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Identifying Chemistry Teachers' Beliefs

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Abstract
The main goal of the study was to describe and understand the development of beliefs related to the thinking and decision-making made by five teachers in teaching chemistry during a two-year intervention study. The participating teachers implemented and, in the second year of the study, developed teaching modules which were geared to the promotion of students' scientific and technological literacy (STL). By means of this intervention, it was hoped to induce change in chemistry teachers' beliefs towards a STL approach. This was expected to involve a shift from beliefs related to more traditional teaching styles, with stronger emphasis on eliciting students' extrinsic interest, into emphasising student centred approaches and students' intrinsic motivation. In order to recognise and identify the teacher beliefs, data were gathered before and during the intervention by means of teacher interviews and classroom observations. These were used to identify teacher beliefs as core (both stated and enacted), peripheral (stated by not enacted), or emerging (newly stated beliefs coming from the intervention). In general it was possible to identify teacher beliefs based on specific components and to further classify them as positive or negative. It was further identified that these beliefs could be related to core, peripheral and emerging beliefs.

Key words: *teacher core beliefs, teacher pheripheral beliefs, teacher emerging beliefs, scientific and technological literacy.*

Introduction

Science curriculum reforms recognize the need to foster and support the development of scientific literacy in students (AAAS, 1989; OECD, 2003). However, 'scientific literacy' has been understood in different ways tending either towards more fundamental science, or towards a wider, more educationally conceptual interpretation. The current study has been influenced by a framework referred to as 'scientific and technological literacy' (STL), first initiated by UNESCO (1993) and further defined as 'the skill to use science knowledge in solving everyday problems, making reasoned decisions and considering values of society' (Holbrook & Rannikmäe,1997).

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Based on this orientation for scientific literacy (Holbrook & Rannikmäe, 1997; UNESCO, 2001), major science teaching components that need to be included are recognised as (Holbrook & Rannikmae, 2007):

1. Development of social skills. (e.g. collaborative learning).
2. Development of personal skills. (e.g. communication skills).
3. Appreciation of Nature of Science and development of scientific process skills.
4. Science (Cognitive) learning abilities (especially transference of learning to new situations).

In order to promote the development of students' scientific literacy, teachers must possess beliefs and gain competences that support this process. Hence, in order to assist chemistry teachers in creating classrooms that represent contemporary visions of scientific literacy (e.g. STL), exploring teacher's beliefs becomes crucial and in light of such beliefs, professional development programmes need to be developed, enacted and evaluated.

Beliefs are complex, context-related and difficult to measure. Nevertheless, the Theory of Planned Behaviour (Fishbein & Ajzen, 1975; Ajzen, 2005) provides a workable model enabling the identification and examination of teachers' beliefs, which can subsequently be analysed in the light of their subsequent practice. According to this theory, a person's beliefs consist of three basic factors:

- behavioural beliefs,
- normative beliefs, and
- control beliefs.

All three factors pre-determine intentions and guide subsequent performance. The first factor is the individual's *attitude towards a behaviour* (AB), the individual's positive or negative evaluation of performing the particular behaviour of interest. In other words, the AB variable includes the individual's salient beliefs that engaging in the behaviour will, or will not, lead to favourable outcomes. Positive evaluation of a behaviour of interest can be classifed as AB^{+}, where as a negative evaluation can be recorded as AB^{-}.

The second factor is the person's perception of social pressure to perform, or not perform, the behaviour of interest under consideration. Since it deals with perceived normative prescriptions, this factor is termed *subjective norm* (SN). If the social pressure is towards supporting the performing of the behaviour, this can be indicated as SN^{+}; correspondingly, a negative pressure can be considered as SN^{-}.

The third factor is the sense of self-efficacy, or the belief one is capable to perform the behaviour of interest, termed *perceived behavioural control* (PBC). The PBC factors can be considered both from a teacher's internal consideration (possessing the skills, abilities, and knowledge), or from the perspective of external considerations (resources, opportunity, and cooperation). Again where factors make it easy to perform the behaviour, this can be indicated as PBC^{+}, whereas factors which are perceived to make it difficult to introduce the behaviour can be recorded as PBC^{-}.

