Upper Secondary School Students' Imagination and Future Thinking on Quantum Computing and Global Warming

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Abstract. Due to global crises, rapid technological development and social liquidity, youth may perceive the future no longer as a promise but as a threat, and have difficulty projecting themselves into the future. Science education needs to find ways to address the uncertainty of the future. We examined upper secondary school students' imagination regarding two societally relevant scientific fields: quantum computing and global warming. Qualitative content analysis of students' essays and interviews revealed pessimistic views and little sense of agency. During a teaching-learning module informed by futures studies and action competence pedagogy, however, the students learned new ways to imagine futures.

1 Introduction

The post-modern era is characterised by global crises, societal uncertainty and rapidly advancing technologies. In such a context, the young generation struggles to project themselves into the future and develop scope as active persons, citizens and professionals. Whereas for past generations science and technology were seen as opportunities for addressing challenges, now students may perceive them as sources themselves of fears and global problems [1].

Although the interdisciplinary field of *futures studies* has been investigating imagination and future thinking from a wide perspective [2], the inclusion of such perspectives within school science curricula is rather rare (for an exception, see [3]). The notion of *agency* as a goal of education presents another pedagogical response to the complex challenges of the future, emphasising the ability to take enlightened decisions and actions as individuals and communities [4]. These approaches may help students to overcome their fears of the future and instead define their roles and ways forward through socio-scientific issues [5].

Science education needs to find ways to address the uncertainty of the future, catalyzed by the so-called *wicked problems* and rapidly evolving technologies with great expectations as well as risks. The purpose of the research presented here is to inform science educators about what students think about the future, and find ways to support students to create and develop preferable futures. In this presentation we examine students' imagination and future thinking on two of such future-relevant scientific fields: quantum computing and global warming.

2 Context and Methods

Our EU project "I SEE" (https://iseeproject.eu) addresses the above-mentioned concerns by employing future studies and action competence pedagogies in upper secondary school STEM

education. Within the project we design innovative approaches and teaching modules on cross-cutting and societally relevant fields. The topic of the first "I SEE" module was climate change. The module was implemented in June 2017 in Bologna, Italy, with a culturally diverse group of 24 Finnish, Icelandic and Italian upper secondary school students and their teachers. The module on quantum computing is implemented in spring 2018 in Helsinki, Finland, with a group of 25 Finnish upper secondary school students.

As a pre-assignment, the students participating in these modules wrote essays about their view of the future. After participating in the 5-day module, the students were interviewed both individually and in groups on how their future thinking has developed during the module.

A qualitative content analysis of the students essays and interview transcripts was carried out. The inductive method of qualitative analysis (Mayring, 2001) was employed to categorise the themes emerging from the interview data, i.e. to characterise students' future thinking concerning the fields in question and the changes in that thinking.

3 Results and Conclusion

Preliminary analysis of the essays confirmed the trends pointed out by the literature [1, 3] and showed a tendency to look to the future with pessimism and little possibilities to influence, mainly citing a sense of negativity conveyed by the media. In the interviews, the students expressed a change in their future thinking which was more positive. The students said they became more confident in themselves and in their ability to manage difficult situations, acquired a sense of security in the sense of widening their perspectives and developing new ways of thinking, and saw the future within their reach and found ways to see themselves as agents and actors of their own future.

The modules also widened some students' imagination about science-related careers. They said they learned to see professions that they had never imagined before and, in this sense, they saw the possibility to create their own job in the future – not necessarily a conventional or existing one.

According to the preliminary analysis, many students abandoned their fear-inducing deterministic future views about climate change and quantum computers, and started to talk about *future scenarios*, referring to a variety of possible, probable, plausible and desirable futures.

We conclude the presentation by discussing the role of science education for preparing learners for the uncertain futures, and the applicability of the "I SEE" approach to that end.

References

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