PhD thesis proposal – 2020/2023

Benefits and Limitations of Location-based Mobile Augmented Reality To Support Learning about Biodiversity: from Learning Experience to Digital Platform.

HES-SO – University of Applied Sciences and Arts Western Switzerland
HEIG-VD - School of Management and Engineering Vaud, Switzerland
MEI – Media Engineering Institute

Categories and Subject Descriptors[1]

H.5 Information Interfaces And Presentation, **J.** Computer Applications, **J.4** Social And Behavioral Sciences, **L.3.0** eLearning Systems - Technology - Tools - Platform, **L.3.6** Technology Enhanced Learning, **L.3.1** Human Computer Interface

Keywords

augmented reality, location-based system, learning interface design, instructional design, human-computer interaction, computer graphics, geospatial visualization, user expectations, user experience design, user experience assessment, technology acceptance

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1   According to ACM & J.UCS classification - http://www.jucs.org/jucs_info/acm_categories

Context

The doctoral thesis topic described below is related to a global research project supported by the National Research Programme "Digital Transformation" (NRP 77[2]) which investigates the interrelationships and concrete effects of digital transformation in Switzerland.

Biodiversity is now a crucial notion that needs to be transmetted to students. Using an augmented reality application, this research proposes a new approach to study this phenomenon. As a multidisciplinary research project, entitled "*Building Location-based Augmented Reality Applications through Advanced Pedagogical Methods to Support Learning about Biodiversity*", the overall goal is to test the impact of augmented reality on the learning and memorisation of biodiversity among pupils in Switzerland. The aim is to evaluate how awareness about biodiversity might be raised using location-based Mobile Augmented Reality (MAR) technologies as a learning tool. The intent is to improve the design, development and use of technology-based teaching practices that allows students to discover biodiversity in a real-life context.

By cross-referencing best practices in user experience design, communication and pedagogical knowledge, as well as geospatial visualization techniques and standards, we aim to implement and evaluate this type of tool to encourage new teaching methods using new technologies. Therefore its evaluation is crucial and we wish to assess the impact of these tools on biodiversity learning among pupils, by measuring the attention given to biodiversity and the medium and long-term learning (memorisation) of this information among pupils using a mixed methodology (eye-tracking, learning measurement and self-confrontation interviews). Especially, this project aims to integrate qualitative and quantitative research methods. Also, it is to answer the question under what conditions it is attractive and profitable to invest in such a learning platform based on MAR.

Finally, this project aims to contribute to a better understanding by students becoming empowered and eco-responsible citizens, of the role of biodiversity in the functioning of natural ecosystems.

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2   The National Research Programme "Digital Transformation" (NRP 77) - www.pnr77.ch

Description

In this context, the proposed PhD thesis can be seen as a continuation of the following major research projects, NatureAR[3] and EcoMOBILE[4], both using different AR techniques (location-based AR for the latter), but do share the common conclusion that using AR in education about biodiversity is a promising approach. The aim is to advance the state of the art on the following issues related to augmented reality technologies for education:

- **Design matters**: although AR can be considered as an advanced and convenient tool when used in education, in the absence of a well-designed interface, it can be very difficult and complicated to use for students. As a consequence there are issues to address that falls within the scope of UX design for learning, with the aim to extend the practical design recommendations when it comes to educate about biodiversity-related purposes. NatureAR proposes some recommendations regarding task design for MAR learning applications that are intended to be used in the nature, but they are too general and not going further than "keep it simple". Especially, given that attention is essential to learning, there are issues to consider so as to get around the risk that technology may draw too much attention.

- **Geovisualization**: among interface design considerations, visualization issues have to be taken into account given the geo-aware context. They are questions related to cartographic symbols perception and how 2D/3D best practices about cartographic design can be transfered for data rendering and interaction in the AR scene. Design guidelines and usability principles related to a learning process might be relevant to be identified and described.

