Immersive Analytics Through HoloSENAI MOTOR Mixed Reality App

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IMMERSIVE ANALYTICS THROUGH HOLOSENAI MOTOR

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Abstract. This study examines the use of HoloSENAI MOTOR as novel approach for preparing students and professionals for the industry 4.0. This new Augmented Reality technology was developed with UNIT3D and C# language for the Microsoft HoloLens®. This educational resource enables the projection of 3D scenes of a real electric motor into the natural world environment. It was used by undergraduates from an Engineering course in Brazil. Our aim is to identify the potential benefits and barriers to promote immersive analytics and authoring skills through HoloSENAI MOTOR for learning and teaching. We present Immersive Analytics as an approach that combines real-time interaction with visualization techniques for students to explore and analyze information about the motor in their physical environment. This study is based on Responsible Research and Innovation approach and supported by e-authentication and authorship verification TeSLA. It revealed that the key benefits for learners were to increase their motivation, curiosity and understanding in terms of features, properties and functionalities of the motor, including better acquisition of information and data analysis skills. They key barriers highlighted by educational technologies, were the high cost equipment, the technical development of applications and the pedagogical approaches for assessment.

Keywords: Microsoft HoloLens, C#, Responsible Research and Innovation, Immersive analytics.

1 Introduction

This study presents the HoloSENAI MOTOR which is an Augmented Reality application developed with UNIT3D and C# language for the Microsoft HoloLens®. This educational resource was created by the technical team from SENAI to help teaching and learning in the area of engineering and computer science.

This study examines learner-centered approaches supported by Augmented Reality (AR) and Visual Analytics (VA) which were connected together through pedagogical activities to promote immersive analytics (IA). Immersive Analytics is a learner centered approach that combines real-time interaction with visualization techniques for students to explore and analyze information about complex objects in their physical environment. Immersive analytics aims to create meaningful opportunities for students to develop analytical reasoning and decision making by immersing themselves on informational environment with real-world analytics tasks. Immersive Analytics builds on augmented reality environments, 3D large touch surfaces, 360 virtual environments with sensor devices and natural user interface devices.

Our research questions are:

- What are the students' views about the benefits of using HoloSENAI MOTOR for learning?
- What are the teachers' views about students' learning gains and barriers?
- What is the impact of HOLOSENAI MOTOR for immersive analytics?

2 Background

Through Augmented Reality physical objects are overlaid with real scenes to create the opportunity for students to explore and acquire information whenever they need. AR objects are frequently merged with information and data, which creates an opportunity for interactive visualisation in context [1]. The key issue in AR and computer-generated information is the limited layout of objects which may cause reduce the visualization of informational zones.

A growing field related to AR is VA, which offers interactive visualisation approaches to solve the challenges of big data. Its aim is to reduce the complexity of data presentation in the limited AR layout. The VA tools are designed for users to visualise the patterns and relationships within datasets. The key difference between VA and traditional interactive tools is focusing on open-ended interactive exploration of data, which is combined with sophisticated analytics. [2, 3]. AR combined to VA offers to students a clear interface, whose layers of data are presented according to their needs, so they can explore based on their own perspective and having access to information and data 'context-driven' [3,4].

3 HoloSENAI motor

This study follows the approach of Responsible Research and Innovation by which researchers and society discuss how technological innovations can better address the societal needs. The HoloSENAI motor was designed to enable students to visualise and explore the internal structure of an equipment during the technical course about Automation and Mechatronics.

Students frequently consider equipment such as motors and valves as black boxes, so what happens inside is a mystery for them. Teaching complex topics with abstract concepts requires various lessons. The immersive interaction between students and AR might increase their understanding of motors' operation, features, functionalities, and properties. However, literature about immersive technologies show that students might feel dizzy or nauseated with AR or VR headset.

The HoloSENAI motor lesson was designed for each student to view and manipulate the equipment and analyse data inside and outside when equipment is in operation. Students should report their positive or negative experience.

4 Methodology

4.1 Participants

HoloSENAI was used by 23 students in the course of Mechanical Engineering. There were 20 males and 3 females. In terms of age, there were seventeen students from 16 to 19 years old and four from 20 to 29 years old, one student from 30 to 39 years old and one student from 40 to 49 years old.

