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DIDAKTIK DES SACHUNTERRICHTS

GeAR

UNIVERSITÄT DES SAARLANDES

Comparing Augmented Reality Technologies in a Learing Scenario on Electrics for Primary Education

Summary We present a planned study aimed at examining the effects of 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 and perceived motivation are compared. The results of the study will serve as anchorpoints regarding challenges and opportunities of the use of AR in introductory science education in primary school.

Theoretical Background

Augmented Reality (AR): Expansion of perception through digital content

→ **Characteristic: Spatial and semantic real-time linkage between real and virtual objects**

Affordances of AR

- Exploration of the environment for spatially and semantically linked virutal content
- Real-time interaction with virtual objects

AR in education…

- can promote the acquisition of knowledge and skills
- can positively influence motivation and interest
- can present technical difficulties

AR technologies

Handheld display devices

Integration of virutal objects into the digital image of the real environment

- Everyday devices (smartphones, tablets)
- Most used AR technology in education

Head-mounted display devices

Integration of virutal objects directly into the real environment

- Mostly unknown (especially to young children)
- Little used AR technology in education

Research comparing AR technologies in secondary or higher (science) education suggests that the technologies can differ in their impact on learning (outcome) and motivation due to variations in (perceived) usability and cognitive load

Aim of the study: Comparison of AR technologies in primary education regarding their effect on learning gain and motivation
(on the example of a scenario on electrics in primary science studies)

Preparatory Work

1) **Pre-Study:** Assessment of primary students' difficulties in learning electrical circuit symbolics

Learning difficulties

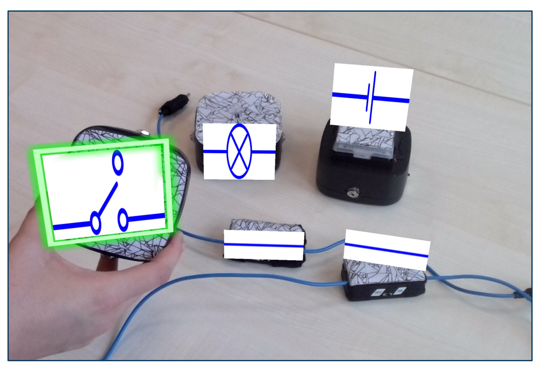
- Matching physical components with the corresponding symbol
- Handling the discrepancy between the spatial arrangement of the components and the simplified structure of the circuit schematic
- Distinguishing different types of circuits

Technical requirements for the AR

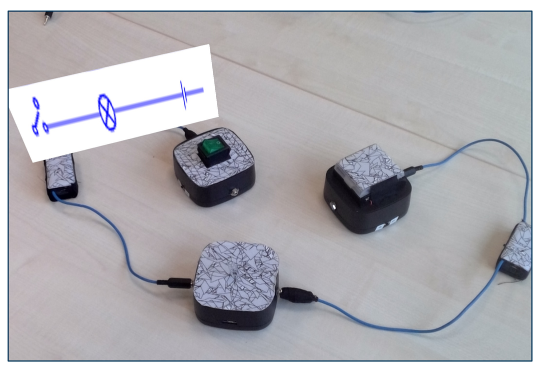
- Real-time component detection and symbol display / highlighting
- Real-time circuit detection and schematic visualization
- Real-time detection of circuit type and schematic adaption

2) **Prototype development** and stress tests with primary school children

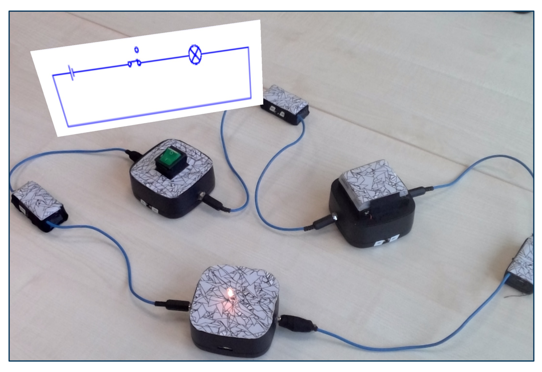
3) **Prototype refinement** concerning hard- and software



