Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 177 (2015) 491 – 495

Procedia
Social and Behavioral Sciences

Global Conference on Contemporary Issues in Education, GLOBE-EDU 2014, 12-14 July 2014, Las Vegas, USA

Students' Self-Efficacy and Values Based on A 21st Century Vision of Scientific Literacy – A Pilot Study

Kerti Ait[a]*, Miia Rannikmäe[c], Regina Soobard[c], Priit Reiska[b], Jack Holbrook[d]

[a] *Ph.D. student, University of Tartu, , Vanemuise 46-226, Tartu 51014 , Estonia*
[b] *Institute of Mathematics and Natural Sciences, Tallinn University, Narva Rd 25, Tallinn 10120, Estonia*
[c] *Centre for Science Education, University of Tartu, Vanemuise 46-226, Tartu 51014 , Estonia*
[d] *Science Education Centre, University of Tartu, Vanemuise St. 46-226, Tartu 51014, Estonia.*

Abstract

The world in the 21st century in which we live is much different than that which has been experienced in the last century. A huge shift has been the replacing of "manpower" with modern digital technology both in the world of work and in our every-day life. In turn this has led to a shift in the skills, attributes and even values needed with which no machine is able to compete, for example, attention to communication and collaboration skills. Today, the goals of education need to respect this shift in student needs and ensure students gain the skills needed for success in both a global market and an urban society. This pilot study is geared towards determining students' self-efficacy in 21st century skills and values associated with a modern conception of scientific literacy and also explores the degree to which students recognize the importance of these skills and values, so as to be successful in their future lives.

Peer-review under responsibility of the Scientific Committee of GLOBE-EDU 2014.

Keywords: scientific literacy, self-efficacy, 21st century skills.

1. Literature overview

There is a profound gap between the knowledge and skills most students learn in school and the knowledge and skills they need in typical 21st century communities and workplaces. (Partnership for 21st century skills). As we move from a context that focuses on the individual and the local society to a more global context, the science

* Kerti Ait. Tel.:+4-5432-3445.
E-mail address: kerta@ut.ee, miia.rannimae@ut.ee.

Peer-review under responsibility of the Scientific Committee of GLOBE-EDU 2014.
doi:10.1016/j.sbspro.2015.02.403

education community needs to rethink student needs for the 21st century (Choi, Lee, Shin, Kim & Krajcik, 2011). New standards related to expected student capabilities need to replace the basic skills and knowledge expectations of the past, not only in the US (NGSS, 2013) but also worldwide. To meet this challenge, six major criteria have been identified related to scientific literacy needs:

(a) schools need to transform in ways that will enable students to acquire the sophisticated thinking, flexible problem solving, and collaboration and communication skills needed to be successful in work and everyday life (Binkley, Erstad, Herman, Raizen, Ripley, Miller-Ricci, Rumble, 2012); (b) through science education, students need to develop an understanding of big ideas about objects, phenomena, materials and relationships in the natural world (Harlen, Bell, Devés, Dyasi, Guillermo, Pierre, Millar, Reiss, Rowell & Wei, 2010); (c) individuals need to be nurtured who are able to appreciate diversity of values and culture sensitivities surrounding issues, to have compassion for others, collaboratively construct values for the larger welfare, and ultimately take action (Choi, et al., 2011); (d) an increasing urgency needs to be recognized for skills such as analyzing the credibility and utility of information, evaluating its appropriateness and intelligently applying it (Griffin, McGaw, 2012); (e) skills are needed to infer meaning from science texts which relates to the ability to recognize the standard genres of science, their appropriate use, and, in the case of argument, to evaluate the claims and evidence advanced (Simon, Erduran & Osborne, 2006); (f) metacognitive knowledge is also an important need for science learning which is related to positive attitudes and knowledge gains (Schraw, Olafson, Weibel & Sewing, 2012); even more, metacognition is needed to enable students to realize, reflect upon, and perhaps ultimately revise the underlying causal structures that they assign to particular concepts (Grotzer, Mittlefehldt, 2012). This can be expected to encourage deeper understanding in science and a greater likelihood in being able to deal with the complexities in life (ibid).

Achieving these conceptions of scientific literacy can be influenced by various attributes. This research explores one factor, that is, student self-efficacy. Bandura (1997) defines self-efficacy as a personal measure of one's own capabilities to perform a task and reach a desired goal. Pajares (1996) even states that self-efficacy beliefs are important influences on motivation and behavior, in part because they mediate the relationship between knowledge and action. As such, these beliefs are strong predictors of individuals' subsequent performance (ibid). For this reason, self-efficacy is utilized as a suitable way to determine students' perceptions of their capabilities and explore whether they comprehend the importance of skills and knowledge to be valued in the 21st century.

