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Popularity and Relevance of Science Education Literacy: Using a Context-based Approach

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Abstract
This article draws attention to the difference between interest and relevance in science education while recognising both can be considered components of intrinsic motivation – motivation for learning coming from students themselves. Research has shown the importance of intrinsic motivation and this study seeks an approach to enhance this through taking examples from everyday life. The approach, citing PARSEL, a project promoting relevance and interest in science education for scientific literacy is to initial the learning through everyday language and to guide the students to recongise their lack of science conceptual learning for considering the everyday isse or concern being considered. The science learning is consolidated by a further stage which attempts to bring the science gained into the everyday issue being discussed.

Key words: *interest, relevance, intrinsic motivation, PARSEL module approach*

Introduction
One of the most common issues in science education is how to motivate students and increase interest towards science learning. Several international meetings and conferences held in the 21st century have highlighted the need to develop science education in a way to make it more relevant for students (European Commission, 2004; IOSTE, 2004; ICASE, 2003). Despite attempts to address these world-wide issues, science educators are still concerned about the decline of students' interest and lack of relevance in science education and towards school science (Fensham, 2004; Holbrook, 2003, 2001; Sjøberg, 2002). It is thus appropriate to establish ways how relevance and interest can motivate students to learn science at school.

Motivation, interest and relevance
Motivation has been interpreted and defined in many ways. The main factor concerning motivation is how to get oneself or others to act. Generally, motivation is an internal state, or condition that activates or energizes behaviour (Huitt, 2001). Similarly, Brophy (2004) defines motivation as the internal state that arouses, directs and sustains human behaviour. Paris and Turner's (1994) emphasized that motivation is highly personalized and there were four characteristics that influenced motivation: *choice, challenge, control and collaboration*. The

Paris and Turner's theory is helpful in explaining why students in science classrooms may be motivated to learn some topics and not others, or why students are motivated by some activities and not others. To gain a measure of motivation, Zusho & Pintrich (2003) considered that motivation could be discerned through students' reports of their beliefs as well as through behaviours such as choice of activities, level and quality of task and engagement, persistence, and performance.

A more cognitive approach to motivation has been put forward by Ryan & Deci (2000) in their Self-Determination Theory (SDT). The SDT theory of motivation is centred on the belief that human nature shows persistent positive features, that repeatedly show effort, agency and commitment in their lives which the theory calls "inherent growth tendencies" (Ryan & Deci, 2000). SDT claims to provide a different approach to motivation, considering what motivates a person at any given time, as opposed to seeing motivation as a unitary concept.),Motivation is effected by students' personal interest, satisfaction and enjoy of activity (Deci & Ryan, 1985; Deci et al., 1991). This suggests that interest rises when students feel that the situation or issue is important for them and they have control of an activity (possess self efficacy - feel themselves competent and confident).

Motivation can be categorized as either extrinsic (outside the person), or intrinsic (internal to the person). Intrinsic motivation refers to motivation that comes from inside an individual rather than from any external person, or outside rewards (rewards such as money or grades) (Deci *et al.*, 1991). These rewards provide satisfaction and pleasure that the task itself may not inherently provide.

Interest is a form of intrinsic motivation, which refers to doing something because it is inherently interesting and enjoyable for students (Ryan & Deci, 2000; Ramsden, 1998) Thus interest is a powerful motivator (Deci, 1992). Four benefits from interest taken as a motivator of learning were described by Edelson & Joseph (2004): natural appeal, mastery goal orientation, persistence and effort; richly and strongly connected knowledge. In this way interest plays a role in learning through its contribution to students' connection with the content and allowing them to maintain that connection for long enough to be able to learn (Ainley, Hidi & Berndorff, 2002). Krapp (2003) recognised two major points of view from which interest can be considered: personal interest and situational interest. Personal interest is topic specific, persists over time and can be divided into latent (potential) and actualized (exhibited) interest (Schiefele, 1991; 1999). A student who has personal interest towards science enjoys learning science - its concepts, phenomena and experimentation. Several factors can stimulate personal interest. Bergin (1999) suggests among these are relevance, competence, identification with, cultural value, social support, emotions, etc. On the other hand, situational interest is related with the concrete learning environment and can vary depending on the learning methods or solutions the teacher has chosen (Bergin, 1999; Hidi & Harackiewicz, 2000).