Relating AB, SN and PBC to Core and Peripheral

While the above suggests an approach to determining teacher beliefs, in practice it is possible for a teacher to say one thing but enact another. This is especially true in the context of guiding a change of teacher beliefs, as is indicated by the introduction of STL teaching where the goals of teaching and learning have changed, or the degree of emphasis on the wider education goals has increased. This leads to distinguishing between core and peripheral beliefs. Core beliefs in this study are defined as those beliefs that are both stated and enacted, whereas the peripheral beliefs are those that are stated, but not operationalised (Haney & McArthur, 2002).

A study of AB, SN, and PBC beliefs
In order to examine chemistry teachers' beliefs regarding the teaching of chemistry, including the approach undertaken, case studies were constructed for five chemistry teachers.

The main goal of our study was to develop an understanding about the chemistry teacher's beliefs in teaching chemistry and also, how these beliefs could be changed. By means of this intervention, it was hoped to induce change in chemistry teachers' beliefs towards the STL approach. This involves a shift from beliefs involving more traditional teaching styles and having a strong emphasis on eliciting students' extrinsic interest into the STL approach, emphasising student centred approaches and the promotion of students' intrinsic motivation. The induced change is characterised as needing to go beyond a peripheral change brought about through an intervention to core beliefs indicating true teacher ownership of the STL idea. This study thus attempts to answer the following research questions:

Can AB, SN, and PBC beliefs be identified, and to what degree can such beliefs be classified as positive and negative?
Can AB, SN and PBC be related to core and peripheral beliefs?
Is it appropriate and useful to identify beliefs which are unclear as emerging beliefs?

Participants
The purposeful selection of participants (Patton, 2002) characterized the methodology of the study. The schools in which the five participated teachers taught were situated in one district in northern Estonia. The selection of five participants from the bigger group of chemistry teachers in a given district aimed to ensure participation of teachers exhibiting a wide range of positions toward chemistry teaching. The selection is based on the subjective perception by the author about these teachers and their teaching style. This was possible because the author has, for many years, been a member of this chemistry teacher community. This increased familiarity led to a high level of comfort between the teachers and the author and further reduced the potentially disruptive effects of the class observation.
All five teachers (Mari, Marge, Kaire, Anneli and Liina – not their real names) were female and taught chemistry at the upper secondary, as well as the compulsory, school level. All had graduated from the same university (there is basically one university in Estonia preparing chemistry teachers). Their studies lasted 5 years and embraced a large spectre of science and pedagogical courses. The major subject for four of the teachers was chemistry and for the other teacher it was biology. Their teaching experiences varied from 15-34 years. Two of the schools were town schools and three were country schools. The school type in all cases was gymnasium (equivalent to grade K-12 education).

Teaching materials
The STL materials used to guide this study were taken from, or were adaptations of modules developed under an European Commission funded project (PARSEL, 2006). These modules featured learning objectives reflecting the need to enhance scientific literacy towards responsible citizenry and covering conceptual chemistry learning, science methods of inquiry, enhancing communication skill and cooperative learning and stressing socio-scientific decision making (Holbrook & Rannikmäe, 1997). Modules included an initiation of the learning by means of a scenario which attempted to highlight the relevance of the conceptual science learning that subsequently took place.

Teacher activities within the study
Stage 1

After initial individual interviews, undertaken by the author, a 3-hour seminar session was conducted to introduce the philosophy, structure and learning goals of the STL modules. The participants "worked through" an exemplar module 'Should vegetable oils be used as a fuel?' to clarify the content and elucidate the learning goals of the module. The participants were given an opportunity to choose modules themselves and the teachers were asked to carry out three modules during the school year. The intervention was conducted for students in the 11th grade. Every teacher received individual guidance from the author before and after the implementation of a particular module. The prototype modules implemented by the teachers were: 'Should vegetable oils be used as a fuel?' 'Which soap is best?' and 'Measuring alcohol: could this save somebody's life?'

Stage 2

In the next school year, five workshops (lasting approximately 3 hours) were carried out where teachers: (1) reflected on their previous STL practice, (2) dealt with challenges and actual problems related to implemented modules, in cooperation with the researcher, and (3) brainstormed and elaborated ideas about new modules. The last issue was initiated by the teachers themselves, because they felt the need for new modules that would cover the basic school chemistry curriculum. Anneli, Kaire, Mari implemented 3 modules, Marge - 5 modules and Liina - 6 modules during the second year of the study which included also the 'self-made' modules: 'How to clean silver?' and 'Oxygen – the element of life or death?'.

