



Towards a Transformative Framework for AR Learning and Instruction Through the Lenses of Research and Practice: An Interdisciplinary Community Workshop

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Abstract. The proposal describes an interdisciplinary community workshop that is executed at iLRN2025. The goal of the workshop is to gather insights from the community concerning their research on and use of AR in education. It is a first step to build a foundation for a broader project creating an evidence- and experience-based framework for the transformation of research on and practice with AR for learning and instruction. In this workshop, members of the iLRN community will have the opportunity to share their personal experiences with AR in education, explore use cases of AR including the potentials of novel, innovative technologies, and connect these with pedagogical theories and frameworks. Through small group brainstorming and discussion sessions, a participatory approach will be adopted with the goal of collecting various perspectives and experiences. The multi- and interdisciplinary perspectives of researchers and practitioners from various fields (e.g., teachers, instructional designers, learning facilitators, museum curators) will be combined in this workshop. With the interdisciplinary insights and novel connections from the workshop a starting point will be formed for the co-creation of a theory-based and practice-inspired framework for the implementation of AR technology in instructional settings.

Keywords: Augmented Reality, Education, Co-Creation, Transformative Framework.

1 Introduction

Research on learning and instruction with Augmented Reality (AR) has received a lot of attention in recent years including studies and implementation in various educational settings [1, 2] like formal education of primary level (e.g., [3–6]), secondary level (e.g., [7–9]) and higher level (e.g., [10–12]), vocational education (e.g., [13–17]), non-formal education (e.g., [18–21]), informal education (e.g., [22–24]), or workplace training (e.g., [25, 26]). This research has resulted in several promises for its use in education, showing, for example, an increase of learners' engagement through interactive and immersive learning experiences [27, 28], promotion of knowledge acquisition [2], support of conceptual learning through hands-on lab work [7], and a benefit for affective learning outcomes [29]. However, more recently, researchers have criticized the AR learning and instruction literature for primarily trying to prove whether learning with immersive media works instead of trying to improve learning with immersive media [30]. Questions more relevant to both educational theory and practice, such as how (e.g., fostering (meta-) cognitive processes), when (e.g., simple or complex tasks), and for whom (e.g., considering prior knowledge) AR contributes to effective and engaging instruction, have been neglected [31]. Some frameworks of instructional design have been developed based on systematic reviews of scientific literature but still need to be more widely established as a basis for research and design guidelines throughout the community. Examples of different types of frameworks based on learning theories, models, and design include a conceptual framework of

design layers for AR learning activities (content layer, mobile layer, motivational layer) [32], a taxonomy of instructional methods in five clusters (Presentation, Experiential, Discovery, Cooperative/Collaborative, Activity-based) for STEM teaching in higher education [33], and a design framework with general suggestions of what to consider concerning three types of features (content features, design features, interaction features) in AR instructional design [34]. Although these and other more general frameworks exist, the definition of AR-specific, concrete and systematically defined evidence-based design guidelines and principles (e.g., “For learning effect X the AR experience should include attribute Y in manner Z”) is still sparse but necessary to move forward with the field in a systematic way [35]. A closer contact between the research and the practice community has been proposed in order to provide a more complete picture of potential use cases, difficulties and needs of implementing AR in education [36]. Recent developments of hardware, artificial intelligence and machine learning have furthermore led to new opportunities for enabling intelligent reality (see a definition here [37]) and immersive AI (see for example here [38]). While intelligent reality and immersive AI include all kinds of immersive technologies, AR-based educational environments come with particular challenges and potentials. In an attempt to address the criticisms, the interdisciplinary nature, and recent technological developments, the immersive learning community needs to work together to form a foundation on which the field of AR in education can grow.

As a starting point for building this foundation, the following tasks have been formulated by an interdisciplinary and international team of members of the research community on immersive learning:

- Analyze the theoretical foundations (e.g., cognitive-affective mechanisms) of how, when, and for whom AR contributes to effective and engaging learning and instruction.
- Explore innovative technologies (e.g., intelligent reality) and transformative pedagogies (e.g., adaptive support, instructional needs) for AR through combining the visions of researchers and practitioners via participatory activities.
- Synthesize the results into a theory-based and practice-inspired framework including concrete design principles of how AR can boost learning and instruction.

The proposed workshop aims at the second point and thus the exploration of innovative technologies and transformative pedagogies in participatory activities with researchers and practitioners. As the iLRN community includes many researchers and practitioners with various perspectives, the community is seen as an extraordinarily relevant target group for this workshop to start this exploration procedure. The other points are beyond the scope of the workshop, but we hope to establish a solid community collaboration among workshop participants for these.