Enhancing relevance and increasing interest in science lessons

Keeping in mind the concepts of interest and motivation written above, the current study defines relevance as something what is valuable, meaningful and/or useful for student. This implies it is learning that occurs in the students' frame of reference. It is situated learning. Situated learning (Lave and Wenger, 1990; McLellan, 1995) occurs best if it is in a context and culture in which it normally occurs. Relevance is, therefore, a necessary condition for situated learning, although it needs to be recognised that additional considerations apply, particularly the need for learning to take place within an appropriate social context. This important consideration implies that not every scientific context or issue is, in itself, relevant. Relevance needs to be considered from the students' point of view (Holbrook & Rannikmae, 2010)

There are several guidelines on how to conduct teaching in a way which would enhance motivation by establishing relevance. For example, Kember and McNaught (2007) suggested a set of principles covering good teaching, one of which was to establish the relevance of what is taught through using real-life examples and relating material to everyday applications, drawing cases from current newsworthy issues, giving local examples (establishing relevance to local cases) and relating theory to practice (how theory can be applied in practice). Good & Brophy (1997) highlighted similar aspects: to explain the application and value of different disciplines or science subjects, to value the given task with personalizing it, showing the relationship between learning and practice, relate science learning with students' future plans or needs, etc. Thus it is possible to establish relevance when students are able to see how the subjects related together and contribute eventually to competency in their discipline or profession.

Neither Kember and McNaught, nor Good and Brophy highlight that relevance requires more than situational interest and that real life examples, issues or even teacher- inspired links to the future aspirations of students, do not in themselves establish relevance in the eyes of students. Likewise case-based teaching or problem-based learning (which utilizes cases), even if they involve the use of realistic cases, or describe common or typical scenarios met by professionals in the field, do not automatically lend themselves to relevance from the students' point of view. This suggests that establishing situation interest so as to strive for intrinsic motivation of students is a useful but insufficient condition.

A similar situation relates to Schank, *et al*., (1993/1994) argument that educational systems (for schools or business) should be redesigned so they consist of goal-based scenarios (GBS). Goal-based scenarios are intended to allow students to pursue well-defined goals that they can recognize and understand where thee goals are of inherent interest to the student. However until relevance is established, an important ingredient of intrinsic motivation is missing. Relevance needs embedding instruction inside a student-developed need-to-know situation. In such a goal-based scenario, teachers identify a specific set of skills (including intellectual skills) and "embed" that skill learning in a task, or activity that the student will find interesting and relevant.

PARSEL

One project that strives towards promoting interest and relevance is PARSEL (popularity and relevance of science education for enhancing scientific literacy). The model on which PARSEL is based pays special attention to be: society based, scientific literacy, popularity relevance. The structure of the model structure follows a philosophy of 'education through science' (Holbrook & Rannikmae, 2007; Holbrook, 2010).

Scientific literacy in this context does not simply mean the gaining of science knowledge (Holbrook, 2010). Students are not scientists and, in most cases are unlikely to become one.

They cannot be expected to have the extensive background that will enable them to appreciate how the fundamental building blocks form the basis for making sense of the scientific world. However, students do have some knowledge about society. They have constructed many conceptual ideas and are aware of many concerns within the society; hence the society is the frame of reference for students.

One possibility to make science lessons popular explored within PARSEL was to use everyday related socio-scientific issues. In the context of the modules, popularity refers to students liking science lessons and wishing to study the subject in school. It also refers to liking science in general. It is thus an emotional component that stems from the module and the way science is presented. It tries to address the concern – school science is not interesting.

In the context of the modules, relevance means the students recognise that the modules are worthy of study by them; they see the learning initiated by their first encounter with the modules as meaningful from their perspective and students are intrinsically motivated to find out more. The students recognise that science lessons have relevance for their current and future lives. PARSEL tries to address the concern expressed by students who say – why are we studying this?

