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GRADE 12 STUDENTS' PERCEIVED SELF-EFFICACY TOWARDS WORKING LIFE SKILLS AND CURRICULUM CONTENT PROMOTED THROUGH SCIENCE EDUCATION

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Abstract. *This research was based on the concern that students didn't see the need for the acquisition of science skills and knowledge perceived as important in relation to different society issues and the world of work. The aim was to determine gymnasium students perceived self-efficacy towards working life skills as well as science curriculum, content-related topics. The sample was composed of grade 12 (N=1375) 18-19-year-old students. Data were obtained using a 4-point Likert scale questionnaire seeking to determine students' perceived self-efficacy towards working life skills and topics in the science curriculum linked to disciplinary core ideas. In general, students perceived their self-efficacy to be above average towards most needed working life skills. However, it was much lower in areas related to problem-solving skills and understanding the nature of science. Results also indicated that the self-efficacy associated with purely Physics curriculum-related topics stood out as being much lower than for the other school science subject areas. Findings suggested there was a need to re-thinking the way science content was presented to students and to consider whether and how this could be restructured around core ideas in science in order to promote the development of problem-solving skills as an important aspect in enhancing working life skills.*
Keywords: *core ideas, working life skills, self-efficacy, science curriculum topics, science education.*

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Introduction

Today, citizens need to be able to resolve different society issues, which have a strong scientific content (e.g. persistent poverty, lack of energy supply, global climate change, and environmental degradation). Dealing with such issues requires the involvement of personnel able to handle complex problem-solving situations, able to communicate effectively as well as prepared to work in dynamic teams seeking solutions using increasingly developing technology and new knowledge (Griffin, McGaw, & Care, 2012; Rotherham & Willingham, 2009). This suggest citizens need to possess a high level of life skills.

To achieve a high level of life skills, school science lessons are expected to enable students to develop attributes beyond subject-related content knowledge and associated operational skills and to acquire wider transdisciplinary competences valued in their everyday life (DeBoer, 2011). The gaining of such competences is aided by the promotion of students' self-efficacy. According to Bandura (1986), people who have high self-efficacy are more likely to view difficult tasks as something to be mastered rather than something to be avoided. This self-efficacy also appears to be positively related to academic motivation, learning and achievement and often independent of actual capabilities (Pajares, 1996). Students' engagement with science education is shaped by their thinking about themselves (what they think they are good at, their attitudes towards science and towards science-related activities) and whether they perceive school science activities as important and useful (OECD, 2016). Thus, raising students' self-efficacy is deemed important.

One possibility to raise students' self-efficacy is to focus on establishing student-relevant contexts, specifically geared to carefully selected, disciplinary core ideas within science (Harlen *et al.*, 2015; 2010). In this manner, students can gain competences by learning in a supportive environment and can strive to attain the goal of becoming responsible citizens in today's society (Broman, Bernholt, & Parchmann, 2015; Greeno & Engestorm, 2014; NRC, 2007). This is valuable, because science-related knowledge is ever expanding. Yet carefully selected disciplinary core ideas and practices can focus students learning to acquiring a strong sense of self efficacy in evaluating and selecting reliable sources of scientific information and also allow continuing development beyond school as learners, users of scientific knowledge and also as producers of such knowledge (NRC, 2012).

The curriculum plays an important role in putting forward competences to be gained and in identifying content-related topics, enabling core ideas to be promoted in science classes. While the core ideas are related and dependent on the curriculum topics, they go further in the sense that they are grade-level independent, encompass societal links and can be expected to go beyond topics to encompass transdisciplinarity. In the case of the Estonian competence-based curriculum, the approach advocated for promoting gains in science education is by means of acquiring core ideas via an "education through science" focus (Holbrook & Rannikmäe, 2007). This is seeking a relevant, educationally sound foundation on which to build cognitive capability, around transdisciplinary core ideas (Duncan, Krajcik, & Ravit, 2016), initiated through visionary scientific and social contexts and connected to subject topics, so as to promote students' self-efficacy.

Nevertheless, research has shown that not all science subject curriculum topics are equally interesting for students (Lavonen *et al*., 2008; Walper, Pollmeier, Lange, Kleickmann, & Möller, 2016). Furthermore, students in general do not choose the science curriculum topics they learn, and hence it is the expectation that teachers present subject topics in a way that all students can be expected to comprehend and value the perceived importance. Thus, students' perceptions related to selected science subject topics (which can be discussed within disciplinary core ideas) need to be considered as an important area of research. Findings from such studies can lead to suggestions as to which topics enhance students' 'education through science' competence and can link to positive visions of scientific core ideas within everyday life and in related careers.

