Comparing Augmented-Reality-Technologies in a Learning Scenario on Electrics for Primary Education (unreviewed)

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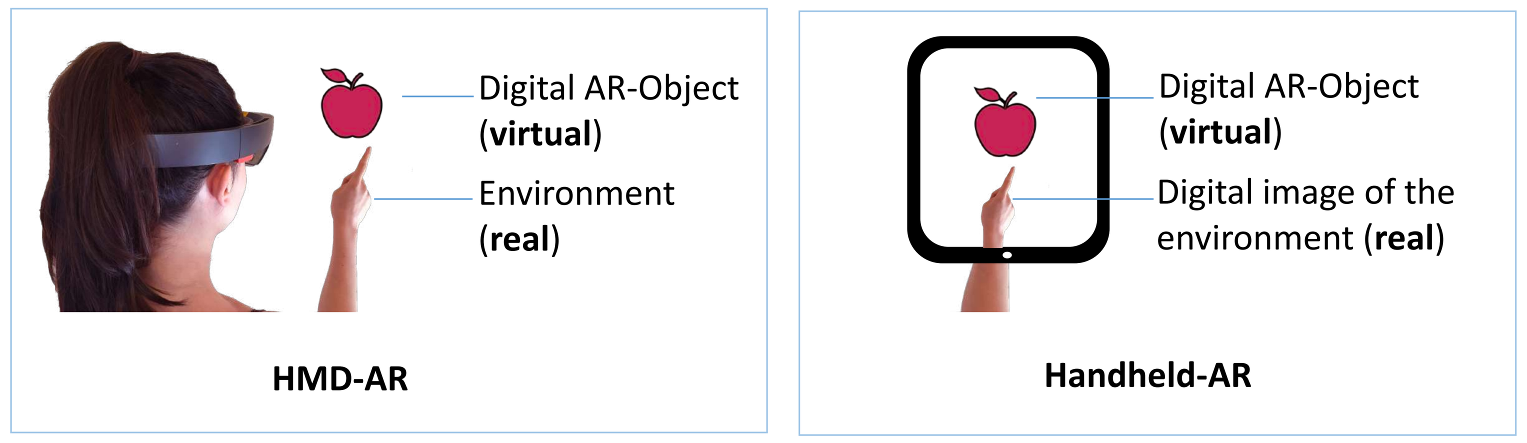
Introduction

We present a study aimed at examining the effects of different Augmented-Reality-technologies on primary students' learning in the field of electrics.
In an experimental design with four groups, children of 8-10 years are given different AR-technologies when learning about circuit schematics. Their learning gains, as well as perceived motivation, cognitive load and system usability are compared. The results of the study will serve as anchorpoints regarding challenges and opportunities of the use of Augmented Reality in introductory science education in primary school.

Theoretical Background

Augmented Reality (AR) allows for an adaptive real-time integration of real and digital objects. The digital objects can be experienced with either specific head mounted display devices (HMD) or with the cameraview of handheld devices such as smartphones or tablets. As shown in the figure below, the spectator is presented with either a combination of real objects and digital objects in the case of HMD-AR, or with a combination of digitally replicated images of real objects (thus presenting an iconic representation of the actual object) and digital objects in the case of handheld-AR.



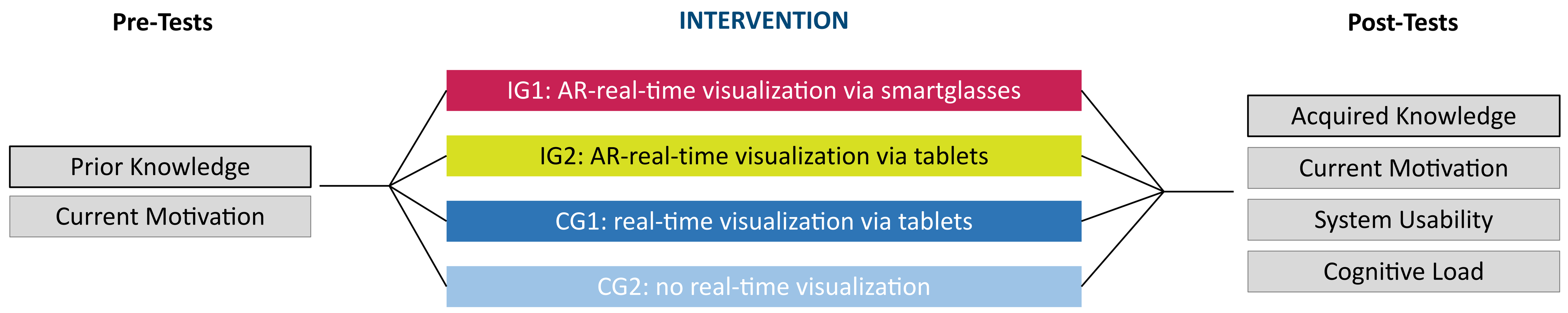
Existing research on learning with AR indicates that learning can benefit from the use of AR, especially when learning science releated topics. Drawing on research activities regarding learning with AR in (mostly) secondary science education, we aim to investigate learning with AR in primary science education as there seems to be a major research desideratum for this area. The field of electrics was chosen for this study as there are already results on learning with AR on electrics for secondary education. Our goeal is to compare the two AR-technologies (HMD-AR and handheld-AR) in terms of their benefits and challanges for supporting learning in primary science education.