The philosophy behind STL teaching, also used as the philosophy in PARSEL modules, is that science conceptual learning is embedded within the resolving of a socio-scientific issue or concern relevant to the student (Holbrook & Rannikmae, 2007).

As research evidence in support of STL teaching, a study with 25 Estonian teachers showed that after a 6-month intervention programme, teacher change was large. This was not, however, sustained by many teachers 1 year later. Yet, the study showed that students preferred the STL teaching, found it interesting and students achieved more in dealing with subjective and critical thinking questioning (Rannikmäe, 2001a). From STS studies, student centred approaches led to better understanding of science ideas and related social issues. Studies also showed that linking teaching to society played a positive role in enhancing the attitudes of students. STS classes led to gains in creative thinking and decision–making skills (Rannikmäe, 2001b).

The PARSEL module approach

The title for a module is likely to be a question. This provides the first invitation to students to initiate their thinking and provides the opportunity to move away from a standard science conceptual learning need, established by the usual teaching, towards wider, student relevant and intrinsically-led learning. The ROSE study has shown that students in Estonia, as in other countries around the world, don't like to study theoretical and descriptive science topics like "atoms and molecules," "plants and animals in my neighbourhood," "electric circuits," etc (Teppo & Rannikmäe, 2006). Further attempts to "hide" the same science content into different types of titles have been made and research evidence has shown that students are interested as well as like to learn topics related to themselves, study intriguing issues from everyday lives, consider interdisciplinary new modern science-related applications, which are transferable to successful functioning in the society (Teppo & Rannikmäe, 2008).

Following this approach, the title is related to an issue or concern for which a decision is required and for which the student, once involved, finds they need to gain science conceptual understanding. The title is written so as to avoid the use of unfamiliar science conceptual expressions.

Competencies form the focus of the STL teaching. Promoting competencies, involving transferability to students' everyday lives, gives another dimension of relevance to students. Earlier research has shown that STL teaching is valued by students, especially when they have the opportunity to be involved in decision making, communication and collaboration-related activities. This gives them 'freedom' to develop creative thinking skills, which unfortunately are not usually part of their everyday learning (Rannikmäe, 2008; Laius, Rannikmäe & Yager 2008).

Competencies specify the learning in terms of: the intentions for learning, based on STL ideas, sub-competencies in a style that shows clearly how assessment practices can determine whether the learning has been achieved. As competencies are seen as the major target, the student activities clearly need to relate to these. The links, between the competencies/sub-competencies and the activities to be undertaken by students, are given in the teaching guide. Each sub-competency relates to one or more activities undertaken by students. Each sub-competency has at least one activity associated with it.

This is a crucial component of the teaching module identified with following the STL context-based approach. The scenario sets the scene for the learning and thus builds on the title of the module. Feedback to the teacher and the students is important (the assessment must not simply measure whether the activities have been accomplished). The assessment in each case is against the sub-competencies. Among the methods suggested are: observation of the students, interacting with students orally, making use of student-student assessment.

Rather than the students being stimulated to learn by the teacher, the subject matter or external pressures e.g. examinations, PARSEL strives to promote self motivation by the students having an inherent desire to study the module. It attempts this by relating to students' needs and desires.

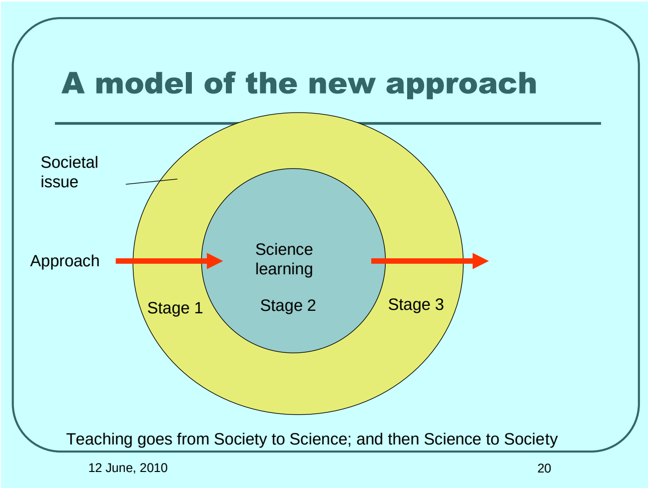

Figure 1. A Model of the new approach

By way of illustration, an example is chosen on - Biodiesel (predominantly chemistry focus)

Title: Should Vegetable Oils be used as a Fuel?