- **Deployment in schools and adoption by teachers**: it is required to explore how to reduce the time of preparation of a nature experience with a provided MAR platform and to favour the adoption by teachers to consider that kind of technology. Does location-based MAR greatly simplify preparation and configuration? By using a simplification based on locations which are by definition virtual, it is possible to manage a catalogue of biodiversity points of interest and configure as required for the pedagogical

3   Alakärppä, Ismo & Jaakkola, Elisa & Väyrynen, Jani & Häkkilä, Jonna. (2017). Using nature elements in mobile AR for education with children. 1-13. DOI: 10.1145/3098279.3098547.

4   Kamarainen A, Reilly J, Metcalf S, Grotzer T, Dede C. 2018. Using Mobile Location-Based Augmented Reality to Support Outdoor Learning in Undergraduate Ecology and Environmental Science Courses. The Bulletin of the Ecological Society of America 99:259-276. DOI: 10.1002/bes2.1396.

experience imagined by a teacher. Moreover, is it possible to really have a simplified authoring platform to reduce preparation time for teachers, or is it the usual illusion of authoring tools "easy to use but limited flexibility/creativity"?

- **Device and sensor abilities**: previous research projects focused mainly on tablet AR only and to our knowledge, none of the projects consider the use of Head Mounted Displays. It is required to study how such a hands-free device may improve the interaction with the scene, the nature in our case. Issues related to the maturity of such devices have to be addressed, also what positive or negative impact on the learner attention and the understanding of the environment. Location accuracy is another issue to address, based on GPS for location-based MAR. What are possible techniques to improve accuracy, evaluate the impact on the pedagogical scenario when accuracy decreases, what are the alternatives while taking benefits of an outdoor experience in nature?

Addressing these issues will require to build a *MAR platform for education about biodiversity*. It is to be noticed the existence of a preliminary platform called BioSentiers[5] that has been developed by the Media Engineering Institute in collaboration with the Territorial Engineering Institute. It can serve as a basis for new thoughts. As a central research instrument, such a platform will be used to organize experiments with teachers and young learners from school partners. Also, the idea is to support the evaluation process planned in the frame of another PhD thesis[6] having in parallel a focus on research methods for the assessment of learning and understanding. In other words, the work will have to be coordinated with that another PhD thesis.

Prerequesites

Two main types of profile are eligible (not excluding their variants).
Master degree or equivalent with a background:

1. either in software engineering and development in computer graphics (if possible related to augmented/virtual reality) with a strong motivation to develop skills about user-centered design and evaluation methods, techniques and tools. A background in geographical sciences oriented

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5   Discover biodiversity through augmented reality, biosentiers.heig-vd.ch, 2017-18

6   Published in carriere.hepl.ch, Doctorant·e FNS (Réf. 60)

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towards methodological approaches and interactive mapping techniques may also be suitable.

2. or in User eXperience Design combining skills from user-centered design methods, computer science, cognitive sciences, with a strong motivation to develop technical skills about the uses and (im)possibilities of visualization technologies such as augmented reality.

In all cases, a vocation for interdisciplinarity and a strong interest in technology-enhanced learning processes are desirable. Also an interest in biodiversity conservation is a significant plus.

Working environment

Working place:
HEIG-VD / Media Engineering Institute, Yverdon-les-Bains, Switzerland

Main supervision and doctoral school:
Dr. Erwan Bocher, Research Engineer at LabSTICC, DECIDE team, CNRS - UMR 6285
Ecole des Docteurs de l'Université Bretagne Loire, France

While leading a research team which develops new methods and techniques to model, represent, process and share spatial data, Erwan Bocher has a part of his research work focusing on geovisualization and cartographic design.

Co-supervision:
Pr. Olivier Ertz, Associate Professor at Media Engineering Institute (MEI)

The thesis work will take place at the **Media Engineering Institute**. Knowledge and skills related to the following research concerns will be made available: user experience & digital humanities (lead by Pr. Laurent Bolli), data visualization & augmented reality (lead by Pr. Olivier Ertz), serious games & learning innovation (lead by Pr. Dominique Jaccard).

The MEI is also member of the MediaMaps group, together with the **Institute of Territorial Engineering** (INSIT). The geoinformatics and GIS team (lead by Dr. Pr. Jens Ingensand) will be able to bring knowledge and skills related to geovisualisation and location-based system.

More information and main contact:

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