Research Problem

Research has shown the importance of students having a meaningful scientific foundation at the end of compulsory schooling and valuing their own competence levels in dealing with multiple scientific challenges within the society, requiring both scientific and socio-scientific attributes (Soobard, 2015). A longitudinal research, monitoring the change of the levels of scientific literacy during gymnasium studies indicates that Estonian grade 10-12 students' higher-order cognitive skills (problem-solving including inquiry skills, decision-making, reasoning) remain at the same level, or show very little increase (no statistical significance) over time (Rannikmäe, Soobard, Reiska, & Holbrook, 2017; Soobard, 2015). The longitudinal research also shows better results are attained at the grade 12, compared to the grade 10, level on memorization of science content and the use of interdisciplinary knowledge in student familiar situations, contrasting with the lack of ability gains in higher order thinking skills. These findings confirm warning messages on the general lack of higher order thinking, coming from PISA studies in Estonia (OECD, 2016) that concern findings emanating from studies on 15 year-old students.

This research reflects on earlier findings and considers students' self-efficacy towards science topics and skills at the grade 12 level as they consider a choice of a future profession. No previous science education studies among gymnasium level students within Estonia have been undertaken for researching students' self-efficacy. Based on outcomes, it is anticipated it becomes possible to give suggestions for improving the way science is taught so that the formulation of visionary core ideas in science education further develop students' self-efficacy and form positive considerations for undertaking science-related professions needed in today's society.

Research Focus

This research determines grade 12 students' perceptions of science curriculum content-related topics and perceived self-efficacy towards working life skills.

The following research questions were put forward:

RQ1: What is the perceived self-efficacy of grade 12 students towards identified working life skills associated with the Estonian curriculum?

RQ2: What is the perceived self-efficacy of grade 12 students towards selected Estonian science curriculum content-related topics taken as a meaningful surrogate for disciplinary core ideas?

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Theoretical Overview

Skills for Work and Life

A stated purpose of school science education is to promote scientific literacy (Estonian Government, 2011) and, within this, to promote the development of multiple skills among students needed to engage in responsible citizenry and enabling a future workforce. The skills associated with enhancing scientific literacy are linked to a number of factors including:

- the nature of the subject, associated with an understanding of the nature of science, subject and interdisciplinary knowledge and cognition;
- personal development especially associated with self-development, self-management and self-efficacy, plus
- acquisition of social skills, such as the ability to interact with others through collaboration, reflecting on the ideas of others, reasoned decision-making and resolving socio-scientific issues.

(Choi, Lee, Shin, Kim, & Krajcik, 2011; Estonian Government, 2011; Holbrook & Rannikmäe, 2007; OECD, 2016). In addition, in order to take responsibility for one's own learning, attention is needed to develop metacognitive and planning skills (Choi *et al*., 2011), thus enabling students to monitoring their own learning progress and to become life-long learners (Estonian Goverment, 2011; World Economic Forum, 2016).

Self-efficacy

Student perceptions towards their attainment of skills can be indicated through indicators of self-efficacy, which is defined as a personal measure of one's own capabilities to perform a task and reach a desired goal (Bandura, 1997). Bandura (1986) even stated that self-efficacy is a better predictor of future behavior than actual capability, because one's self-efficacy determines what people actually do with the knowledge and skills they possess, enabling greater exploits and the ability to succeed in life. Self-efficacy is also positively related to academic motivation, learning and achievement and is independent of actual capabilities (Pajares, 1996). On the other hand, negative self-efficacy (inactivity and non-performance) can lead to de-motivation and drop-out (Bandura, 1997). Students who show increased science self-efficacy over time have a tendency to succeed academically in their science learning (Alkan, 2016; Phan, 2011; Sadi & Uyar, 2013).

Self-efficacy is a useful measurement with which to predict behavioral outcomes when compared to other constructs related to motivation, especially in psychology and education (Graham & Weiner, 1996). Research indicates that students' self-efficacy towards achieving goals in science lessons has an important impact on their choices of science-related activities (Bandura, 1997; Zeldin & Pajares, 2000). Students who have high confidence in their ability and who feel able when undertaking certain activities tend to select these activities and put more effort into be more successful. As Bandura and other researchers have shown (Bandura 1997, Pajares, 1996, Schrunk, 1991), perceived self-efficacy can have an impact on everything from psychological state to motivation to behaviour. The PISA study (OECD, 2016) has found that students with low perceived science self-efficacy perform lower in science learning measures compared to students with high perceived self-efficacy, who tend to use their science knowledge and skills in everyday contexts.