Instruments

The following qualitative data gathering instruments were used in this study:

1. **Semi-structured interviews on teacher beliefs** which were designed to develop an understanding of how each teacher viewed chemistry teaching, as well as underlying beliefs impacting on their implementation of the STL approach. The semi-structured interview instrument was developed following a procedure described by Ajzen and Fishbein (Ajzen, 2005). Each participant was interviewed at the beginning and at the end of the school year (in stage 1 and again in stage 2) by the author. The three main questions asked, adapted from Haney et al. (1996), were:

   1. In your opinion, which is the best way to teach chemistry? (Gathering AB data)
   2. Who (a) supports, or (b) opposes your way of teaching? (SN data)
   3. What aspects made it (a) easy; (b) difficult for you to teach chemistry? (PBC data)

The main questions incorporated many sub-questions asked, as necessary, about lesson design, experimental work, assessment, and students' motivation, school climate, etc. Additionally background information about the school and teacher practice was gathered.

The format of the follow-up interviews (at the end of the stage 1 and stage 2) was also based on the Ajzen and Fishbein's procedure (Ajzen, 2005). For this purpose the questions asked in pre-intervention interview were modified to be more relevant to the intervention.

1. What do you see as the (a) advantages; (b) disadvantages of your implementation of the STL (modules) in your teaching (The AB question).
2. Who (a) supported, (b) opposed your implementation of the modules in your teaching? (The SN question).
3. What aspects made it (a) easy; (b) difficult for you to implement the modules in your teaching? (The PBC question).

Questions 1 in the pre- intervention interview and, 1(a), 2(a) and 3(a) in both the follow-up and post-intervention interviews were identified as positive AB, SN and PBC factors (influencing the intentions and following actions) whereas 2(b) and 3(b) in the pre-intervention interview and 1(b), 2(b) and 3(b) in the post-intervention interview were taken as negative factors.

The interviews lasted about one and half hours in order to ensure the interviews were conducted in a friendly atmosphere, the teachers were permitted to digress from the questions and even comment on unrelated matters. All interviews were recorded and transcribed for analysis.

2. **Classroom observations,** following a non-participative format, were carried out at the beginning of the intervention prior to the introduction of STL ideas. The observation data (collected as detailed field notes) were analyzed and compared with AB teacher belief factors as an outcome of the interview findings in order to identify: a) core beliefs, and b) peripheral beliefs of participating teachers. Follow-up observations were carried out during the stage 1 to obtain a better understanding of how STL- modules were adapted and implemented in the classroom.

3. **Teachers' reflective commentaries**, collected in oral format, were recorded and transcribed in order to obtain feedback from the teachers regarding their experiences with the STL modules and challenges they confronted.

4. **Workshop data**

All workshops were recorded and used as an additional instrument alongside the other data. The triangulation of such data led to the drawing of sound evidence about teachers' developing beliefs towards STL.

Findings and interpretation

Stage 1

Based on the a results of the first stage of the study (Vaino & Holbrook, 2008), an attempt was made to identify a range of different beliefs regarding chemistry teaching. These were categorised as AB, SN and PBC as indicated in table 1 (for three of the five teachers)

Amongst the AB beliefs, several beliefs, relevant to the STL approach, were proposed but classified as peripheral as the teachers did not show they were able to put these into practice, e.g. the belief that chemistry teaching should provide students with possibilities for self-discovery, or that school chemistry should prepare students for life. Other AB beliefs were classified as emerging in the belief that they were new beliefs coming from the study, but it was not clear that they were at the level of core beliefs at this stage.

At the beginning of the intervention, three common negative PBC (PBC^-) belief factors in common among the teachers were suggested which more or less influenced the teachers' usual practice: (1) a perceived pressure to cover content, (2) an indicated lack of appropriate learning-teaching materials and (3) a lack of self-efficacy beliefs in motivating students. These were suggested to be PBC belief factors, because they were related to teacher's perceived ability to perform the behaviour (their best way to teach chemistry), and recorded as negative because each of these three factors made it difficult to perform the behaviour being put forward in the study.

