

# Synthesising Augmented Reality and Learning Analytics For Effective Workplace Learning

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## ABSTRACT

Augmented Reality (AR) has the potential to support effective learning in informal and non-formal learning environments and not only in school or higher education [1], but also in professional education [2]. Learning Analytics (LA) provides various tools and concepts to support learning and especially people who are involved in learning processes (trainer, trainee and evaluator). The project aims to create a framework on the basis of LA insights, for implementing elements in AR learning applications which supports learners and trainers in their teaching and learning processes towards a higher efficiency and efficacy. To support this, a consortium of leading European scientist coming from the areas of LA and AR aims to establish a strategic partnership in which the conceptualisation of the topics LA and AR should be used to apply in the field of professional education, especially in informal learning environments and directly at the workplaces.

**Keywords:** Mixed and Augmented Reality, Learning Analytics, Multimedia Learning

## Index Terms:

## 1 INTRODUCTION

Workplaces are getting more and more international, especially specific sectors are international oriented and companies traveling to where the work is, i.e. operating in several countries. There is a large number of labour migration (artists and technicians move, in areas like facility management, safety and security, etc.), also a need for similar skills and agreement on good practice between sectors. Finally, the event sector for instance is changing at a high speed and there is a need for fast updates of competence / knowledge (what we currently teach is per definition history).

Furthermore, according to the statements provided by the European Commission in their communication concerning the needs of the ERASMUS+ programme, the present project initiative addresses directly the following:

- Extraordinary broadening of learning offered and potential of ICT: first, AR supports learning especially in informal learning environments [1, 2]; furthermore, LA is based on Educational Big Data as a key potential of ICT.

- Complementarity between formal, informal and non-formal learning: supported through active learning experiences in AR/VR/game based learning settings, especially when identifying individual learning paths using learning semantics and analytics.

## 2 THEORY

In terms of multimedia learning, Mayer's model for description of multimedia learning [3] takes place in preparation for the development process of the AR applications.

The multimedia principle states that people learn better from words and pictures than words alone. AR can implement this principle by overlaying printed texts with virtual pictorial content (e.g., integrating videos into a textbook) or, vice versa, by augmenting physical objects with virtual texts (e.g., displaying labels and measures when focusing on a technical object).

The spatial and temporal contiguity principles state that learning is enhanced when the space and/or time between disparate but related elements of information is minimized. AR can implement the contiguity principles by superimposing virtual content onto physical objects in real-time and thereby spatially and temporally aligning related physical and virtual information.

The modality principle states that learning can be enhanced by presenting textual information in an auditory format, rather than a visual format, when accompanying related visual content. AR can implement the modality principle by playing spoken text, instead of displaying printed text, when recognizing a trigger event.

Finally, the signaling principle states that people learn better when cues highlight the organization of essential information in a learning environment. AR can implement signaling by directing and guiding people through learning environments using geographic location information and visual triggers.

### 2.1 AR Learning Tools

The main innovative step for learning in informal learning environments is, to implement applications providing content and training activities to create effective learning experiences,

considering basic elements of the cognitive theory of multimedia learning (CTML, see Mayer, 2002) and situation based learning, for connecting / transferring lessons learned between various professional contexts.

Having a mixed partner consortium of professional and higher education organisations offer additional benefits, especially in ensuring a transition incorporating new insights about teaching and training using new media effect professional education at any level, and in the application of effective assessment methods using AR and LA in this present and promising combination. As we identify a similar development in terms of industry 4.0 for the education sector, this project leads to open and innovative practices in the present digital era, understood as "education 4.0".

## 2.2 Learning Analytics

LA supports the measurement, analysis and reporting of data about learners and their contexts for purposes of understanding and optimizing learning and the environments in which it occurs. LA focuses on learning and teaching activities in digital supported learning environments such as Learning Management Systems (LMS) and in connection with AR- and VR learning, game-based learning (gamification), additionally to develop effective assessments in the project's setting. This enables both learners and teachers to receive feedback and status reports about the own learning / teaching track and therefore enables to put quality aspects into learning and teaching processes, emphasizing self-evaluation on individual learning / teaching tracks. Hence, teaching and training will become much more transparent, this enables access on collected data and information for identifying individual key performance indicators for these processes.

