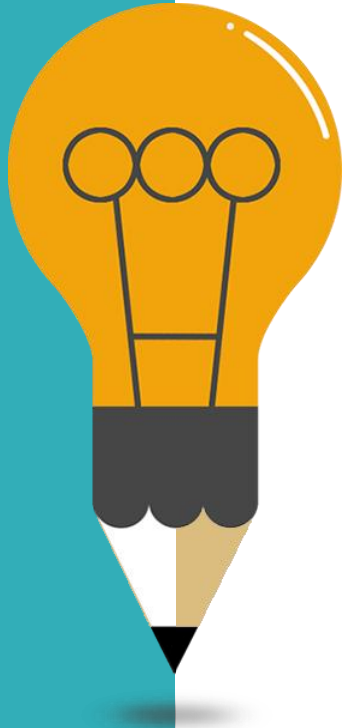


A Systematic Review of the Design of Augmented Reality Applications for Young Children

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Introduction

Augmented Reality - Definition



Augmented Reality has three main characteristics as follows:

(i) consists of a combination of real-world objects and virtual elements, (ii) highly interactive, and (iii) based on three-dimensional (3D) rendered environment.



Azuma (1997)

Methodology

The PRISMA Statement

The PRISMA Statement was developed to offer a systematic way for researchers to conduct and report systematic reviews and meta-analyses (Acquah & Katz, 2020).

According to Sierra-Correa and Cantera Kintz (2015), PRISMA has three unique advantages as follows:

- (1) it can define clear research questions that facilitate systematic research,
- (2) it can identify inclusion and exclusion criteria,
- (3) it can examine a large database of scientific literature in a pre-defined time.

Methodology

- Used two well-known databases:
 1. Web of Science
 - has a collection of more than 21,777 journals, books, and conference proceedings gathered since 1900
 2. Scopus
 - which are highly reputable sources consisting of 10, 000 of scientific and technical papers, books, reports, and others.

Resources

Methodology

Inclusion & Exclusion Criteria

Criterion	Eligibility	Exclusion
Document type	Journal and conference	Journal (Systematic Review), book series, book, chapter in book
Language	English	Non-English
Timeline	2011-2020	< 2011
Target User	Pre-operational user group	Less than 2 years, More than 7 years
Domain	Education	Disabilities Non-education
Accessibility	Open access	Not open access

Methodology

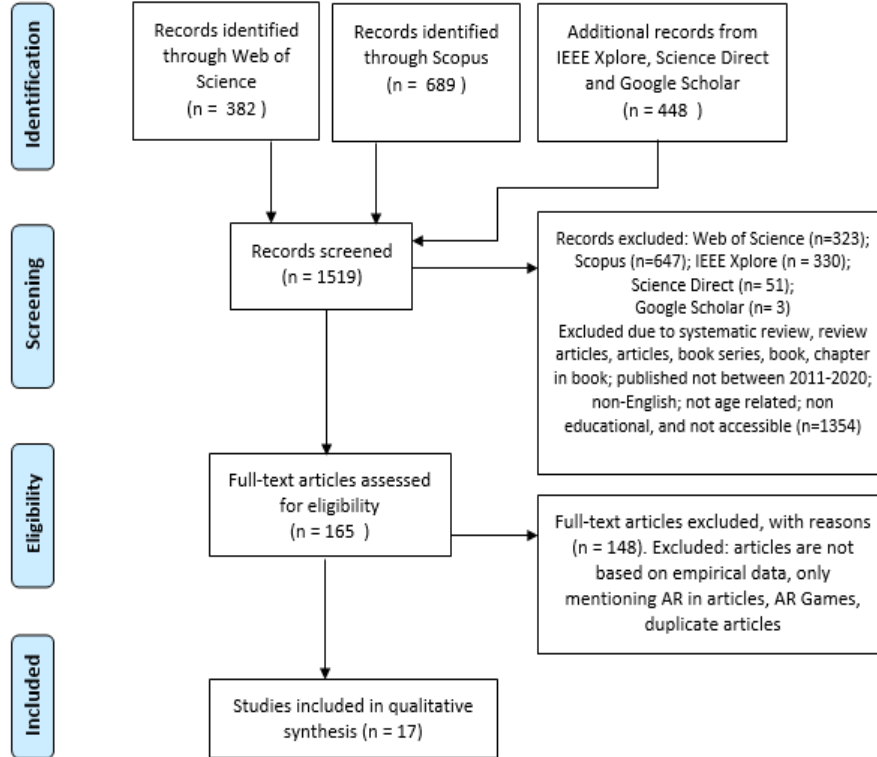
- Conducted in January 2020
- The first stage was to identify the keywords for the search of relevant articles, such as the words 'augmented reality' and 'preschoolers'.
- Keywords related to disabilities were excluded – children with disabilities & impairment have different needs (Shoib, Hussain, Mirza & Tayyab, 2017).
- Based on such keywords, 1519 articles were retrieved consisting of 382 articles from WoS, 689 articles from Scopus, and 448 articles from other additional resources, including Science Direct (n=63), IEEE Xplore (n=363), and Google Scholar (n=22)