The results of the last stage 1 interview with the teachers showed that several positive beliefs towards STL emerged: the new approaches increased students' motivation to learn and changed the teacher's role in classroom; teachers suggested it became easier to make students learn; modules enabled students' self-discovery (all AB beliefs); the participants felt the support from students and other participants (SN beliefs), and that the project offered appropriate teaching-learning materials (PBC belief).

Nevertheless problems arose throughout the implementation of the STL modules, and these were mainly related to formative assessment strategies suggested by the STL teaching materials. Additionally, it was recognised that emerging beliefs (beliefs emerging throughout the implementation of the STL modules) cannot be unambiguously equated with core beliefs and there is a need for further research in order to confirm changes in core beliefs (or peripheral beliefs becoming core beliefs) of these chemistry teachers.

Table 1: Beliefs established in the case of three teachers in stage 1 (Vaino & Holbrook, 2008)

		Mari	Renate	Marge
AB beliefs	**Core**	Individualised approach Hands on activities as an illustration of theory Basic skills	Chemistry is a body of knowledge Basic skills Individualised approach with scaffolding Testing as a main motivator Students are not able to undertake inquiry	Personal relevance Preparing students for life Students decision-making Formative assessment as an indicator of progress Encouragement as the best motivator
	Peripheral	Variety of learning activities Prepare students for life Personal relevance	-	Problem solving through inquiry process and students' self-discovery
SN beliefs		SN^+: colleagues as a source of teaching ideas SN-: unmotivated students	-	SN^+: colleague's support as a possibility to share ideas SN-: pressure of school staff and public opinion to get high numbers in state examinations
PBC beliefs		PBC^-: lack of time and ability to cover the chemistry curriculum; lack of appropriate learning materials; lack of ability to make students learn	PBC^+: her hobby PBC-: lack of appropriate teaching-learning materials; abstract chemistry curriculum	PBC^-: lack of time because of overloaded curriculum, lack of appropriate learning materials
Emerging beliefs		AB^+: new approach increased students' motivation to learn, and changed teacher's role in classroom; it was easy to make students learn and they were interested in very different things AB^-: the things the students were interested in during the modules were not allways connected to chemistry content. SN^+: support from students and other participants (for sharing ideas and giving feedback) PBC^+: increased self-efficacy belief in motivating students and in formative assessment skills PBC^-: lack of equipment; demanding assessment system suggested by the project	AB^+: new approach increased students' motivation to learn AB^-: students gained less content knowledge than usually PBC^-: lack of time in order to cover the chemistry curriculum; demanding assessment system suggested by project	AB^+: new approach increased students' motivation to learn and it was caused by the possibility to discover and decide more things themselves; it was easy to make students learn SN^+: support from students and other participants (sharing ideas and giving feedback) PBC^+: appropriate teaching-learning materials

Stage 2

Based on teacher interviews, informal commentaries and workshop data, several additional teacher beliefs (labelled as emerging beliefs) were identified during stage 2 and analysed following the belief structures suggested by the Theory of Planned Behaviour (Ajzen, 2005). A summary of teachers' emerging beliefs is given in table 2.

Table 2. Emerging beliefs identified in stage 2 by the five teachers.

Teacher	AB beliefs	SN beliefs	PBC beliefs
Marge	New approach gave a possibility for a change	Support from the other participants	Increased self-efficacy in implementig STL modules
Mari	Alternative assessment methods increased students' self-reflection and motivation	Support from the school administration	Increased self-efficacy in implementig STL modules
		Support from the laboratory assistant	Alternative assessment methods were too time-consuming
		Some classes were not as motivated as expected	Lack of time in preparing students for state examination
Liina	New approach gave a possibility for a change	Support from the other participants	Increased self-efficacy in implementig STL modules
	Modules enabled students to see that scientific knowledge are tentative in nature	Support from the laboratory assistant	Lack of time in covering chemistry curriculum
	Modules raised students' responsibility for their learning		
	modules made student more happy		
Anneli	New approach gave a possibility for a change	Support from the school administration	Increased self-efficacy in implementig STL modules
	Modules enabled to demonstrate teacher's self-development to the others	Missing laboratory assistant	
	Modules afforded students to self-reflect their learning		
	It was not easy to make students explain scientifically		
Kaire	Modules developed students' critical thinking skills		Increased self-efficacy in implementig STL modules
	Students remember things learned by means of STL modules longer than by context-free chemistry teaching		