Students with high self-efficacy tend to have higher motivation and engage in more perspectives, compared with low self-efficacy students who don't feel the value in making an effort (Puzziferro, 2008). Higher perceived self-efficacy contributes significantly to acquiring the necessary motivation in science education and achieving the desired result. However, motivation itself can have several effects on how students learn and their attitudes towards science subjects (Ormrod, 2006).

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A Frame for Learning

Generally, within syllabuses, the frame for learning is a list of subject content topics, where the content tends to be associated with educational concepts and skills (or competences). To aid the development of skills, students need a motivational learning context, such as relevant experiences from real-life, to associate gains in science content acquisition (DeBoer, 2011).

One approach to promote real-life experiences is to initiate the learning within relevant, or familiar contexts, promoting students' intrinsic motivation (Ryan & Deci, 2002) and stimulating conceptual science learning through associated disciplinary core ideas (Duncan, Krajcik, & Ravit, 2016; Harlen *et al*., 2015; NRC, 2012; Stevens, Sutherland & Krajcik, 2009). Also, discipline core ideas have been suggested as being central to science learning, serving as a focus to make sense of phenomena, while also serving as building blocks interrelating the learning within and between disciplines, thus making connections to other ideas (NRC, 2012; Stevens, Sutherland, & Krajcik, 2009).

Core ideas are seen as meeting at least two of the following criteria (NGSS, 2013):

a) possessing wide importance across science or STEM (transdisciplinary) learning, or being a key conceptual area within a single discipline;
b) a key platform for investigating more complex or overarching ideas and solving associated problems;
c) strongly associated with the interests and experiences of students and society issues, which have a scientific content;
d) lending itself to a teachable and learnable progression over grades allowing increasing levels of sophistication or abstraction of learning.

Whereas curriculum subject content topics (Estonian Government, 2011) can be considered as leading to topics simply taught as knowledge core ideas (NGSS, 2013 relate to two dimensions: an idea of why (conceptualisation of knowledge) and an idea of how (process including skills). Based on this, core ideas are important when considering the need to promote capability (to do something with the application of knowledge and also skills to undertake new learning tasks, work, or promote a career) rather than only ability (to be able to do something routinely). Core ideas serve as a common ground for the multiple knowledge components accumulated from learning in science subjects and are valuable for creating a transdisciplinary understanding about phenomena in nature (AAAS, 2013; Clark, 1997; Harlen et al., 2010; 2015).

Methodology of Research

Estonian Science Curriculum as Research Context

The science curriculum in Estonia, since 2011, is competence-based with the stated purpose to promote scientific literacy (Estonian Government, 2011). There is thus a recognised need to develop transdisciplinary understanding about science. The Estonian curriculum indicates key competencies to be promoted throughout all school subjects and which, as components of scientific literacy, are intended to be promoted in science classes. Examples are: using knowledge gained from Biology, Geography, Chemistry and Physics purposefully; developing scientific problem-solving and socio-scientific decision-making skills; developing students' personal competencies (including creativity, communication, planning, interpersonal and teamwork skills), attitudes towards science, understanding technology, risks assessment, in choosing a career. Many of these are related to needed working life skills in today's society.

Nevertheless, the Estonian science curriculum topics are presented via a traditional syllabus, meaning that the science content is divided between subjects like Biology, Chemistry, Physics and Geography (Earth science). Elements of core ideas, as identified in NGSS (2013), are included under different science subjects as content-related topics. Examples of such topics are: Solar system & planets, climate change, destroying rainforests, hereditary genetic diseases, redox reactions, matter and energy exchanges in living organisms, energy conversions from one form to another, Newton's laws of motion and sound transmission.

General Background of Research

This research seeks to determine grade 12 students' perceived self-efficacy for gaining competences associated with working life skills related to the Estonian curriculum content topics. In this research, working life skills were chosen to be in line with the science domain within the Estonian competence-based curriculum (Estonian Government, 2011).

