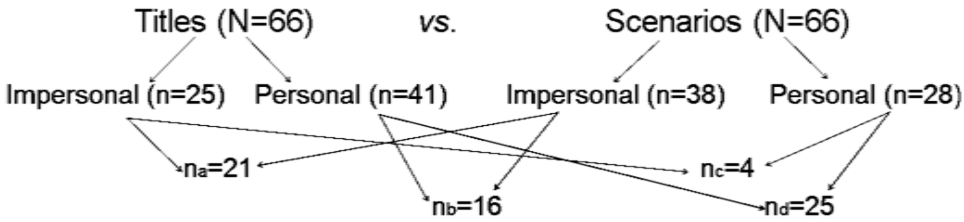

Figure 2.Titles and scenarios compared among category "impact range".

n_a- title lacking personal impact, followed with scenario lacking personal impact;
n_b- personally impacting title followed with scenario lacking personal impact;
n_c- title lacking personal impact, followed with personal scenario;
n_d- personally impacting title followed with personal scenario**.**

Twenty mismatches (related to nb and nc, in Figure. 2) were detected between the title and the scenario impact levels, with sixteen of the mismatches indicating that a personal title was followed by an impersonal scenario (nb, Fig. 2). One module, about natural gas, had an impersonal title, followed by a locally/globally impacting scenario. Another module with a locally/globally impacting title was followed by an emotional scenario about a sea turtle stuck in plastics, which was seen as possibly personally relevant to students.

Combining title and scenario comparison among categories "field of focus" and "impact range"

As a further step, a comparison of titles and scenarios among two categories "impact range" and "field of focus", was undertaken (Table 5). As can be seen, the majority of the titles that had a personal impact were followed by a focused on a socio-scientific context. Additionally, the majority of scenarios (n=37) lacked an indication of a personal impact belonging, mostly (n=24) to the subcategory "scientific".

DISCUSSION

The current study aimed to determine characteristics of teaching/learning materials, which help students perceive intrinsic relevance.
Categorization of the titles showed the majority of titles were in a question form, which indicates that a question, as a title, is the most preferred format aiming to be intrinsically relevant. This suggests a preferred approach to arouse curiosity in students and encourage students to interact with the topic being covered.

The titles of TLMs were also categorized based on their “field of focus,” meaning whether the titles represented characteristics of scientific, socio-scientific/mathematic or social context. The results of the analysis of TLM titles indicated that educators, who developed these TLMs, did recognize the value of including socio-scientific issue in the title. Nonetheless, an alarming result was indicated by the number of titles, which did not indicate any social aspects connected with scientific concepts. This, in turn, suggested the authors disagreed with the PROFILES approach, or were not able to perceive socio-scientific as part of meaningful constructivist teaching. It could also be pointing to the obsession to a science, rather than an education, focus and thus seeing little relevant role for 21st century skills (P21, 2008) in the teaching of science.

In the context of the current study, the personal impact sub-category was seen as one aspect heavily promoting intrinsic relevance. When the student felt the topic personally impacting on him or her in some way, there was a greater possibility for the TLM to be considered as intrinsically relevant. As a result of the title analysis, it could be concluded that the majority of TLM developers did incorporate aspects that would indicate personal impact (e.g. “Are we overusing plastics”) with the word ´we´, referring to the local community and therefore considered as an important aspect for inducing relevance among students.

It has been suggested that in order for students to see the relevance of science studies, connections with everyday life were necessary and were also beneficial in motivating students to learn science in the future (Holbrook & Rannikmäe, 2009; Frymier & Shulman, 1995, Hulleman & Harakiewicz, 2009). Therefore the titles, which focused on a socio-scientific issue, were speculated to be more relevant to the students than those focusing on scientific topics. Furthermore, the analysis of the titles showed that the titles, which focused on socio-scientific issues, in most cases, strived for a personal impact as well. Unfortunately however, when the title of a TLM focused on a socio-scientific issue, it did not automatically mean that it also had a personal impact on the student. The same discussion related to scientific issues, presented in the title. Although the majority of the titles that had a “scientific” focus, also lacked a personal impact to the reader, there were eight scientific titles that did indicate personal impact, and therefore could help students connect to the scientific topic and help to enable students to perceive intrinsic relevance.

