Mitigating the Negative Impacts when Designing Educational VR Applications for Children

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Abstract
Educational VR applications, mainly designed for children, are often used to showcase the benefits of VR. While such applications highlight a lot of the potentials for future learning environments, we miss a deep and critical reflection of the negative impacts that those mixed-reality technologies may have on children. We believe that it is very important for us technologists to minimize the risks for this particular vulnerable user group. In the light of the recent debates on abusive ethical, social and political issues of mixed-reality technologies, we outline how developers can mitigate the negative impacts of educational VR applications designed for children such as social isolation and an overestimation of abilities.

Author Keywords
Social Isolation; Overestimation of Abilities; VR; Children and VR; Risks of IVEs

CCS Concepts
•**Human-centered computing** → **Virtual reality; Human computer interaction (HCI);** *Mixed / augmented reality; HCI theory, concepts and models;*

Introduction & Motivation
Since the first commercial releases of HMDs around 2010, educational VR applications were often one of the first

showcases to highlight the benefits and potential of VR technologies. Since then, VR has become much more affordable and schools adopted these new technologies (see figure 1). Google, for example, started VR Expeditions in 2015 to enable children to go on virtual field trips [10]. They emphasize that VR technology represents a cost-saving and undiscriminating way of experiencing places the children normally would not be able to go to. In addition, Allison showed that virtual field trips to zoos or to historical eras can improve the children's learning abilities [1, 4].

Other research on educational VR applications highlight that students of universities enjoy being educated via online courses [2]. Bailenson et al. found that virtual teachers in a virtual classroom would allow an individual learning pace for children [3]. VR-immersed classrooms have further been tested with geography lessons and received strong positive feedback [11]. VR is also frequently used to investigate distraction, attention and inhibition of children in school [6, 17].

Even though there have been many technological advances and a lot of fundamental research in the field of VR in education, it is surprising that there is little work reflecting on the risks of this novel technology as recently suggested by Hecht et al. [12]. This is especially astonishing because even more privacy-risking features are supposed to be build into future VR-settings, such as eyetracking, EEG and galvanic skin response, that gather data about involuntary nonverbal reactions of users [7].

Today, there is only limited research that examines the risk for children using VR applications [4]. Bailey and Bailenson assume, for example, that children are more likely to be addicted to VR than adults and that they lose a sense of their physical surroundings due to the highly engaging content [4]. Aspects like manipulation through advertising in VR, privacy matters and data collection have not been sufficiently considered for adults, let alone for children.

Figure 1 speaks volumes of the difference between how educational VR apps are being advertised and how first trials in reality look like. One shows the novelty effect of experiencing VR for the first time, which can be astonishing, and the other social isolation from students being in their own digital bubble. We propose that it is important to also discuss the negative impacts when designing educational VR applications. Especially for children and teens VR applications may bear risks, which have not yet been sufficiently explored [4]. In this workshop paper, we discuss the potential of negative impacts of VR applications used for children in an educational setting.

Negative Impacts of Educational VR Applications

While there is a long list of positive aspects of educational VR applications we want to focus on two possible negative effects of educational VR applications in the next section. We briefly introduce the concepts and outline how to mitigate these negative aspects from an HCI perspective.

Social Isolation

The concept of social isolation is closely linked to the feeling of loneliness. It is defined by an insufficient quality or quantity of social relationships, which risks both the cognitive and affective mental health of people [13]. This concept can also relate to an associated visual and mental separation from other people, even if they are in the same room [20].

There has been research in the field of social isolation regarding aging people. Mostly, VR is seen as a treatment, offering games and social networking possibilities with others [13]. Some forms of social interaction opportunities have already been invented in VR like AltspaceVR [16]

Figure 1: The left image was used in a commercial video by Google, the right image depicts a photo taken from a teacher in the UK during a trial of VR applications in the wild [10, 5].

or VRChat [15], in which one can chat, speak to avatars or share mutual events like watching movies seemingly together. Moreover, several VR games focus on two- or multiplayer cooperative games like Kinesics [14] or Life of us [23].

Nevertheless, VR can also bear the risk of inducing social isolation. The total occlusion of the real world achieved by the HMDs also means that one is immersed alone in a virtual environment [20]. Especially in a school setting, social interactions get lost when everyone is being by themselves, as can be seen in figure 1. Research has shown that wearing an HMD while viewing a movie together in VR leads to less (non-) verbal communication, a loss of the feeling of 'being together' and social isolation [20].

As of today, VR is mostly used in short sessions. If the amount of time spent wearing an HMD increases, as can be expected, using VR might lead to a less social behaviour. However, behaving socially in both non-verbal and spoken language is important for inclusive societies as well as improves results in academic achievements [8].

Overestimation of Abilities

Imagination and reality are closely related with each other. In the sports domain, for example, mental training and previsualisation of movements lead to a measurable improvement of the performance of athletes [19]. It would seem obvious that VR with its so far unique possibility to completely immerse the user in a new world is much stronger in succeeding than any other medium before. Thus, first approaches have tried to map the concept of mental training to VR by creating a training parkour, for example in order to get used to heights in a special climbing route [21].

Although imagination can lead to improvement, it may also

result in an overestimation of the real abilities, especially regarding a younger user group. A study by Segovia and Bailenson showed that elementary school children mistook experiences of a virtual doppelganger, which is a virtual representation of themselves, for their own real memories [22]. Some children reported remembering swimming with orcas on vacation although this only happened in VR. This suggests, that the age as well as experiencing an immersive virtual environment (IVE) hinder them from correctly distinguishing a symbol or digital representation from reality [4, 9].

When abilities are seemingly learned in VR, many might overestimate their skills in reality. Effectively, the perception of the self might differ so much as to result in a loss of distinction between fiction and reality or, in extreme cases, in multiple dissociation and delusional disorders. Tightrope walking, parkour or car driving might thus end rather hurtful and hazardous in reality.

Mitigation of Negative Effects

Despite this workshop paper putting focus on the negative impact of VR technology used with children, we believe that the overall impacts can be positive. We as HCI researchers can design technological solutions to mitigate these negative effects. To mitigate social isolation evoked by wearing an HMD, one could, for example, add technical features in the HMD, working at least for a small group. Some examples for such technical improvements could be to frame the viewport of the co-watcher, to include a picture-in-picture-method showing a little screen of the co-watcher's field of view or to activate a voice chat [20]. These would enable awareness of other people being at the same time in VR.

We are also of the opinion that the HCI community is one of the key players in formulating appropriate guidelines regarding the usage of VR in education and for children in general. VR sessions should be in general included carefully into the school setting, being paired with team tasks in VR and face-to-face interactions in reality in order to share a similar experience. Moreover, most HMD manufacturers already advise an age restriction of at least thirteen [18] and on top of that propose a close monitoring by a parent or guardian for older children. The given reason, however, is the improper sizing of the HMD and arising symptoms of sickness or discomfort. On the basis of the presented negative effects within this paper, a heavier age restriction could be discussed within this workshop. It would be also interesting to elaborate on an establishment of a *forced reflection phase* after an IVE for children and teens together with the HCI community. This would, on the one hand, mitigate the effect of an overestimation of abilities but, on the other hand, would restrict the individual freedom of the user.

Outlook

In order to mitigate the negative impacts when designing educational VR applications, more research needs to be done to fully understand these side effects, in particular for children. We believe the HCI community can play an important role to illuminate and discuss these risks and further ethical problems in this workshop and we hope to stimulate discussions with our ideas presented in the paper.

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