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Research Sample

Data were collected through an Estonian, large-scale scientific literacy study (LoteGym). LoteGym study was about testing Estonian grade 10-12 students' scientific literacy level and for this study, an original test for scientific literacy was developed (Rannikmäe, Soobard, Reiska, & Holbrook, 2017; Soobard, 2015). This research used a school-related representative sample, compiled from grade 12 (N=1375) 18-19 years old students from 44 Estonian schools. All grade 12 students from all selected schools participated in this study. To obtain the sample schools, all schools in Estonia were grouped based on three locations (the capital; towns with at least 2 gymnasiums and rural areas). Schools within each area had an equal probability to be selected. After grouping schools based on their locations, schools were then ordered, based on average national examination results. Every 4th school was chosen and all students from these schools were involved in the research.

Instrument and Procedures

This research used a paper and pencil questionnaire to collect grade 12 students' perceptions related to self-efficacy towards skills and core ideas related, science content topics. For this purpose, an instrument consisting of two parts was composed:

- Part 1 measuring perceived self-efficacy towards skills (N_{items}=34). Example items in these categories were:
  - I can solve science problems.
  - My communication skills are good.
  - I prefer to work in a group/team.
  - I can explain science related natural phenomena in everyday life.
  - I am motivated to solve challenging problems.
  - When I make decisions, I consider the positive and negative consequences towards the natural environment.
  - Scientific models (like DNA) portray nature as it exists.
  - Creativity and imagination are important factors for establishing scientific knowledge.
  - I can apply knowledge from science lessons in new situations.

- Part 2 measuring perceived self-efficacy towards core ideas related science content topics (N_{items}=19). Example topics were:
  - Hereditary of genetic diseases.
  - Matter and energy exchange in living organisms.
  - Redox reactions in everyday life.
  - Energy conversion from one form into another.
  - Newton's laws of motion.
  - Solar system and planets.
  - Solar and lunar eclipse.

A 4-point Likert scale (1- I strongly disagree; 2- I disagree; 3- I agree and 4- I completely agree), chosen for convenience, was used for all parts of the instrument. Mattel and Jacoby (1971) stated that the reliability and validity of an instrument was not affected by the number of scale points used for items. Odd-numbered Likert scales provided an option for indecision or neutrality. In this research, it was decided not to include a neutral opinion, because many researchers outlined that this significantly increased the number of people stating they had no opinion when they actually did (Johns, 2005; Krosnick et al., 2002; Nowlis, Kahn, & Dhar, 2002).

Students were given 45 minutes to answer the questions, this questionnaire being administered during one science lesson.

The instrument was validated by four science teachers and four scientists from the University of Tartu. These experts assessed the content and construct validity of the instrument (Table 1). After their input and suggestions, the final questionnaire version was produced for test of reliability. Reliability of the whole instrument was determined using Cronbach alpha (α=.97), showing a strong internal (>.70) consistency (Hair, William, Berry, Rolph, Ronald, 2010).

Table 1. Validation and reliability of created instrument for this research.

Instrument/method	Validity/reliability	Used validation/reliability method
Students perceived self-efficacy towards working life skills and content related topics in science subjects determined by using a 4-point Likert scale questionnaire	Content validity	Expert opinion method: four independent experts (from Estonia) in the field of science education. And also international experts for statements categorisation.
	Construct validity	Analysis of Estonian middle and secondary science curriculum and syllabus to ensure that items are valid in terms of expected learning outcomes
	Reliability	Cronbach alpha=0.87

Data Analysis

The students' perceived self-efficacy was determined quantitatively by students' agreement or disagreement responses towards working life skills and core ideas related to the science content topics. Data analysis was conducted using SPSS version 24. Descriptive statistics (mean, standard deviation) were determined for all parameters (statements sections). Data was checked for normal distribution (data fitting a bell-shaped curve).

Categorisation of statements in both datasets was undertaken~~,~~ based on Principal Component Analysis (PCA) using two stages. PCA was used to reduce the dimensionality of the data set, which consisted of a large number of interrelated variables, but still saving as much relevant information as possible from the dataset (Jolliffe, 2002).

First, the categorisation was carried out, based on the components extracted from the 34 items on perceived self-efficacy towards working life skills. However, two items were omitted (communication and teamwork skills) because the~~ir~~ component loading was low and they did not meaningfully fit into the six components. Secondly, PCA was undertaken, based on the 19 items on perceived self-efficacy in science topics related to core ideas.

Results of Research

Perceived Self-efficacy towards Working Life Skills and Science Learning

Principal Component Analysis (PCA) gave six components (Table 2) – cognitive skills, planning skills, employability and citizenship, beliefs established through science learning, mindset for scientific research. A separate component was formed from science learning attributes.