2. Research goal

The current study seeks to determine how students, themselves, evaluate their knowledge, skills and values, appropriate for the 21st century and the perceived importance of these so as to be successful in future careers, or everyday life.

3. Research questions

1. What self-efficacies do students' possess related to different components of a proposed model of scientific literacy?

2. To what degree do students value the importance of the different components of the model so as to be successful in their future careers?

3. How much, in students´ opinions, do science lessons develop such knowledge, skills and values and how much do they feel these knowledge, skills and values should be developed further, compared to their current situation?

4. Research design

The research instrument used was a questionnaire, validated by using expert opinions, which was designed to measure students' self-efficacy related to recent scientific literacy models and ideas (Choi, et al., 2011; Griffin, et al, 2012; Harlen, et al., 2010). The questionnaire components, also taking into account requirements of the national curriculum, were: Skills (inquiry skills, creative thinking skills, communication and collaboration skills and

information management skills); content knowledge (big ideas encompassing a wide, general understanding about science phenomena in the natural world. For example, "The composition of the Earth, its atmosphere and the processes occurring within them which shape the Earth's surface and its climate (Harlen, et al., 2010). Also included are real life, socio-scientific situations. For example, "impact of climate change caused by melting glaciers"); metacognition (degree to which students control their thinking and acting when they solve problems. For example, do they actually plan their work before problem solving? Do they control their action and thinking during the problem solving? And do they analyze the effectiveness of their work after problem solving?); characteristics of scientific knowledge (comprehension about characteristics of scientific knowledge. For example, do they agree, that scientific knowledge is tentative and subjective?); values (this covers the students' whole value system about the world in which they live. For example, do they try to understand the reasons for other peoples' actions, instead of simply judging them?).

Items were constructed as statements about each component in the scientific literacy model. For each statement, students were asked to decide; the level to which they disagree or agree with the statement, based on a 6-point Likert scale (1- I totally disagree……6- I totally agree).

This initial pilot study was carried out with a convenient sample of 294 12th grade students, studying in eight different schools.

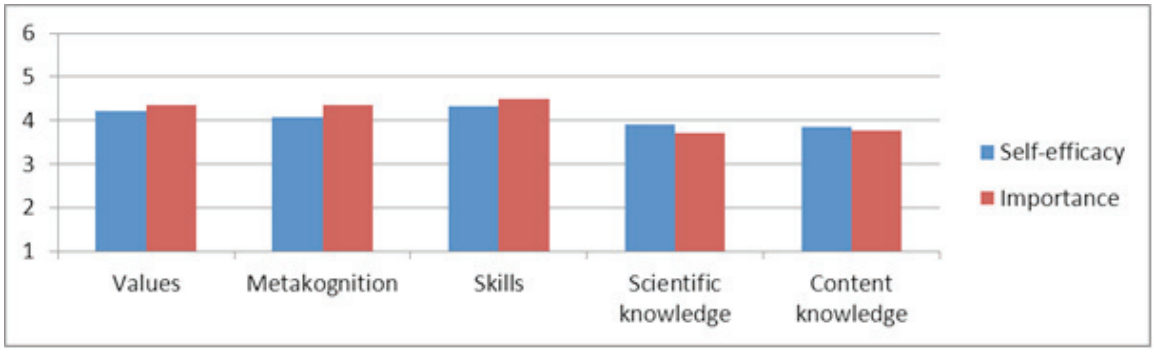
5. Results and discussion

Students' self- efficacy about their different knowledge, skills and values were higher than the mean value in all components. The highest mean value (mean= 4,3) was given to the value component, which indicated students did value, respect and feel compassion about life around them and to act like responsible and self-aware citizens. Their self-efficacy mean value was lowest in understanding characteristics of scientific knowledge (mean= 3,9) and in content knowledge (mean= 3,8). Also, there was no statistically significant differences between the mean values of these two components.

Within the skills component, evaluated highly (highest next to the values component) showed that students feel more confident and they also value more communication and collaboration skills but less so, problem solving and inquiry skills. But unfortunately, data suggested that students with good communication and collaboration skills doesn´t solve problems more effectively than other students. Also it seemed that the ability to argue on scientific topics and the ability to work collaboratively to solve problems is something which still must develop in school lessons.

Figure 1 indicates that students value almost all scientific literacy components more related to their future life, than the actual capabilities they exhibit about these components.