4.2 Method and procedures

This exploratory work focused on users' learning experience with the AR HoloLens headset and HoloSENAI motor was based on qualitative study. Students replied the pre-and post- semi-structure questionnaires. All of them completed their learning activities, which were recorded with video. All of them signed a consent form for data collection and videoclip about their learning experience.
Data analysis were based on three categories of AR described by Kalkofen et al. [1]:

- **Data integration:** enhances the blending of virtual information with AR object
- **Scene manipulation**: offers options to augment data (colour, zoom, position)
- **Context-driven**: highlights visual information based on the context

Fig1. HoloSENAI Motor – example created to illustrate the AR experience
https://www.youtube.com/watch?v=nnebPmlqmw0

The HoloSENAI application (Figure1) was used in the Electrotechnics and Electrical Machines Fundamentals unit. It was designed for students explore data, information and knowledge about magnetism and electromagnetism in electric machines and electric motors of alternating current. Students should explore the electric motor – its parts and functions, analyze the concepts of magnetism and electromagnetism and explain how these forces contribute to the operation of the motor. The learning situation for immersive analytics was guided by the following questions: How does an electric motor work? What is the relationship between magnetism and the electric motor? Which parts make up an electric motor? What role do these parts play within the engine?
Students received the instructions and explanations to visualize and manipulate an electric motor through the AR glasses. The manipulation should be done by voice command and by gestures made with their hands. Before using HoloSENAI, students saw a similar activity was developed by Microsoft, using Microsoft HoloLens, where the user should manipulate an airplane turbine.

5 Findings

Data from que pre-questionnaire revealed that all students had used AR in their mobile phones before but none of them have used the Microsoft HoloLens headset. The majority of students agreed that immersive analytics with AR HoloLens headset increased their visual understanding of the "electric motor". All of them found it easy-to-use and would like to learn with immersive analytics again. Teaching staff mentioned that the learning gains were very positive in terms of knowledge acquisition and skills. In terms of potential barriers, they indicated the high cost equipment including the technical development of applications and the pedagogical approaches for assessment. To identify the impact of AR HoloLens for immersive analytics the Kalkofen et al. [1] categories were applied for thematic analysis.

In terms of **Data Integration**, students found the experience dynamic, innovative, immersive, and topical. The AR HoloLens "offered new ways of learning with excellent informational quality". It enabled them to explore "how the parts move and explore data when these are working without any danger". "It is an important learning tool for engineering learners and workers". With reference to **Scene manipulation**, students found the interface easy-to-use and practical. They "had no effect of dizziness or anything similar" and "enjoyed the experience" In respect of **Context-driven**, they found the immersive analytics "useful and fun for understanding abstract concepts". They found "easier to learn difficult concepts through visual information and "exploring the parts linked to data was cool, fun and useful way of learning".

6 Conclusion

This study presented an open educational resource developed with Microsoft HoloLens in Brazil by SENAI, which is one of the biggest professional development centers for industry in the world. AR applications with HoloLens for immersive analytics help students develop knowledge and key skills such as visualizing information, manipulating objects and data and analyzing abstract concepts. However, the key challenge is to examine less expensive approaches for widening up professional development in Brazil for digital transformation. Our next study, part of RRIdata.com focuses on immersive analytics for inclusive data science education[4].

7 References

1. D. Kalkofen, C. Sandor, S. White, D. Schmalstieg, Visualization Techniques for Augmented Reality, Springer-Verlag, New York, 2011.
2. Chandler, T., Cordeil, M., Czauderna, T., Dwyer, T., …& Wilson, E. (2015, September). Immersive analytics. In Big Data Visual Analytics (BDVA), 2015 (pp. 1-8). IEEE.
3. N. ElSayed, B. Thomas, K. Marriott, J. Piantadosi, R. Smith, Situated analytics, in: 2015 Big Data Visual Analytics (BDVA), IEEE, Hobart, Australia, 2015, pp. 1–8.
4. Okada, A.; Kowalski, R.; Kirner, C. and Torres, P. (2018). Factors influencing teachers' adoption of AR inquiry games to foster skills for Responsible Research and Innovation. Interactive Learning Environments Journal V(26)