Positive belief factors Negative belief factors

Comments put forward by the teachers

New experiences

(a) Three of the teachers, Liina, Anneli, and Marge, accentuated their personal need for change and challenge and for an opportunity to modify their usual work routine. For example, Liina stated during the last interview:

> *I think it is like breath of fresh air. You are teaching all these usual things: how to compile correct formulas and equations, the students are bored and, honestly saying, it is quite boring still for onesself. But when we started with the silver module ['How to clean silver?'] when students realised that they were going to clean their own silver things,the effect was electrifying… It was just rewarding for me to see them act so enthusiastically.*

Marge expressed herself even more strongly:

> *It is like an addiction, if you have felt what does it [a module] mean for you and your students, and that it is vastly different from your previous practice, then you want to repeat it.*

These statements reinforced their emerged beliefs ('new approaches gave a possibility for a change') as stated at the end of the stage 1 and these were categorised as AB^{+}.

(b) The second group of beliefs related to STL teaching benefits were connected to how and what students learn:

> *I think that in our world is necessary to find out information you need. In the oxygen project they had to work quite a lot with a computer and find things out by themselves. Received information was contradictonary in a way, and then this made them to think about… (*stated by Kaire during the second workshop).

The last statement was labeled as ' modules developed students' critical thinking skills.'

(c) Comments from Anneli were more related to the students' reflection on their own learning (labelled as 'modules afforded students to self-reflect their learning' and categorised as AB^{+}).

> *The fact that they [different groups] utilized different [silver] cleaning methods and got different results made them more interested, it made students think about their own results, and caused sometimes hot debates in groups…*(Anneli, last interview)

(d) Recognition of the tentative nature of scientific knowledge can be seen in the following interview excerpt, expressed by Liina.

> *During the biodiesel module… what was very surprising, the caloric value of biofuels was totally different from the last year results. After I had informed sudents about the gap between the two years, we started to brainstorm about possible causes. They suggested that, maybe, the weather was colder and heat losses could be bigger and other things like that…*

This comment was summarised as a belief that 'modules enabled students to see that scientific knowledge are tentative in nature' and categorised as AB^{+}.

(e) Students responsibility for their work was a concern for both Liina and Mari, but they interpreted the influence of STL teaching somewhat differently. According to Liina, modules raised students' responsibility (AB^{+}) for their learning because they had to present their work and self-made artefacts in front of the classroom:

> *They definitely tried more than preparing for the test, because most studenrs like to show themselves from the best side staying in the front of the others. I think, it would be quite embarassing to let your group down… …. Some groups who had made an especially nice poster or Powerpoint presentation, I saw how proud they were of what they had done…(stage 2, the 4th workshop)*

Mari saw the group work format as something that, on the contrary, might hinder students' individual responsibility and enable "idlers" to exploit the other classmates (stage 2, the 1st workshop). In the second year she tried to apply more alternative assessment methods like students' self- and peer assessment and she let students write individual reports.

> *Assessing each other in the group, it still made students to think more about their own provision, and in the next module, I think, some not very motivated students tried more.*

The last was named as 'alternative assessment methods increased students' self-reflection and motivation ' and was classified as AB^{+}.

However, Mari considered this way of assessing students too time-consuming (as evidenced from the last interview). Whereas Mari tried to overcome the initial problem (potential negative AB belief) by using some new ways of assessing students, it was not directly categorised into AB^-, rather into AB^+. Still, as she found this to be too time-consuming, the last was categorised as PBC^- (perceived lack of resources).

(f) Anneli, who seemed to be quite depressed during the first stage by the feeling that "you have to demonstrate in the school how good you are and that you are developing all the time", found by means of modules the possibility to "advertise" her work to the headmaster and the other colleagues by inviting them to the module lessons. She expressed their reaction followingly:

> *Our headmaster and a couple of teachers were very surprised seeing our students emotionally arguing with each other who's soap is best. After my biodiesel lesson, our headmaster asked me to explain the chemistry content, to understand better what the students said. It seemed that he was really interested.*

The last expression could be categorised differently: on the one hand into AB^+ as 'modules enabled to demonstrate teacher's self-development to the others', but on the other hand, used as a means for gaining support from others of importance (headmaster and colleagues), partly into the SN^+ beliefs.