AR symbolics of single components, touch-highlighting



AR schematic of an incomplete circuit



AR schematic of a complete circuit

4) **Learning scenario conceptualization**, testing with primary school children and refinement

5) **Adaption of test instruments** for primary school children

Method: Design and Data Analysis

Design

- Experimental design with four modifications of the intervention
- Children of 8–10 years are randomly assigned to one of the interventions and are guided through the scenario individually
- During the intervention, the children learn about electrical circuit symbolics with the help of the respective form of (AR-) support
- Independent variables: Knowledge gain (IV 1 post – IV 1 pre) and motivational change (IV 2 post – IV 2 pre) , usability and cognitive load serve as covariates

Data analysis

- Knowledge gain and motivational change are examined in general linar models with repeated measures with usability and cognitive load as covariates (ANCOVAs)
- As the four intervention modes vary in the degree of integration of real and virtual objects, pairwise comparisons between the intervention modes are used to further differentiate the influence of the AR itself from the influence of the real-time visualization of symbolics in general

Pre-test variables

Variable	
Prior Knowledge	(IV 1 pre)
Current Motivation	(IV 2 pre)

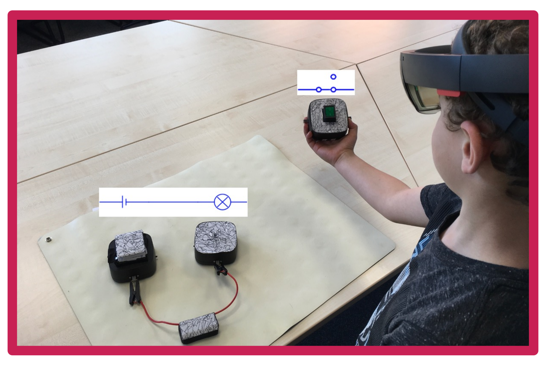
INTERVENTION
Guided learning scenario on electrical circuit symbolics

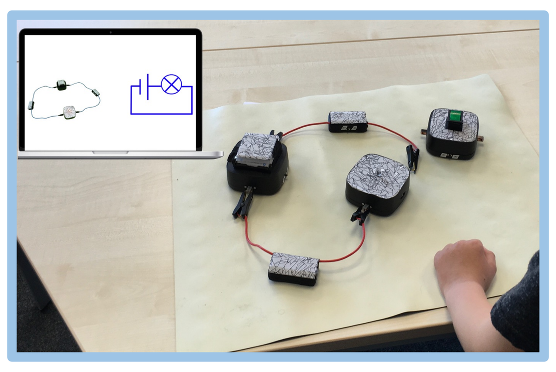
- IG1: AR-real-time visualization via smartglasses
- IG2: AR-real-time visualization via tablets
- CG1: real-time visualization via tablets
- CG2: no real-time visualization

Integration of real and virtual objects

Post-test variables

Variable	
Acquired Knowledge	(IV 1 post)
Current Motivation	(IV 2 post)
System Usability	(CV 1a)
Pedagogical Usability	(CV 1b)
Cognitive Load	(CV 2)





The conditions differ in the AR technologies used for real-time display of circuit symbolics. Pairwise comparison will answer the research question "How do different AR technologies influence learning on electrical circuit symbolics?"

The conditions differ in the presented real-time display of circuit symbolics. Pairwise comparison will thus answer the research question "How does AR technology influence the learning on electrical circuit symbolics in comparison to non-AR visualization?"

The conditions differ in the introduction of the electrical circuit symbolics. Pairwise comparison will thus answer the research question "How does real-time display influence the learning on electrical circuit symbolics in comparison to non-realtime visual support?"

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References and Acknowledgements

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We specially thank Prof. Dr. Paul Lukowicz and his research group from DFKI Klaiserslautern for developing and optimizing the hard- and software of the presented AR system.