The different AR-technologies do not only vary in technological aspects (i.e. presenting different forms of representations to the spectator regarding the real environment) and thus may affect learning in different ways as described above, but may also affect the motivation, usability and cognitive load of the spectator in different ways. Therefore, we include these factors into our study design in order to gain further insight on the factors that are (or are not) responsible for any differences in the results.

Method: Study Design and Procedure

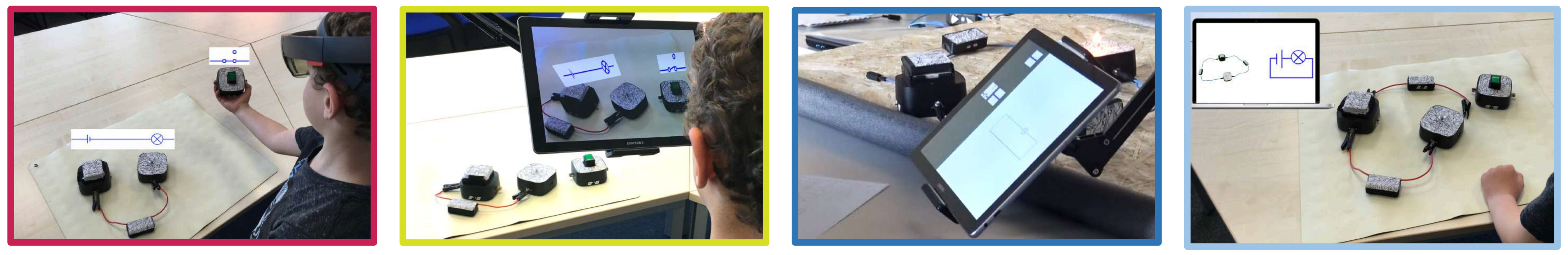
In an experimental design with four different modifications of the intervention, children between 8 and 10 years undergo a learning scenario on eletric circuit schematics. During the intervention, they are given support by either AR-real-time-visualization of circuit schematics via smartglasses (IG1) or tablets (IG2), or they are supported by non-AR-real-time-visualization of circuit schematics (CG1) or no real-time-visualization (CG2).

The figure on the right provides an overview of the study procedure: The children are randomly distributed to one of the four intervention conditions. Before the intervention, their prior knowledge on circuit building and circuit schematic drawing, as well as their current motivation are captured. After the intervention, their acquired knowledge on drawing circuit schematics and building circuits from given schematics is evaluated by the use of a specially designed paper-pencil-test. Further, the current perceived motvation, cognitive load and system usability for the respective condition are evaluated with a questionnaire.