Under the category “field of focus” subcategory “socio-scientific/mathematical,” 13 out of 33 scenarios could be recognized as lacking personal impact on a student. For example, problems with high electricity bills, cost of heating the house, reducing traffic accidents, legal amounts of drinking, speeding, car insurance, maintenance of metal constructions, problems with fuel deficiency were not perceived to be part of students’ everyday life.

Table 5.Title and scenario comparison among categories “impact range” and “field of focus” combine

		Title				Scenario			
		Field of focus				Field of focus			
		Scientific	Socio-scientific	Social	Total	Scientific	Socio-scientific	Social	Total
Title Impact level	Impersonal	15	8	2	25	24	13	0	37
	Personal	8	21	12	41	3	20	6	29
	Total	23	29	14	66	27	33	6	66

These problems were probably more relevant for grown-ups, teachers, or learning material developers, but further research would be needed to ascertain how relevant students consider these more society relevant contexts, especially when no additional rationale was presented.

Newton (1988) has proposed that the younger the student, the more self-centred he/she was in considering what was relevant to him/her, and this should be considered in science curriculum development. Therefore for younger students, the emphasis, while developing teaching/learning materials, should be put on science contexts that students had experienced themselves, or related to the context through their close relationship. For mature students, societal contexts that connected science with society could become intrinsically relevant and therefore the relevance of science could be perceived through issues at either the local or global level. Nonetheless, students would need to be able to perceive the connection for them in order to support constructing mental maps (Gilbert *et al.,* 2011; Stuckey *et al.,* 2013).

A third category emerged from the need to distinguish how scientific concepts were presented in a scenario context. Like Gilbert *et al.* (2011) deliberated, there were several ways how a context could be presented in a context-based course and "Context as the Direct Application of Concepts model" this could be seen as representing the "application as an example" subcategory. Approximately one-fifth (14 out of 66) of the researched scenarios were placed in this subcategory, surprisingly indicating that for some TLM developers, focusing on scientific concepts, was motivational for students to learn science, even though the literature abounds with contrary evidence. This TLM approach seemed to indicate a problem or the lacking of skill or knowledge on how to contextualize scientific concepts in a intrinsically relevant way for students.

Fortunately, the majority of the scenarios were presented in a way, such that the students, themselves, were put in the position of applying science concepts, in context of solving a problem. This analysis subcategory resembled with Gilberts' (2011) fourth model of context use "Context as Social Circumstances" and included scenarios that incorporated socio-scientific issues as a focal event or issue.

During the analysis of the scenarios, certain patterns were detected. Specifically, all scenarios (except "Stop having sex- the world is overpopulated", which was placed in the category - socio-scientific issue under sub-category "Application as an example") were presented in the framework of science, which lacked connections with everyday life. Additionally scenarios that belonged to the category "Application as an example" lacked the indication of personal impact on students and were focusing on a specific group like scientists, doctors or product users. This kind of presentation could reduce students' perception of intrinsic relevance as it was speculated that students would not have the ability to connect personally to the situation covered and these kinds of scenarios led to a, "learning to become a scientist" way of teaching. Therefore, for the students, who were interested in science individually, it would be interested to learn the topic presented this way, but for those, who lack interest in learning science, it could be seen to work as a demotivating agent, with students unable to perceive intrinsic relevance.

In order to help students perceive relevance toward the learning process, the process needed to be perceived as important to him/her and this could be achieved by intertwining specific characteristics within the context of the topic being taught. More specifically, if the aim was to make science topics, presented in the curriculum, relevant for students, it should be presented in a context that shows students it was connected to their life. Based on the analysis undertaken in this article, there was a suggested need to combine the topic being taught around a socio-scientific issue, which had a personal impact, either represented through situations faced among close relationships, problems faced in a local community, or at the high school level, global problems with which the students could relate and which should involve students in a problem solving situation.