Figure 1. Mean values indicating students´ self-efficacy and importance for their life in the 5 components related to a scientific literacy model.



Within the content knowledge component, students indicated their knowledge was greater where it related to everyday life and also where it was more important for their future life, than the general big ideas. A possible reason why students felt less confident in a wide, generalized comprehension of science and valued this knowledge less, was seen as being because they could not see the relationships between the need for wider understanding and the link to everyday life. This could be taken as a sign that, in the school situation, there was a need to facilitate this wide understanding through everyday life contexts. This was in line with the views expressed by Harlen (2010) "through science education, students should develop understanding of big ideas about objects, phenomena, materials and relationships in the natural world."

The scientific knowledge component was the only component where students evaluated their current understanding statistically significantly higher than the importance of having this knowledge for their future life. At the same time, students evaluated the school's contribution the highest in just that component. The reason for this controversial result might be that their science learning is limited, because school lessons insufficiently promoted scientific knowledge via inquiry learning and had not explored how and why such knowledge might be useful for future careers. This supposition was supported by the absence of a statistically significant correlation between characteristics of scientific knowledge and the ability to use scientific methods (a part of the skills component).

Students evaluated the school's contribution much lower than expected (mean= 3,6) in the metacognition component (described in the instrument part). They also thought that the school developed metacognitive skills less than it should. These results could be a sign that metacognition skills, which have not yet been emphasized in scientific literacy, tended to be still important for students to be successful in the future (including planning skills). In analyzing the metacognition component more deeply, it was found that, where students had high self-efficacy such as in monitoring and evaluation their own action and thinking, these correlated with the ability to reach to the desired goal of solving problems and had more impact on raising self-motivation to face challenges. Noting that metacognitive skills in science learning have been shown to be related to positive attitudes and higher knowledge (Schraw, Olafson, Weibel & Sewing, 2012; Grotzer, Mittlefehldt, 2012)," the findings from this study could be taken as a sign that teachers needed to pay more attention to developing metacognitive skills.

6. Conclusion

Students' self- efficacy about 21st century skills were higher than the mean value in all components. Their self-efficacy was most high in valuing science for life globally and was lowest in understanding characteristics of scientific knowledge and content knowledge. We also found out that student´s did value almost all skills of 21st century skills more than they admitted to having actual capabilities. An exception to this was understanding the characteristics of scientific knowledge. Students also thought that school lessons had developed most characteristics of scientific knowledge but less so metacognitive skills while, in students´ opinions, school lessons needed to develop almost all the 21st century skills more than teachers had undertaken so far, except for the understanding of characteristics of scientific knowledge.

References

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. *Englewood Cliffs*, NJ: Prentice-Hall.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., Rumble, M., (2012). Defining Twenty-First Century Skills. In B. McGaw & E. Care (Eds), *Assessment and Teaching of 21st Century Skills* (pp 17-.66). New York, NY: Springer.

Choi, K., Lee, H., Shin, N., Kim, S. & Krajcik J, 2011. Re-Conceptualization of Scientific Literacy in South Korea for the 21st Century, *Journal of Research in Science Teaching, 48*(6) 6, 670–697.

Griffin, P., McGaw, P. & Care, E., (2012). Assessment and Teaching of 21st Century Skills. New York, NY: Springer. Harlen, W., Bell, D., Devés, R., Dyasi, H., Guillermo, F. de la Garza, Pierre, L., Millar, R., Reiss, M., Rowell, P. & Wei, Y, (2010). Principles and big ideas of science education. *Association for Science Education.*

Grotzer, T., Mittlefehldt, S., (2012).The Role of Metacognition in Students´ Understanding and Transfer of Explanatory Structures in Science. In A. Zohar & Y. J. Dori (Eds.), Metacognition in science education; *Trends in current research* (pp.79-100). New York, NY: Springer.

National Research Council. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. American Educational Research Association (SanFrancisco, CA, April 18-22, 1995).

Partnership for 21st century skills. “Framework for 21st Century Learning“ Retrieved from: http://www.p21.org/our-work/p21-framework.

Schraw, G., Olafson, L., Weibel, M. & Sewing, D., (2012). Metacognitive knowledge and field- based science learning in an outdoor environmental education program. In A. Zohar & Y. J. Dori (Eds.), Metacognition in science education; *Trends in current research* (pp. 57-78). New York, NY: Springer.

Simon, S., Erduran, E & Osborne, J., (2006). Learning to Teach Argumentation: Research and development in the science classroom, *International Journal of Science Education, 28*:2-3, 235-260.