Methodology

- The second phase involved the screening of the 1519 retrieved articles that removed 1354 articles based on inclusion and exclusion criteria.
- The third phase involved a careful review of the remaining articles.
- After careful examination, only 17 articles were selected for further analysis.
- The fourth phase is data abstraction and analysis (see next slide)

The Systematic Process

Methodology



Results

Themes and subthemes

The themes and subthemes of the design of AR applications for young children

Main theme	Subtheme	Recommendation
Information Design	Physical Content Design	<ul style="list-style-type: none">• The AR design for learning purposes must use educational-related content.• The contents must be appropriately designed based on young children's age.
	Virtual Content Design	<ul style="list-style-type: none">• The design of virtual contents (overlays) must use multimedia elements.
	Marker Design	<ul style="list-style-type: none">• Use 2D colorful images to attract young children's attention.• Marker must be invisible to increase children's level of imagination.• Used large markers with a border of 0.5 cm on each side.• Design markers with a handle to prevent children's fingers or hands from blocking images.• Set distances between markers within a 10-30 cm margin for easy marker detection.
Interface Design	User interface	<ul style="list-style-type: none">• AR applications must be designed with a simple user interface.

Results

Themes and subthemes

Interaction Design	Participant-application interaction	<ul style="list-style-type: none">• Point, scan, rotation, zooming, photo-taking, and games can increase children's level of interaction.• Use multimodal interaction to achieve a high level of interaction, such as voice recognition as an input.• Arrange makers that can facilitate easy selection (scanning) and design activities that can make children remain alert during the learning process.
	Participant-participant(s) interaction	<ul style="list-style-type: none">• Design activities that involve more than two participants to enhance children's sense of enjoyment and motivation.
Imagination Design	Animated virtual objects	<ul style="list-style-type: none">• Use animated virtual objects to increase young children's imagination.
	Characters	<ul style="list-style-type: none">• Use design characters that can respond verbally (using audios) such that children can feel they are talking with such characters during the learning process.
Immersion Design	Display size	<ul style="list-style-type: none">• Use large displays to immerse young children in AR applications

Conclusion

- As highlighted, five main themes (with nine subthemes) emerged from the review of 17 selected articles relating to the design of such applications, namely information design, interface design, interaction design, immersion design, and imagination design.
- As such, all five themes related to the design aspects of AR learning applications need to be carefully addressed and taken into account in developing efficacious AR learning applications for young children.

Conclusion

Conclusion

Overall, the findings of this study based on the systematic review of the current AR literature can be used as a guideline for developers of AR learning applications to ensure their products can be both efficacious and entertaining, the impact of which can surely improve children's learning performance, motivation, and interest.

Conclusion

Future works

- The findings of this systematic review can be used as a guideline for other researchers to conduct more in-depth studies relating to the impact of new designs of AR learning applications on young children's learning from the emotional, cognitive, and motivational aspects.
- In addition, future studies can use other types of databases to retrieve more articles regarding the AR design for young children.

Future works



Thank you

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