The measurement of learned competence will follow ESCO [4], who provide an EU-wide set of competences to reference against the national qualifications), this project aims to complement professional training at different levels. A good example is the main output from the project ETTE [5], which showed it is possible to develop learning content and assessment methodologies for a single competence.

## 3 DISCUSSION

There already exist a number of significant studies investigating the application of Augmented Reality (AR) in order to enhance training procedures in the workplace (). Understanding general principles that arise from these studies and establishing a technical and methodological framework to support prototype development in AR is the main objective of this collaborative effort entitled "Principles for effective Learning Analytics in Augmented Reality learning applications for professional education" [6].

The project described here brings together LA, AR, competence management and learning methodology with a focus on individual tracks, that is, the path taken by either educator or learner. While the main focus is learning in the workplace, associated activities will also aim to develop and provide access to digital information, which is thought to further personalise the learning track, allowing the learner to progress at their own pace.

### 3.1 Target Groups

These comprise learners, in various contexts, including adults (i.e. periodical safety briefings), apprenticeship students at workplaces and regular students with a short track.

A further, direct target group are organisations providing these different tracks, mainly professional education organisations, but also accident insurer, Chamber of Industry and Commerce, and organisations providing in-house training.

Indirect target groups can be coaches on the work floor, who are assisted when checking the learners activity and in their evaluation of them. Also learners with fewer opportunities (i.e. those with migrant backgrounds, or refugees) or those guided by supported employment activities. Finally, learners who do not easily fit the above categories, such as those who are competence focused rather than knowledge focused, or those being more active in learning by doing, mobile learning, or dispersed over different places.

Since a lot of people (i.e. many theatre or event technicians) have "learning disabilities" in the traditional sense of the word, the use of new and different systems to traditional training potentially break such barriers.

### 3.2 Objectives of the Workshop

The project objective is to create and test innovative learning methodologies adapted to a changing learning and working relation. The workshop will seek to familiarise the participants with the key themes, to facilitate a discussion around this conception of a new, technologically-enhanced learning space. Attention will be given to the potential benefits and challenges of implementation, in the following areas:

- Technical / Methodological framework and the creation of new learning tools for work-based training and learning in form of Augmented Reality (AR) applications used in a setting for international training and assessment.
- Prototype AR learning application with integrated LA elements: covering the topics of the Hilversum test procedure (project ETTE) as well as safety/security aspects of workplaces
- Setting up of appropriate research environments at real workplaces; considerations in conducting a successful field experiment.

#### 4 SUMMARY

The project will directly affect the participating staff and organisations through intensive transfer of innovation (knowledge transfer between partner organisations). During the prototyping processes the involved target groups like students or academic staff / teachers will have contact to new tools for teaching and learning and will benefit from the examination with structure and design of learning processes. The partners will also benefit from the internal collaboration processes. Those partners as new to the AR/VR/LA community will benefit to have access and getting involved in currently running such initiatives.

The project itself is furthermore a contribution for the developing AR/VR/LA/gamification community in Europe (and worldwide), because of the new focus on professional education and training at workplaces. External stakeholders will have access to the results of the project through research publications in journals or presentation at conferences, as well as out of the dissemination activities at fairs. The expected impact for the key target group of organisations working in professional teaching and training area: they can benefit from the project outcomes and use this project as reference project for implementing AR/VR/LA applications in their home organisation.

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#### PROJECT PARTNERS

Name of Organisation	Country of Organisation
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IT-UNIVERSITETET I KOBENHAVN	Denmark
Oxford Brookes University	United Kingdom
STEPP vzw	Belgium
VPLT - Der Verband für Medien- und Veranstaltungstechnik e.V.	Germany