CONCLUSION

During the development process of TLMs,

(a) educators needed to keep in mind several aspects like, what was requested in a science curriculum, and what skills and knowledge were necessary for a successful independent life after graduation;

(b) developers sought to make the learning process relevant for the students, because it has been shown that students' perception of the relevance of science education was low (Sjoberg & Schreiner, 2010; Potvin & Hasni, 2014);

(c) educators pursued their opinion of what was considered relevant in the eyes of a student, which could be rather different from students' perception of relevance.

As a result of this research, we concluded that important characteristics of the titles, intending to be intrinsically relevant were:

(a) presented in a question form, either in a traditional format or in an extended form;

(b) the topic is presented in a socio-scientific context, which indicated a personal impact to which, students could relate.

Introductory scenarios or texts, aiming to be perceived as intrinsically relevant to students, were seen as having the following characteristics:

(a) involving students actively by initially making students aware of the concepts which needed to being taught in a problem solving context;

(b) the context should be intertwined around a socio-scientific issue;

(c) the context should impact on student personally, either at a close relationship level, or on a local, or global, level.

The comparison of title and scenario categorization implicated inconsistencies among the categories "field of focus" and "impact range." More specifically in the category "field of focus", ten titles that were in the subcategory "socio-scientific/mathematic issue", were followed with a purely scientific scenario,

which was seen as a "negative shift" with respect to promoting intrinsic relevance.
Among the category "impact range", one third of the titles, which had indicated an impact on students personally, were followed with a scenario, which had no indication of having a personal impact on students. Also there was a big proportion of the titles under the subcategory "impersonal", and also a big proportion of titles under the subcategory "personal", which were followed with impersonal scenario. This was seen as alarming result, as this kind of representation was perceived to be contrary to the ideas in the project in helping students relate with the contexts in the topic being covered.

IMPLICATIONS AND RECOMMENDATIONS

It has been shown that when students perceive the connection between their lives and subject material learned at school, they performed better and felt more interested in the subject (Hulleman & Harakiewicz, 2009; Gaspard et al., 2015). Therefore, when TLMs are developed, like the ones analysed here, more opportunities for perception of relevance should be given to students. Although there was a need to achieve gain in science content knowledge, besides the ability to cope with societal demands, the learning should be put in a framework familiar to students. Future research has to show, whether the characteristics of supposedly relevant scenarios as put forward in this article, could be shown to help students perceive the connection of subject content with their daily lives and their long- and short-term learning goals.

LIMITATIONS

Although this article determines characteristics of relevance in titles and scenarios, there are certain limitations one needs to acknowledge.

(a) There could be additional characteristics not determined by that the authors of the current article, which could influence students' perception of intrinsic relevance.

(b)The teaching/learning materials analysed here actually had three components or stages, which gave an opportunity for students to perceive relevance through the second or third stage (investigative and decision-making stages). These parts were not analysed in the current article.

(c) The authors tried to determine how the scenarios had an impact on a student through characteristics of the texts, but how the texts were actually perceived among students in reality was not known.

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Appendix. Categorization of the scenarios (11 out of 66, lacked introductory scenario)

	Roll of application		Field of focus			Impact range			
Description of a category	Introductory scenarios can be divided into two subcategories, considering the way scientific or non-scientific (social) concepts are presented. It can be presented through a problem solving prism or it can be presented as descriptive text and application is used as an example for decoration purpose.		Describes, how concepts are presented, how scientific concepts are framed			Describes on what level students are affected or issue presented affects people.			
Subcategory	Application as an example	Problem solving through application of scientific/mathematical/ social concepts	Scientific	Socio-scientific/-mathematical	Social	Impersonal	Personal	Local	Global
No of scenarios in a category	14	52	27	32	6	37	27	13	12
% of all (N=66)	21%	79%	41%	48%	9%	56%	41%	20%	24%