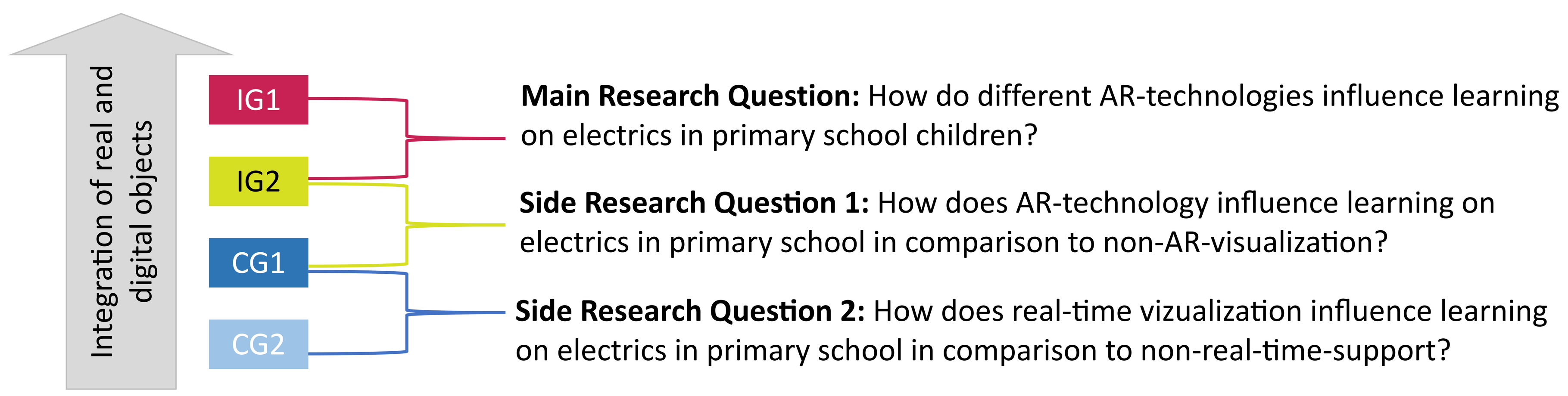
The pictures on the right show the technical realization of each of the four conditions of the intervention (f. l. t. r.):

- IG1: real-time visualized circuit schematics via head mounted AR-smartglasses on top of the real objects
- IG2: real-time visualized circuit schematics in the AR-camera view of a tablet on top of the real objects
- CG1: real-time visualized circuit schematics on a tablet separately from the real objects
- CG2: no real-time visualization of circuit schematics, but an introduction with premade information sheets is given



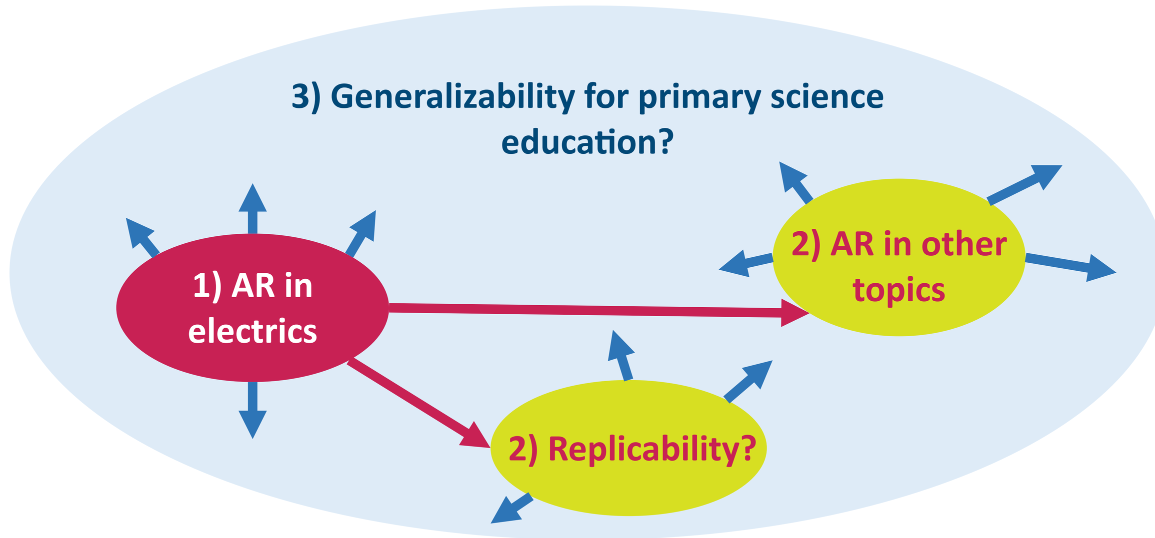
Data Analysis

The different conditions vary in the degree of integration of real and digital objects (from most integration in IG1 to least integration in CG2). The influence of the different conditions on the participants' learning gains will be analyzed by the use of a covariance-analysis, where perceived motivation, system usability and cognitive load serve as covariates. The results will be the basis to answer either the main research question or the side research questions (see figure below) that are required to isolate the effect of the AR-technology.



Outlook

The goal for the following studies is to first investigate the replicability of the results for other fields of primary scjience education and to then conduct generalizable results for learning with AR im primary science education.



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