Students' self-efficacy perceptions in *Cognitive skills* showed that self-efficacy was higher in evaluating information critically and distinguishing scientific evidence from non-scientific. Self-efficacy was lowest in the case of problem-solving.

Students self-efficacy perceptions in *Planning skills* showed that it was higher in the case when the initial method for solving a problem didn't work; students seemed ready to find alternative strategies, to evaluate their efforts and the effectiveness of a selected strategy and to continue to work with problems despite the difficulties. Again, self-efficacy was lowest in the case of problem-solving (motivated to solve challenging problems; designing appropriate strategy before starting to solve problems).

Table 2. Perceived self-efficacy towards skills within science learning.

Working life skills within science lessons	Component load	Self-efficacy	
		M	*SD*
Cognitive skills			
I can critically evaluate the quality of information	.65	2.84	0.64
I can distinguish scientific from non-scientific evidence	.62	2.84	0.69
I can apply new ideas in the problem-solving process	.58	2.78	0.64
I can solve science problems	.56	2.28	0.56

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Working life skills within science lessons	Component load	Self-efficacy	
		M	*SD*
I can defend my standpoint when arguing, using scientific evidence	.56	2.41	0.67
I can explain natural phenomena in everyday life	.55	2.68	0.73
I understand relationships between science, technology and society	.45	2.84	0.68
Planning skills			
I evaluate the efforts and the effectiveness of selected strategies after reaching the desired goal	.66	2.80	0.72
I continue trying to solve a problem despite difficulties	.65	2.84	0.73
I evaluate the efforts and the effectiveness of a selected strategy even when I don´t reach the desired goal	.63	2.84	0.72
Before I start to solve problems, I make sure whether the problem is within my level of understanding or whether I need extra help	.61	2.73	0.71
I can design the most appropriate strategy to solve problems	.60	2.51	0.70
I can find alternative strategies if an initial method doesn't work	.58	2.97	0.67
I am motivated to solve challenging problems	.57	2.46	0.83
Employability and citizenship			
My personal well-being is connected to what happens in nature at a global level	.70	2.87	0.75
I feel responsibility for what happens in the environment	.69	3.03	0.76
In decision-making, I consider the positive and negative consequences towards the environment	.65	2.72	0.69
I would like to have a career, where I can contribute to protecting the natural environment	.59	2.20	0.80
In problem-solving, I am sensitive to ethical standards, which are valued by society	.52	2.76	0.68
Beliefs established through science learning			
In my opinion, scientific knowledge can change	.58	3.29	0.68
I show respect for other human beings regardless of their cultural backgrounds and nationalities	.55	3.55	0.66
I try to understand the reasons for other peoples' actions instead of judging them	.55	3.19	0.74
In my opinion, the efficiency of scientific knowledge depends on how and for what purpose such knowledge is used	.53	3.03	0.68
Mindset for scientific research			
In my opinion, scientific models (like DNA) portray nature as it exists	.71	2.60	0.76
In my opinion, carefully collected data will give perfect knowledge	.67	2.73	0.75
In my opinion, there is only one certain scientific method for creating scientific knowledge	.57	2.06	0.72
In my opinion, creativity and imagination are important factors for establishing scientific knowledge	.43	2.79	0.76
Science learning attributes			
In my opinion, science lessons develop skills needed to control thinking and action during the problem-solving process	.73	2.58	0.80
In my opinion, science lessons develop useful skills for solving problems in everyday life	.71	2.44	0.74
In my opinion, science lessons have developed values, which are important for success in everyday life	.67	2.55	0.75
In my opinion, science lessons have helped me to understand the characteristic of scientific knowledge	.63	2.74	0.71
I can apply knowledge from science lessons in new situations	.59	2.58	0.63

Students' self-efficacy perceptions within the component - *Employability and citizenship* showed a higher feeling of responsibility for what happens in the environment and a well-being related to global issues. Self-efficacy was lower related to a possible career geared to nature protection.

Students self-efficacy perceptions in *Beliefs established through science learning* showed that in this component students strongly agree with the given statements.

Students self-efficacy perceptions in *Mindset for scientific research* showed that students perceive a higher self-efficacy in the role of creativity and imagination when establishing scientific knowledge, believing that carefully collected data gives perfect knowledge. Also, students perceived higher self-efficacy in their belief that scientific models portrayed nature as it exists. At the same time, self-efficacy was lower through statements indicating only one scientific method existed in obtaining new knowledge.