Scenario: Fred lives in a big city. He suffers from bronchitis and finds it difficult to breathe. His doctors advise him to move away from the city to somewhere where the air is fresher and contains much less hydrocarbon and sulphur emissions. Alas, Fred cannot afford to move, but instead plans to interest diesel vehicle manufacturers in a cleaner fuel. Fuels based on vegetable oils produce much less hydrocarbon emissions and practically no sulphur emissions. Although, direct use of the oil itself is possible only with modification to existing diesel engines, Fred suggests vegetable oils can be changed to biodiesel. Biodiesel requires little modification to existing vehicle engines.

Unfortunately biodiesel, made from vegetable oil, is based on foodstuffs such as corn. It can take away food from hungry mouths!! The ethical question thus arises - Is it appropriate to use vegetable oils as fuels? But are ethics and science in conflict?

Learning towards scientific and personal competencies
The students are expected to gain the ability to:

- follow procedures to prepare bio-diesel experimentally using a commonly available vegetable oil;
- plan and devising procedures for testing the suitability of the bio-diesel created; carry out and interpret experiments to determine the suitability of bio-diesel as a fuel;
- explain the manner in which diesel and biodiesel are able to act as fuels in an internal combustion engine, suggest how the suitability of a fuel can be determine and suggest parameters for deciding on the 'best' bio-diesel;
- cooperate as a team member in the carrying out of the experimental procedures, and devising tests for determining the suitability of the bio-diesel created;
- understand the formation and hydrolysis of esters and be able to contrast this with the trans-esterification of esters.

Learning towards scientific and social competencies
The students are expected to gain the ability to:

- put forward socio-scientific reasons on the merits and demerits of using vegetable oils as fuels and formulate a justified decision;
- consolidate their explanation of how diesel and biodiesel can be used in an internal combustion engine and indicate how the suitability of a fuel can be determined.
- cooperate as a team member in discussing the merits and demerits of using vegetable oils as fuels;
- communicate orally by putting forward justified reasons in a discussion deciding whether biodiesel should be used as a fuel;
- consolidate their understanding of the formation and hydrolysis of esters and contrast this with the trans-esterification of esters to form biodiesel.

Experiences from nine Estonian teachers point to the module being both highly interesting and motivational for students and teacher alike (Holbrook, Rannikmae & Kask, 2008). Involving students in undertaken learning which gives new dimensions to the chemistry class – discussions about ethical issues, making modern fuels and testing its properties were mentioned by students as something that they really liked and were interested in. However, curriculum content-related learning, although present, was not, directly, the focus of the outcome. Technology related components of the learning were highlighted by students as bringing the learning closer to workplace related aspects. Girls became interested in foodstuffs such as cooking oils, which had a wider technological application.

The concern in developing the module that the making of biodiesel (a transformation process) was actually outside the teaching curriculum was not seen as an obstacle. Nevertheless, while the modules was developed to give extensive information to the teacher, it was found that teacher acceptance and hence ownership of the idea of education through science was essential for using the modules in a meaningful way. Without teacher ownership it was found that the teachers were liable to modify the modules to fit their existing teaching approach. Under these circumstances, the value of the module in realising its purpose was lost and student motivation suffered.

Most of the PARSEL type modules move away from standard curriculum related topics, bring into the classroom wider implications of updated science, remove barriers between typical school science divisions (chemistry, physics, biology) extensive interdisciplinary knowledge from science teachers. This gives new dimensions for updating teacher training and points to the need for the upgrading of PCK (pedagogical content knowledge) for teachers to encompass the development of a stronger CK (content knowledge) in which the CK refers to interdisciplinary science.

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