Concept Learning in Electricity Enhanced by Virtual Reality

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Abstract. Virtual Reality (VR) is a promising technology for enhancing concept learning in physics. A learning tool for VR about electric potentials and electric fields represented with vectors has been developed and tested on 26 high school students. Using pre- and posttests, we evaluated how students progressed on different types of items.

Introduction

Many studies (Maloney et al., 2000; Saarelainen et al., 2006; Sayre & Heckler, 2009) have shown that students have problems in understanding basic concepts in physics. A major challenge concerns understanding abstract external representations and relating them to the physical phenomena. The concept of *fields* is central to understanding electricity. Making fields visible by use of VR can support the understanding of such abstract concepts (Squire et al., 2004; Olympiou, Zacharias & de Jong, 2013; Grivokostopoulou et al., 2017).

Theoretical framework, research and research questions, original aspects

The overriding goal of this study is to make a contribution to the question how VR can be used in physics education to support the understanding of physics concepts. Electric fields were considered a suitable topic for the study because they are invisible without VR and quantities that are distributed in space. We want to investigate whether students make progress in understanding the concepts of representing electric fields with vectors after using VR.

Methods and findings

For this purpose, a learning tool was developed for Microsoft HoloLens. It is about assigning the correct vector field to a landscape of a potential. A pretest and a posttest with different problems are used to check the students' understanding and learning progress. A first study with 26 students has been conducted at the Gymnasium Kirchenfeld. To evaluate the results, we calculated the average normalized gain factor $\langle g \rangle$ from (Hake, 1998):

$$\langle g \rangle = \frac{\%\langle \text{post} \rangle - \%\langle \text{pre} \rangle}{100 - \%\langle \text{pre} \rangle} \qquad (1)$$

The results show that students make progress in solving physics problems that are similar to those used in the learning tool ($\langle g \rangle$ = 74%). However, they have problems transferring the knowledge about vector fields and potentials to the context of electric fields of charges.

Conclusion

The results show that students make substantial progress when using the learning tool. However, future studies need to evaluate whether using VR is indeed more beneficial than playing the same tool on a computer or paper-pencil base. Furthermore, strategies how to facilitate transfer to the contexts of electric potentials and electric fields have to be elaborated.

References (Vancouver numeration and APA Style)

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