2 Workshop

2.1 Goals for the Workshop

The workshop has multiple goals. Within the larger context, its goal is to create a starting point for building an evidence- and experience-based foundation on which the field of AR education can grow through transformation of research and practice. For this, the workshop is a first puzzle piece and aims at collecting various perspectives, experiences and innovative ideas from researchers and practitioners from various fields. The workshop activities bring researchers and practitioners from the field of AR in education together to share their ideas with each other. In interdisciplinary groups, they will be given the opportunity to share and reflect on their own experiences with AR in education, and explore the potentials of innovative technologies and transformative pedagogies for AR. The insights from the discussions will be collected in written form during the workshop and after the workshop they will be analyzed and systematized by the workshop organizers and shared with all participants. The exact outcomes of the workshop are dependent on the input from the participants, who have the opportunity to co-create the results, but potential outcomes include clusters of types of use cases and ideas, a collection of theories and guidelines that practitioners implement, connections between specific use cases and theories, and lists of recommendations and cautionary tales from the implementation of and research on AR in education. Beyond the workshop, the insights will be used to inform the process of co-creating a theory-based and practice-inspired interdisciplinary framework including concrete design principles of how AR can boost learning and instruction.

2.2 Workshop Activities

The workshop will be open for everyone who is interested in AR in education. For an interdisciplinary workshop experience and relevant results, the target group is a very diverse audience, including researchers and practitioners (e.g., in-/pre-service teachers, computer scientists, instructional designers, learning facilitators, museum curators). As part of the session, the participants will go through different activities (see Table 1), starting with an

introduction to AR with first examples of innovative technologies and transformative pedagogies to build a common ground for all participants. After a group formation phase which will be pre-structured so that it supports the formation of particularly heterogeneous groups, a sharing and brainstorming phase will be executed in the groups for 30 minutes. Some questions to discuss in the groups will be provided by the workshop facilitators (see Table 1 for potential questions) and additional questions can be added by the participants in a participatory approach. Within the next 30 minutes, the groups will be invited to write down their experiences and ideas on various aspects of the topic (e.g., AR theoretical/pedagogical frameworks and models, contributing factors to successful AR learning and instruction, uses cases, etc.) in a pre-structured document template which will be provided by the workshop organizers. This document will be shared with the workshop facilitators and everyone afterwards. In the last step, the groups will share their results with the whole group and future steps will be discussed. An option to sign up to a mailing list and a group on a communication platform (e.g., Discord, Slack) for future collaboration will be provided to participants, who are asked to also share it within their networks.

Table 1. Activities planned for the workshop and their duration.

Workshop part	Duration	Activities
Introduction	10 min.	Short input phase, introducing participants to AR to form a common ground. Furthermore, first connections of AR with innovative technologies and transformative pedagogies will be described to inspire the workshop group.
Group formation	5 min.	Formation of interdisciplinary groups supported through color-coded stickers for different backgrounds (e.g., researchers, teachers, instructional designers, computer scientists).
Sharing and Brainstorming	30 min.	Talking about own experiences with AR in the interdisciplinary groups, including questions concerning the participants' experiences and the potentials they see, for example: <u>Experiences:</u> • Which experiences do you have with AR in education? • Which theoretical or pedagogical frameworks, models, theories, etc. do you refer to or use concerning AR in education? • What are your experiences concerning how, when, and for whom AR contributes to effective and engaging learning and instruction? • What aspects do you find to be neglected in existing learning environments? What weaknesses do current AR environments have? <u>Potentials:</u> • What important use cases do you see for AR in education and why? • Where do you see gaps in the research (laboratory or field) concerning how, when, and for whom AR contributes to effective and engaging learning and instruction? • What opportunities do you see concerning innovative technologies and transformative pedagogies for AR in education? • How can these future potentials be exploited? (e.g., What studies need to be conducted, what teams need to be formed, what target groups need to be investigated?)
Writing up ideas	30 min.	A digital writing tool (e.g., Padlet, Miro, Google Docs, Mural) will be provided for participants to write down their experiences and the ideas concerning the potentials. A pre-structured document will help with sharing the ideas.
Presenting outcomes	15 min.	The groups share their ideas with the whole workshop group. They can use their written notes for this. A discussion will be facilitated by the workshop organizers to decide on future steps of the workshop group and future goals for the output of the workshop.

3 Future Steps

The workshop is part of a bigger project of co-creating a theory-based and practice-inspired framework including concrete design principles of how AR can boost learning and instruction, as described in the three tasks in the introduction section. Additional tasks that will be executed by the workshop organizers in preparation for and inspired by the workshop insights include the analysis of existing theoretical foundations (e.g., cognitive-affective mechanisms) of how, when, and for whom AR contributes to effective and engaging learning and instruction.

The workshop will leverage the combination of experiences of researchers and practitioners for the exploration of innovative technologies and transformative pedagogies for AR. As described above, exact workshop outcomes depend on participants' input, but we expect insights into specific use cases for AR and their connection to theories

and guidelines used by practitioners. The workshop organizing team will cluster and code the written outcomes after the workshop. Results will be submitted to a future iLRN conference for dissemination beyond the workshop.

Beyond the workshop itself, unique perspectives and innovative ideas from the workshop will be used as the foundation for future discussions and the co-creation of a framework for the design, implementation and usage of AR in education. This framework is supposed to offer valuable information for educational practice with research-based suggestions for designing and applying more effective AR learning environments using the latest technologies. The framework should also guide future research on teaching and learning with AR. We anticipate that the framework can be used to examine hypotheses to test and further refine the framework. The workshop forms a starting point for the co-creation of a theory-based and practice-inspired framework for the implementation of AR technology in instructional settings. The participants will be invited to participate in future co-creation steps, and communication channels will be established through communication platforms.

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