Students' self-efficacy perceptions in *Science learning attributes* showed that students agreed their self-efficacy was higher when recognising that lessons develop understanding about characteristics of scientific knowledge, planning skills and the ability to apply knowledge to new situations. At the same time, students perceived a lower self-efficacy in cognitive skills gained from science lessons based on problem-solving.

Science Curriculum Content Related Topics

Principal Component Analysis (PCA) gave three components (Table 3) – Biology and Chemistry content related topics, Physics content related topics and Geography content related topics.

Self-efficacy towards *Biology and Chemistry content related topics* showed that students perceived high self-efficacy in topics associated with the development of the foetus, matter and energy exchange in living organisms and in hereditary of genetic diseases. Their self-efficacy was lower related to cell functions in various human tissues and in redox reactions in everyday life.

Table 3. Perceived self-efficacy towards Biology, Chemistry, Geography and Physics related curriculum content topics.

Content related topics from science subjects	Component loads	Self-efficacy	
		M	*SD*
Biology and Chemistry content related topics			
Hereditary of genetic diseases	.72	2.68	0.72
Hereditary process (replication, transcription, translation)	.71	2.65	0.70
Cell functions in various human tissues	.63	2.53	0.72
Comparing the efficiency of aerobic and anaerobic respiration	.61	2.61	0.77
Matter and energy exchange in living organisms	.60	2.72	0.68
Redox reactions occurring in everyday life	.59	2.22	0.73
Development of the foetus	.52	2.95	0.67
Physics content related topics			
Electricity generator - working principle	.80	2.23	0.80
Energy conversions	.71	2.50	0.72
Sound transmission	.65	2.40	0.72
Perception of weight when being in a lift	.65	2.45	0.82
Newton's laws of motion	.56	2.51	0.75
Nature of phenomena at the particulate level	.52	2.31	0.64
Interactions between bodies	.50	2.64	0.69
Geography content related topics			
Our Solar system, planets and small celestial bodies	.77	2.77	0.71
Climate change and consequences for Estonia	.57	2.91	0.66

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Content related topics from science subjects	Component loads	Self-efficacy	
		M	*SD*
Solar and lunar eclipse	.55	2.75	0.78
Relief deformation and climate change (including lithosphere, biosphere, hydrosphere atmosphere levels)	.51	2.58	0.69
Destroying the rainforest and my own well-being	.46	2.85	0.68

Students' self-efficacy within *Physics content related topics* was higher in topics like the nature of interactions between bodies and in Newton's laws of motion. For other topics (e.g. sound transmission, natural phenomena at the particulate and sub-particulate level, working principle of an electricity generator), perceived self-efficacy was low.

Students' self-efficacy towards *Geography topics wa*s high in all topics. However, even if students had high self efficacy, they didn't always recognise that these topics (especially when focusing on global issues) were highly important from the perspective of everyday life (e.g. Solar system, destroying the rainforest).

Discussion

Self-Efficacy towards Skills

In the literature student self- efficacy is shown to be a good approach to determine students' weaknesses and strengths (references). In fact, it can also give good indicators of student motivation (references). In this research, students' perceived self-efficacy is taken to be a major indicator of student skills and beliefs and seeks to identify this through six components, labelled as - *cognitive skills, planning skills, employability and citizenship, beliefs established through science learning, mindset for scientific research and science learning attributes.*

The component labelled *Cognitive skills* covers students' perception of self-efficacy related to *evaluating information and evidence critically, solving problems (e.g. applying new ideas), explaining phenomena, and understanding relationships between science, society and technology.* Outcomes based on the responses to items within the cognitive skills category show that students tend to indicate lower self-efficacy related to possessing skills to find solution to problems and in making use of scientific evidence. As previous research has shown that problem-solving skills are essential for dealing with scientific challenges and are needed in science-related careers (OECD, 2015; Salonen et al., 2017), this outcome needs to be seen as a matter of concern. Even more, according to the World Econmic Forum (2016), complex problem-solving is seen as a very much needed skill in future careers beyond 2020 and is more important compared with single content related skills. Suggested reasons for the low self-efficacy can be that students perceive they do not possess a clear conceptual understanding about the scientific approach to problem-solving (above and beyond calculating mathematical solutions) and how to arrive at meaningful solutions. This reasoning is in agreement with results obtained from Estonian students on a scientific literacy test (Rannikmäe et al., 2017), indicating that students' actual problem solving skills remains at a low level, even after three years of schooling from grade 10 to 12.

