Contributions from Pilot Projects in Quantum Technology Education as Support Action to Quantum Flagship

Community-based development of the Quantum Concept Inventory

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Abstract. For the improvement of quantum physics education at the secondary level, it is important to develop a flexible assessment tool, which is suitable for evaluating the numerous existing teaching concepts that have emerged from physics education research over the last decades. We therefore give an overview of the plans of the QTEdu pilot project 'Community-based development of the Quantum Concept Inventory' to create such an assessment tool. Additionally, we will present the results of a Delphi study aiming to identify the community's perspective on key topics for teaching quantum physics at the secondary school level.

Introduction

In the last years, teaching proposals for quantum physics have been developed in order to make quantum physics (QP) accessible at the secondary school level, and to promote conceptual understanding of quantum physics among learners. Quantum physics can be taught in different contexts (e.g., historical approach, experiment-based approach, two-state approach) and by using different key topics [1]. This makes the evaluation and comparison of the different developed approaches difficult. In order to be able to evaluate the developed teaching proposals, it is important to have instruments available which can be used to assess students' conceptual understanding within the framework of the individual teaching proposal. Since there is no such an instrument available at present, the authors of this paper have started the QTEdu pilot project *"Community-based development of the Quantum Concept Inventory (QCI)"*. In this project a modular concept inventory will be developed based on community input which allows for the assessment of students' understanding of quantum physics' key concepts within different contexts and for different key topics. Thus, we aim to create a concept inventory that is found useful for evaluating the numerous teaching concepts despite their different emphasis.

Project objectives

To create a concept inventory that is based on the communities' perspectives and that is applicable for different contexts and key topics, in this project we aim to:

1. Identify quantum physics' key concepts to be taught to secondary school students from a community perspective,
2. collect existing test instruments (published or unpublished) from the literature and from our research groups to create a platform of existing test items on the central concepts of quantum physics,
3. create additional test items in various task formats (e.g., multiple choice, likert scale items, open-ended questions, concept cartoons), and
4. evaluate the existing and additional test items qualitatively (e.g. think-aloud interviews) and quantitatively in a later stage of the project.

At present, the project members have collected existing test instruments, and distributed a Delphi study to identify the key concepts. This procedure ensures content validity of our instrument in an early stage of its development.

Results of the Delphi study

A Delphi study was conducted in order to identify key concepts that represents a community-based view. In the first round of this Delphi study, physicists, physics teachers, and physics education researchers where asked why secondary school students should learn quantum physics and what topics should be addressed in classroom teaching. Currently, a second questionnaire is distributed, in which the QP community is asked to select which of these topics (including various specifications considering QTEdu's Competence Framework [2]) should be part of the secondary school curriculum.

Outlook

Based on the results of the Delphi study, the QP topics that should be addressed by the QCI will be determined, and the relation between profession, country, and proposed topics will be analysed. Subsequently, we will create a database of existing test items referring to the identified key concepts, and new test items will be developed. This will form the basis for a flexible and community-based QCI.

References

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