(g) As a disadvantage of STL teaching, Anneli saw the problem related to the second part (students' experiment) of the modules

> *It was not easy sometimes to make them explain what happened and why. For example, by silver module ['How to clean silver?']. The scenario was interesting [for students], they were keen on raising research questions and undertaking the experiment but, after this they were not so interested to explain their results using chemistry knowledge. I think, they were too much engaged with "what happened?" and not so much "why it happened?*

The last was labelled as 'it was not easy to make students explain scientifically' and it was categorised into AB^-.

<u>Who supported, or opposed the teachers in their implementation of the STL modules (SN beliefs)</u>

Both Anneli and Mari referred to the fact that their headmaster and/or headteacher were satisfied about the fact that their teacher was involved in the new interesting project that would be beneficial for the school and the students (they gained support from the school administration). Liina and Marge said that it was really important to get support from group members during the workshops and even between the workshops. During the last interview, Liina stated:

> *If you are the only chemistry teacher in your school, then it is not possible to share ideas and problems, some of them are still very subject specific…And if you have a possibility to share your problems in different setting and to come up with new ideas, I think that it really works for me…*

Mari and Liina felt support from their laboratory assistant and they considered her existance very important. "Anyway it [carrying out modules] would have not been possible" as stated by Liina.

Explicitly stated SN^- beliefs were not found amongst the teachers However during an interview session, for example, Mari's complaint about the reaction of one class who was not as motivated as the students of a previous class when teaching the biodiesel module was inferred in this manner.

<u>What aspects made it easy, or difficult for teachers to implement the STL modules (PBC beliefs)</u>

In looking for PBC beliefs, teachers statements were mostly related to their increased self-efficacy, established more or less by all teachers and were categorised as PBC^+. For example

> *For me, It was easier to carry out modules in this year comparing to the previous year. All was new and confusing at first. At the moment, lessons don't take very much time to prepare.* (Anneli, last interview).
> *I now feel less anxiety in module lessons, especially when we made up our own module* (Liina).

For Anneli, it seemed still to be quite exhaustive to prepare all laboratory equiptment alone because she did not have a laboratory assistant in her school (expressed in informal talk with the researcher). However, she did not say it out during the interview and in answer to the direct question (2b). However, it was still categorised as PBC^- ('missing laboratory assistant').

Whereas the teachers' concern of how to cover chemistry curriculum on schedule was highlighted during stage 1 (Vaino & Holbrook, 2008) and it strongly constrained teachers' work, this issue was carefully explored by the author in the stage 2, especially in determining how they were able to cope with the problem.

During the 3rd workshop, Mari and Liina commented that they have not reached as far as expected in covering the curriculum. The following illustrates how the teachers tackled this problem:

> *...you have to make a choice, whether to follow blindly the content and be stressed (anyway it is impossible to teach all what is required), or you handle it more freely and your students are more happy...* (Liina)
>
> *... and even if you really try to keep step with the learning plan, after a couple of month you discover that many students show they have gained little of what you teach…* (Anneli)
>
> *I am sure that after graduating the school they definitly remember how we made soap than all these abstract things nothing to do with their own lives* (Kaire).

The last utterances were summarised as 'modules made students more happy' and 'students remember things learned by means of STL modules longer than by context-free chemistry teaching.' These finding suggest that teachers generally recognised the problem, but they also found arguments for themselves in order to outweigh the problem by positive factors.

In the last interview asking about constraints (interview question 3b), only Mari was directly pointing to the lack of time.

> *While we wasted too much time to the modules, it was really hard for me at the end of the year to sum things up and prepare students for the state exam.*

Discussion

The findings show that, generally, AB, SN, and PBC beliefs could be identified related to the teachers participating in this study and classified as positive or negative.. Triangulation of the data through multiple methods (interviews, informal commentaries, workshop data) led to collaborative findings. However, in some case, the problem of classifying beliefs into negative or positive created difficulties. For example, when a teacher is finding ways to overcome AB- problems, it was recognised that beliefs were still developing and initial negative AB beliefs could change somewhat to become more positive (Mari's case). This led to a need to consider the classification of many beliefs as emerging.

