Affordances and Limitations of Head-Mounted Augmented Reality Devices for Primary School Children – Technical Usability Assessment of the Microsoft HoloLens 2

Presentation Handout

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Augmented Reality (AR) in Education

Augmented Reality: Expansion of perception through digital content (Azuma, 2001)

- **Affordances of AR**
  - Exploring the environment for spatially and semantically linked digital content
  - Real-time interaction with virtual objects
- **AR in education…**
  - Can promote the acquisition of knowledge and skills (Arici et al., 2019; Garzón & Acevedo, 2019)
  - Can positively influence motivation and interest (Zhang et al., 2020)
  - Can present technical difficulties (Munoz-Cristobal et al., 2015)
  - Requires further scientific research (Akçayır & Akçayır, 2017)

AR-Technologies

Handheld display devices

Digital image of environment (**real**)

Digital AR-object (**virtual**)

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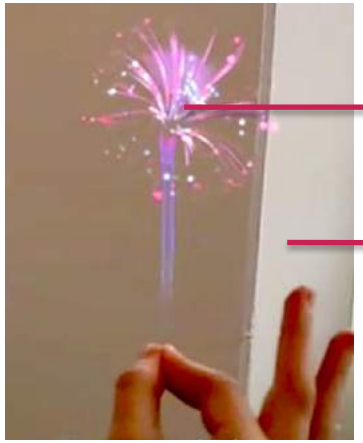
- Usable with everyday devices (smartphones, tablets)
- Most used AR-technology in education (Akçayır & Akçayır, 2017)

Head-mounted Smartglasses



Digital AR-object (**virtual**)

Environment (**real**)

- Mostly unknown (especially to young children)
- Little used AR-technology in education (Akçayır & Akçayır, 2017)

Usability of AR-Smartglasses for Primary School Children

Usability comprises (technically conditioned) aspects of technology-supported educational settings

(model of usefulness of web-based learning environments by Nielsen, 1993; revised by Tervakari & Silius, 2002/2003)

- **Challenges for children when using AR-smartglasses:**
  - Differences in physical body body characteristics (e. g., arm length or hand size) and in the state of cognitive development in terms of motoric skills or spatial cognition between children and adults (acutal target group of HMD-AR-devices) (Radu & MacIntyre, 2012)
  - Individual preferences and skills in using different AR-interaction types offered by the device (Oviatt et al., 2018)
- **Challenges caused by the technology when using AR-smartglasses:**
  - Complex device operation, frequent technical issues (Munoz-Christobal et al., 2015)
  - Detection of AR-interaction for device operation can sometimes be unreliable, especially the detection of children‘s voices (Chang et al., 2014; Kennedy et al., 2017; Munsinger et al., 2019)

Usability of the MS HoloLens 2 for Primary School Children

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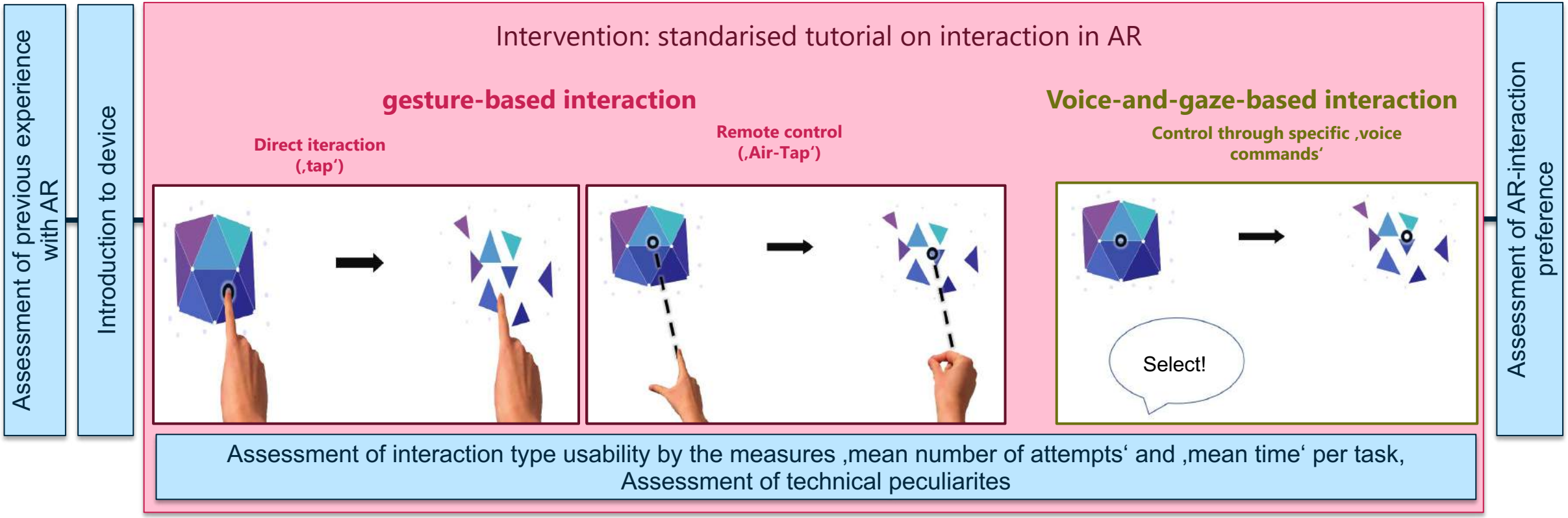
- Technical innovations and improvements (improved gesture and speech recognition, intuitive opertion) could particularly improve usability for primary school children

- **Study: Usability Assessment of the MS HoloLens 2**
  1. Usability comparison between different AR-interaction types offered by the device
  2. Asssessment of technical peculiarites of the use of the device with young children

→ **Aim of the study:** acquisition of basic findings concerning general affordances and limitations of the use of AR-smartglasses with primary school children

Study Design

- Sample: n=46 (27 m, 19 f.; age: 9,3 +/- 0,9 years)
- Laboratory study with individual appoinments, within-subjects design



Results

1) Usability assessment for the three AR-interaction types

Mean number of task attempts

→ Significant differences between the used AR-interaction types:
mean number of task attempts is significantly higher for ‚air-tap' interaction

Mean task time

→ Significant differences between the used AR-interaction types:
mean task time is significantly higher for ‚air-tap' interaction

2) Technical peculiarites caused by children's reduced arm length and hand size (videos will be shown in presentation)

- Spatial AR-positioning issues during interaction with AR-objects
- Correctly performed gestures are not detected

Discussion

- The main affordance of the evaluated AR-device is the (direct) real-time interaction with AR-objects
- The evaluated device offers two rather intuitive and easy-to-learn AR-interaction types (‚tap' and ‚voice-command') and one that requires practise (‚air-tap')
- AR-smartglasses may require further technical optimisation for the use in educational situations, especially with young children
- Although the results were not obtained in a specific educational context, they are nevertheless of great importance for the development of any teaching-learning applications with AR an can be seen as baseline-guidelines
- Future learning applications in AR with smartglasses should offer different interaction types, giving children the opportunity to choose or switch according to their preference at any point

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