The *Planning skills* component refers to *students' perceived competence to plan one's own activity (e.g. in problem-solving, achieving goals, need for help, strategies, motivation).* Students demonstrate lower self-efficacy in problem-solving (e.g. choosing the appropriate strategy for problem-solving, motivation to solve problems - as indicated in the previous paragraph).

While students' self-efficacy perception is higher when referring to continuing to engage in seeking ways to undertake problem-solving irrespective of whether the plan is meaningful, they have lower perceptions that they can be motivated to put forward suitable methods for seeking solutions. Today's society is faced with multiple scientific challenges having a social impact and perseverance in interacting with such kinds of problem-solving skills needed by a future workforce, as a crucial component of working life skills, as well as good cognitive and planning skills in problem-solving.

The items in *Employability and citizenship* refer to *students' perceptions regarding responsibility towards the environment (e.g. nature and society) and their perceived competence to make justified and responsible decisions when needed.* Results show that, in general, students' perceived self-efficacy is high. However, at the same time, their perceptions about wishing employability in this area are not high and also they don't recognise this as an important work-related field. The dichotomy indicated is taken as problematic, because a good scientific background and understanding about society is needed to face the many challenges in today's world. The results suggest that more emphasis is needed in raising students' science-related career awareness and making them more aware of how science can contribute to solving scientific challenges.

Tytler and Osborne (2012) note that students who have more positive attitudes towards science, are more likely to relate their future career with science-related careers, compared with other fields. This suggests there is a need to more strongly relate core ideas in science teaching to show they can have:

- a meaningful input in dealing with today's scientific challenges;
- indicating needed working life skills in this area, and also
- possible professions within multiple related fields.

Although the initial intention is to aim for one component for the nature of science, student responses indicate a two-component solution: *Beliefs established through science learning* and *Mindset for scientific research*.

The items in *Beliefs established through science learning* refer to *students' perceptions about changes in scientific knowledge, personal opinions and the purposeful use of scientific knowledge.* Students' self-efficacy is low compared with other items in this component in response to item asking the efficiency of scientific knowledge depends on how and for what purpose such knowledge is used. This finding is with the idea that science topics are taught in schools as knowledge (students do not recognise the usefulness of such knowledge in real-life situations) rather than for conceptualisation (why and how this knowledge can be used). It seems that students are gaining abilities rather than capabilities.

Self-efficacy is lowest in the component *Mindset for scientific research*, which refers to *students' perceptions about scientific research, the role of models and creativity within this, and ways to obtain scientific knowledge.* Students seem to believe that they can understand the changeability of scientific knowledge, but their self-efficacy for undertaking scientific research is lower and they seem to believe that scientific models portray nature as it actually exists and, associated with this, that there is a way to get perfect knowledge.

Based on the items in *Science learning attributes*, this component refers to *students' perceptions about science lessons for developing needed working life skills*. Students' self-efficacy, related to problem-solving skills, in response to this component, is again low. However, students' perceptions seem to point out they agree that developing such skills is important. This seems to indicate students feel there is a gap between the skills needed and those they gain from science lessons.

Based on this research, students feel they have a higher self-efficacy in some skill aspects compared with others; it also seems they perceive that some skills are not associated with science education, but are general skills acquired over all aspects of school education, for example, communication and teamwork skills. This indicates that there is a need to re-think the way science content is presented to students (content knowledge, its conceptualisation and the application of this knowledge in multiple situations associated with the appropriate set of working life skills) and to consider more thoroughly how to support students' lifelong learning habits. At the end of grade 12, students don't feel themselves competent in problem solving skills, based on their reported self-efficacy, even though these skills are very much needed in today's society. Emphasising the need for lifelong learning is important for dealing with challenges in society and in future professions (World Econmic Forum, 2016) and seems to be a further area of need within science teaching.

Self-Efficacy towards Content Related Topics from Science Subjects

Self-efficacy related to three foci within science topics is determined, based on components associated with *Biology and Chemistry, Physics and Geography content related topics.* Results indicate that students' perceptions of their self-efficacy towards content related topics differ. Students' self-efficacy is higher for topics with a Geography and Biology/Chemistry focus, compared with topics from Physics. This can be related to studies on students' interest and motivation (Puzziferro, 2008; Ormrod, 2008), which indicate students are more interested in topics in Geography and Biology compared with topics from Physics (Teppo et al., 2017). A possible explanation for students' perceived lower self-efficacy in Physics-related topics is that such topics are seen as more abstract and, as students are not able to perceive the value of such learning, they find it difficult to relate new knowledge with everyday life situations.

