Quantum Technology as Occupational Field: Twofold Practice in Physics Teacher Preparation

Gesche POSPIECH, Moritz FÖRSTER, Julia UNGER

TU Dresden, Department of Physics, Haeckelstraße 3, D-01069 Dresden, Germany

Abstract. As a high demand for specialists in the field of quantum technologies is expected, interest in this area should be encouraged at school. Teachers play a central role in this: they should be empowered to design lessons that introduce pupils to this topic and provide insight into corresponding professional contexts. To this end, a university course has been designed integrating theoretical basics, personal experiences through a didactic industrial internship in quantum technology companies and designing corresponding own lessons. By semi-structured interviews, we investigate the course's influence on prospective teachers' attitudes and knowledge. We present the analysis of the interview data.

Introduction

Quantum technologies have gained massive importance in recent years and are projected to continue growing in significance. Consequently, there is an anticipated increase in demand for specifically trained workers in this industry. It will therefore be necessary to attract specialists in the long term, which could be accomplished by showcasing career prospects to interested students already in school. Hence, it is crucial for teachers to be able to integrate career-oriented contexts in their lessons, as teachers wield significant influence over the future career paths of their students [1]. One problem is that prospective teachers as well as in-service teachers often lack awareness of the professional world beyond school and university, particularly in emerging fields such as quantum technologies, and herewith especially quantum computing. Hence a university course was developed to provide prospective teachers with insights into quantum technologies from both a professional and educational standpoint, as well as to equip them with the skills for planning and conducting context-oriented teaching using professional tasks in quantum technology companies as context.

Course Design and Research Questions

The developed course consists of three parts. The first, theoretical, part is a lecture on quantum technologies and quantum information, covering topics such as quantum key distribution and quantum computation, as well as basics of context-oriented teaching. In the practical part, prospective teachers do an internship in a quantum technology company or research institute, accompanying engineers and researchers in their daily work to analyse the scientific and quantum knowledge required for their tasks. The students can select their internship among five research institutes and companies. After completing this internship and based on their explorations, in a transfer phase students design a (physics) lesson for upper-level secondary school related to their findings and providing the high school students with insights into occupational areas in quantum technology.

The main goal of the research focusses on the effectiveness of the course and its influence on prospective teachers' attitudes, perception and knowledge, concerning quantum technology and the implementation of corresponding career-oriented teaching units at upper-level secondary schools. In detail the following questions should be answered:

1. How does the course in general and the internship in special affect prospective teachers' attitudes, perception and knowledge about quantum technologies?

2. To what extent can career-oriented teaching units on quantum technologies and quantum information successfully be implemented in the classroom?

Methods and Findings

The course underwent three cycles of design-enactment-analysis-redesign, following a design-based research approach. This approach is suitable, because we want to evaluate the course and in parallel present practical solutions as well as develop theoretical insights [2]. In this setting an explorative research design is adequate. Therefore the course was evaluated through an explorative interview study, which allows to gain insights into prospective teachers' attitudes towards learning and teaching about quantum technologies in the context of the professional field. We also describe the development of the students' attitudes during the course.

To this aim we conduct semi-structured interviews with pairs of students, as they complete the internship in pairs. With each pair of students two interviews are conducted to evaluate both, the lecture and the internship.

Up to now, the course was conducted twice, with a total of ten students participating. Thus, $N=5$ interviews were conducted after the lecture and $N=6$ interviews were conducted after the internship. The interviews were transcribed and the data were analysed by a structuring qualitative content analysis [3]. After the first design-redesign-cycle there will be another cycle during the summer-term in 2024.

Our findings indicate that prospective teachers initially have limited knowledge of how companies and research institutes operate in the field of quantum technologies and quantum information before the internship. As a result, students express concerns about being adequately prepared for the internship. Furthermore, they express concerns about planning career-oriented lessons in secondary school mainly for two reasons. Firstly, finding ideas for such lessons based on the internship is difficult and secondly an adequate reduction of the contents for upper-level secondary school is also considered complicated.

Despite this, our research shows that prospective teachers find quantum technologies and quantum information fascinating and engaging.

Conclusion and Outlook

In order to improve teachers' abilities for conducting context-oriented teaching with occupational fields in quantum technologies as context, it is necessary to provide workshops for professional development in addition to university courses. Such workshops will be conceived in the future. Also, there is the necessity of investigating the influence of such context-orientated lessons on upper-level secondary school students which should be part of future research.

References

[1] S. Lein, *Das Betriebspraktikum in der Lehrerbildung. Eine Untersuchung zur Förderung der Wissenschafts- und Technikbildung im allgemeinbildenden Unterricht*, Berlin: Logos Verlag Berlin GmbH, 2014.

[2] C. Haagen-Schützenhöfer, M. Obczovsky, P. Kislinger, P. (2024). Design-based research–Tension between practical relevance and knowledge generation–What can we learn from projects?, *Eurasia Journal of Mathematics, Science and Technology Education* **20(**1) (2024) em2378.

[3] U. Kuckartz and S. Rädiker, *Qualitative content analysis: Methods, practice and software* (2nd edition). SAGE, 2023.