Fostering STEM learning with educational technologies in the upper secondary school: opportunities and critical aspects

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INTRODUCTION

The Italian students of the upper secondary school showed low levels of science knowledge and competencies, with males performing better than females (PISA 2018).

The use of the X-Realities seems very promising for acquiring scientific skills and augmenting the interest in scientific disciplines (Arici et al., 2019; Ibanez & Delgado-Kloos, 2018).

X-Realities can engage students in learning in real situations, with methods similar to those of professional scientists, drawing inspiration from the principles of Situated Cognition (Brown, Collins, Duguid, 1989) and Experiential Learning (Kolb, 1984).

AIMS

During the first year of the PhD, I performed a literature review on STEM teaching and learning with digital technologies in the upper secondary school, with the following Research Questions (RQs):

RQ1. What are the characteristics of the published study in the field of STEM teaching and learning with X-Realities?

RQ2. What are the topics addressed, the teaching strategies and the educational experience design for STEM teaching and learning?

RQ3. What are the benefits, critical aspects and challenges for teachers and students of using technologies for STEM teaching and learning?

METHODOLOGY

A Scoping Review has been conducted according to PRISMA guidelines on ERIC and Scopus, using the following string:
(stem OR steam OR science OR technolog* OR engineering OR mathematics) AND (education OR learning OR teaching) AND ("digital technolog*" OR "mixed realit*" OR "virtual reality" OR "augmented reality") AND ("secondary education" OR "secondary school") (see Fig 1 for search process).

Inclusion criteria: Peer-reviewed journals, English language, proceedings, chapters, empirical papers, upper secondary school

Exclusion criteria: Technical papers, Not school context, Papers on usability of digital technologies, on development of teaching models

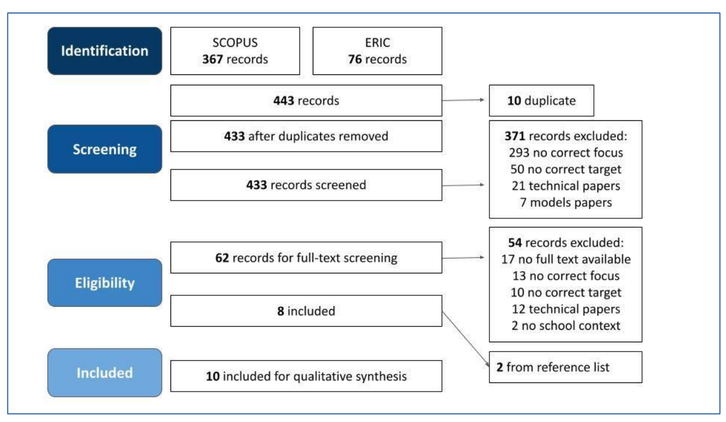
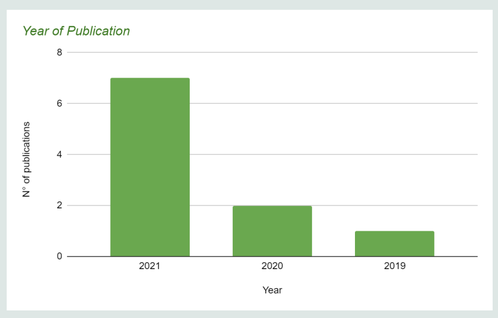


Figure 1: Phases of search and selection process according to PRISMA guidelines

RESULTS

RQ1



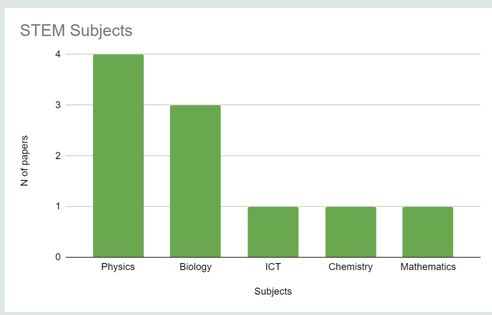
Technology: **70%** use of Augmented Reality; **30%** use of Virtual Reality

Study design: **> 50%** Experimental or Quasi-Experimental Desing

RQ2

Teaching Strategies: The most used: collaborative and inquire based

Duration of activities: **50%** Several intervention; **40%** A single intervention



RQ3

Benefits: Positive effect on attitude towards the discipline, on interest and motivation, on learning gain and on knowledge retention. The use of X-Realities in STEM teaching and learning are also able to reduce the cognitive load allocated to completing some tasks.

Critical Aspects: The technical drawbacks are the most reported, that can lead to a decrease of the enthusiasm and thus impact the performance.

DISCUSSION

This Scoping Review aimed at mapping the existing literature on the use of X-Realities in STEM education in the secondary upper school context, focusing on the type of technology used and on the methods for X-Realities integration in the educational activities.

Positive results have been reported, in particular regarding the attitude toward disciplines, interest, motivation and learning gain. At the same time, some critical aspects have been identified that need to be improved, especially related to the technical dimension.

These results are informing the second phase of the project: the co-design with teachers of educational scenarios for STEM teaching with innovative digital technologies and the subsequent testing.

Educational scenarios co-desing

- Development of indications for STEM learning design with X-Realities

- Mapping of existing virtual environments for the selection of the proper technology for co-design

The testing phase

- Design of the testing phase, including the proper methodology and the development of tools for scenario evaluation (such as, questionnaire, log-book, focus groups)

REFERENCES

1) Arici, F., Yildirim, P., Caliklar, Ş., & Yilmaz, R. M. (2019). Research trends in the use of augmented reality in science education: Content and bibliometric mapping analysis. Computers & Education, 142, 103647. **2)** Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational researcher, 18(1), 32-42. **3)** Kolb, D.A. (1984). Experiential learning: experience as the source of learning and development. Englewood Cliffs, NJ: Prentice Hall. **4)** https://www.invalsi.it/invalsi/ri/pisa2018/docris/2019/Rapporto_Nazionale.pdf. **5)** Ibáñez, M. B., & Delgado-Kloos, C. (2018). Augmented reality for STEM learning: A systematic review. Computers & Education, 123, 109–123.

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