Students' actual achievement on a scientific literacy test (Rannikmäe et al., 2017) shows that at the grade 10 level, students give many wrong responses and indicate misconceptions while applying disciplinary related knowledge to problem-solving, or reasoned, decision-making situations. In grade 12, there is a decrease in the

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number of incorrect responses and misconceptions given by students. with more students giving partially correct response, although the number of correct disciplinary responses did not change significantly (only a gain of a few percentage points after three years of schooling). Even more, a similar tendency is also noted for cross-disciplinary responses. Results from the current research related to self-efficacy towards science topics show that students do not feel they are able to give meaningful responses in many science topics.

Many Estonian curriculum topics can be considered to be related with important core ideas in science. By relating core ideas more strongly with working life skills and possible career pathways, students' perceptions towards such topics may change. This is seen as important, because today's society is asked to handle many scientific challenges having a social impact and thus a future workforce needs to be prepared to deal with such issues. For this, they need strong working life skills, which can be promoted through science subjects and made applicable to real-life situations. While results from this research show that student's self-efficacy, related to some skill areas, is high (e.g. critically evaluating the quality of information and applying new ideas in the problem-solving process), at the same time, self-efficacy in other skills is rated much lower (e.g. actually solving scientific problems, using scientific evidence).

To ensure that grade 12 students are being adequately prepared as the future workforce within science-related careers, there is a need for a more coherent teaching approach, compared with that taking place at present. The usefulness of disciplinary core ideas for achieving students' greater awareness of science phenomena and the development of transdisciplinary skills, is associated with learning related to core ideas through different grade levels and in this way can provide students with opportunities to engage more deeply and meaningfully, based on the interrelating of a wider coverage of science content.

Adopting a core idea basis, for introducing students to interrelated science content and scientific challenges over different subject areas and at different grade levels, with the added dimension of science-related careers linked to the acquisition of needed work and-life skills, can be suggested as a meaningful approach to raising science-related career awareness and preparing students for the world of work. This leads to deeper conceptualisation in science learning and promotes students' capabilities (to do something original) rather than abilities (to do something routinely).

A recommendation for further research is related with the idea of investigating how students perceive the same core idea related topics in different science subjects (for example, aspects of energy is covered in all four subject disciplines, but at different times and with different emphases). While results from the current research show that Physics topics are perceived differently compared with other subjects, it is recommended for more deep and meaningful learning, students need to interrelate science content from different subjects and conceptualise how this all relates to the same core idea in science.

Conclusions

This research sought to determine gymnasium students perceived self-efficacy towards selected working life skills and also core ideas related to science content topics within the Estonian curriculum.

Results indicated that, in general, students perceived working life skills as important and hence seen as important to relate to students' learning experiences. Nevertheless, students' perceived self-efficacy was shown to be lower in relation to the important area of problem-solving skills. This was seen as a matter of concern, because many scientific challenges required strong problem-solving skills, plus these were also needed in other careers not perceived as science-related.

Where perceived self-efficacy towards some working life skills was shown to be lower, there was a need to rethink the manner in which science content was presented to students, amplifying the link to everyday life, or the scientific challenges in the real world. In this respect, there was also a need to encompass more about possible science-related careers interrelating this with challenges and the working life skills required. Further research was needed to determine whether such kinds of approaches would be effective.

Students' perceived self-efficacy toward core ideas is approach through seeking comments related to science content topics. The results showed that students felt a lower self-efficacy towards more abstract topics such as those related to Physics, compared with more life-related topics within Geography, or Biology/Chemistry. Overall, students' self-efficacy towards science content topics were positive indicating that these tended to play a motivational role with respect to student engagement in science lessons. That was seen as an important outcome, especially when recognising that science education needed to support students gaining disciplinary core ideas, essential for the world in which they live, rather than seeing science education portray science as informational or simply as a body of knowledge.

Limitations

This research focused only on grade 12 students and therefore it was not possible to describe how students view themselves changing over time. Only a paper and pencil instrument was used for data collection and there was no possibility to clarify students' responses later (e.g. using interviews).

This research used a 4-point Likert scale, which gave a good overview of how students responses were divided between positive and negative side. At the same time, there was no possibility for students to put forward a neutral position.

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