Additionally, it was recognized by the author, that the belief expressed by the teacher and initially considered as AB, could be categorised also as SN when the teacher's attitude towards implementing STL teaching was very much influenced by other persons - e.g. using STL modules as a means to get support and appreciation from the school staff (Anneli's case).

In comparing the first year beliefs emanating from the intervention, called emerging beliefs, with the second year emerging beliefs, it became evidence that there was a change of focus. In the first year the teachers discerned more their students' increased motivation (stated by all teachers), but in the second year (while still referring implicitly to students' motivation and interest), they were more aware what students were learning and that there existed different learning goals (gaining knowledge is not the only learning outcome). Additionally, it seemed that the covering of chemistry curriculum was not as important as at the beginning of the intervention. Rather, the problem was perceived by the teachers in the format of "tacit knowledge" (problems that all the teachers shared, but, at the same time, helped each other

not to overemphasise), such as the importance of content and how to interpret learning goals more widely.

Although the predictable power and relative weights of the AB, SN and PBC factors may vary from one teacher to another, and depend on the kinds of behaviour exhibited, it can be claimed (based on the theory of planned behaviour) that teachers intend to exhibit a behaviour when they evaluate it positively, when they experience social pressure to perform it, and when they believe that they have the means and opportunities to do so. Thus, it is reasonable to conclude that when a teacher has all positive AB, SN, and PBC beliefs towards STL teaching (e.g. Liina, Marge), then it is quite likely that they will use STL teaching (modules) in their everyday practice and not only until the end of the intervention. In this case, the beliefs could be considered as likely to go beyond emerging beliefs and represent core beliefs of the teacher.

Nevertheless, as suggested by Green (1971), beliefs acquired in one context (e.g. during current intervention) do not have to connected to the other (customary teaching practice). Thus, it is quite possible that a teacher is holding simultaneously incompatible beliefs (e.g. when teaching STL modules, the teacher uses more student-centred teaching and outside of the modules, the teaching is more teacher-centred). Hence, there is a need for further research in order to confirm changes to core beliefs (to what extent are STL related beliefs transferred to their customary teaching practice). This is especially the cases where teacher hold some negative AB, SN, or PBC beliefs towards the new approach.

It is thus suggested to identify beliefs, which are tending towards core beliefs during the intervention, as emerging beliefs. These emerging beliefs are considered as immature at first, but may gradually develop as considerations become favourable. As indicated above, it may be inappropriate to call these core beliefs as AB, SN, PCS factors may not be sufficiently conducive for the teacher to put these beliefs into practice in all appropriate situations. It seems quite likely that teachers who experience frustration and failure implementing the new approach will throw out strategies they perceive to be the source of negative factors.

Identifying teacher's beliefs towards the new teaching approach as emerging was useful because it helps to design further interventions and activities with the teachers. By providing teachers with the relevant support and helping them overcome initial constraints, it is more likely to change negative emerging beliefs by these teachers into positive and, potentially in future teaching, into core beliefs.

Conclusions

This study shows that AB, SN, PBC beliefs can be identified and to a large extent can be classified as positive and negative. Furthermore these AB, SN and PBC beliefs can be interpreted as core or peripheral beliefs where they relate to the beliefs held by the teachers prior to an intervention. However it is unclear whether beliefs emerging from an intervention such as in stage 1 and stage 2 can really be identified as core beliefs. And with this in mind it is proposed that these beliefs be classified as emerging beliefs until such time as the stated beliefs have, or have not, been corroborated by a sufficient range of actions by teachers in the classroom, above and beyond the intervention.

Implication

Once teacher beliefs are determined and separated into core and peripheral beliefs then it is possible, by means of suitable activities and actions, to go further and guide the teacher to adopt peripheral beliefs into their teaching, recognising that: 1) a person's beliefs are precursors to action (Ajzen, 2005), and 2) satisfying needs has a motivating force for action (Leontjev, 1978; Deci & Ryan, 2000). With this in mind, the main mesasage from the study is suggested as the need to enhance teachers' self-satisfaction through (a) making teachers more

aware of alternative approaches to teaching; (b) paying attention to meeting the teachers' three basic psychological (AB, SN, PBC) needs, particularly through self-reflection and self-development; and (c) permitting individualised approaches to satisfy the needs of a paricular teacher.

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