

Appendix 1: Definitions:

Through my research I have decided to use the following terms as reference from the material I have read regarding Augmented reality, virtual reality and mixed reality. I have placed them here so I have a reference to the meanings as in many publications the terms are being interchanged and in particular the immersion into the virtual world.

AR - Augmented Reality. Jorge et al. (2014) clarified AR technology as a technology which produces an environment for generating information by computers within the real world sceneries.

AR has been defined as an overlay of information or virtual objects into the real world, allowing a reality where virtual objects seem to coexist in the same space with the real world (Azuma, 1997). Augmented reality requires a trigger to activate an augmentation (a superimposition of 3D material).

VR - Virtual Reality. Refers to the complete immersion of a user 'in a synthetic world without seeing the real world' (Carmigniani et al., 2011, p. 342).

Fully immersive VR refers to the use of a head-mounted display, connected to or comprising a computer which allows the user to physically move or use a joystick to control movement within a 3D virtual environment (Lee & Wong, 2014; Southgate et al., 2016). Non-immersive VR, also referred to as desktop VR, involves accessing a virtual environment, 360-degree images/videos or other 3D environments using a desktop computer and monitor with peripherals such as a joystick, mouse or gloves to control movement and explore (Lee & Wong, 2014).

MR - Mixed Reality. Stretching along the virtuality continuum between AR and augmented virtuality is mixed reality. MR is a combination of both AR and VR that offers the ability to physically interact with virtual objects in the real world (Milgram & Kishino, 1994; Yusooff et al., 2011). Within an MR environment, the user is not only able to 'see' the virtual/digital overlay or object, but they can also physically or mentally interact with and/or manipulate it.

Metacognition. Has the power to improve pupil outcomes by encouraging deeper thinking. It helps to develop and deepen students' subject knowledge. This is because metacognition should enable pupils to think more cohesively about the subject content, for example, to make connections between content or apply old information in new contexts. It also develops their ability to think critically, which is an essential skill in the 21st century. Metacognition develops transferable skills, such as reasoning, analysis and evaluation, which is also critical skills for the 21st century. <https://www.educare.co.uk/news/what-is-metacognition>

LEA - Local Education Authority

DFE - Department for Education

Appendix 2:

Ontario Ministry of Education (OME). (2016). *21st-century competencies: Foundation document for discussion*. Ontario Public Service. Online document: [Mar 2022] http://www.edugains.ca/resources21CL/About21stCentury/21CL_21stCenturyCompetencies.pdf

Defines employability skills in the 21st century to be :

“The Conference Board of Canada (2000) has identified employability skills in three areas: Fundamental Skills (Communicate, Manage Information, Use Numbers, Think, and Solve Problems); Personal Management Skills (Demonstrate Positive Attitudes and Behaviours, Be Responsible, Be Adaptable, Learn Continuously, Work Safely); and Teamwork Skills (Work with Others, Participate in Projects and Tasks). It has also profiled innovation skills in the following areas:

- Creativity, problem-solving, and continuous improvement skills
- risk-assessment and risk-taking skills
- Relationship-building and communication skills
- Implementation skills.”

Skills versus Competencies, P9:

“The European Commission’s Cedefop glossary (Cedefop, 2014) approaches “skills” and “competencies” as follows: a skill is seen as the ability to perform tasks and solve problems, while a competency is seen as the ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development). A competency is not limited to cognitive elements (involving the use of theory, concepts, or tacit knowledge); it also encompasses functional aspects (involving technical skills) as well as interpersonal attributes (e.g., social or organizational skills) and ethical values. A competency is therefore a broader concept that may actually comprise skills (as well as attitudes, knowledge, etc.).”

Source: The Learning Partnership (unpublished internal report; reprinted with permission)

21st Century Skills Frameworks Across Canada and Internationally (as of July 2014)															Accountability / Responsibility	Adaptability / Flexibility	Analytical skills	Character	Citizenship / Civic & Community	Collaboration / Teamwork	Communication
CANADA: Government/Education															✓					✓	
Government of Alberta: Education and Training (2013)																					
British Columbia Ministry of Education- Premier's Technology Council (2010)																✓			✓		
Employment and Social Development Canada (2014)																					
New Brunswick Department of Education: Anglophone Sector (2010)															✓	✓	✓				
Nova Scotia School Boards Association (2014)																✓		✓			
Ontario Ministry of Education: Achieving Excellence (2014)																✓			✓		
Ontario Ministry of Training, Colleges, and Universities (2012)																✓					
Prince Edward Island: Minister's Summit on Learning (2010)															✓		✓		✓		
CANADA: Other																					
Canadians for 21st Century Learning: C21 Canada (2012) - Non-profit															✓			✓		✓	
Conference Board of Canada (2012) - Non-profit																					
Canadian Council of Chief Executives (2012) - Non-profit															✓	✓					
Council of Ontario Directors of Education (2012) - Non-profit																					
Don Tapscott (2008) - Canadian Businessman																					
Education Quality and Accountability Office (2012) - Non-profit																✓					
Michael Fullan (2013) - Canadian Educator																	✓				
Pearson Canada (2014) - Corporate																✓					
Royal Bank Canada (2014) - Corporate																				✓	
Seneca College (2014) - Postsecondary Institution															✓		✓				✓
INTERNATIONAL																					
Assessment and Teaching of 21st-Century Skills (2012) - Finland, Singapore, USA, Australia, University of Melbourne, Microsoft, Intel, and Cisco															✓				✓		✓
Cisco Systems, Inc. (2008) - Corporate																✓				✓	
Deloitte International (2014) - Corporate																					
Organisation for Economic Co-operation and Development (2012) - Non-profit																✓					
Singapore Ministry of Education (2014) - Government															✓			✓			
The Partnership for 21st Century Skills (2009) - U.S. Department of Education, AOL, Apple, Cable in the Classroom, Cisco, Dell, Microsoft, National Education Association, and SAP															✓	✓			✓	✓	
U.S. National Research Council (2012) - Non-profit															✓	✓	✓		✓		✓

Appendix 4: Alistair Smith – Accelerated learning cycle and VAK learning styles

Info from - <http://www.magicalmaths.org/what-is-the-accelerated-learning-cycle-in-teaching-learning-finally-a-summary-of-alc/>

Accelerated learning cycle

This is a summary of each of the phases;

1. Connection

- This stage is about orienting the learner to the learning.
- Connect by grabbing their attention, through games, music, pictures and so on.
- Show the Big Picture and justify the learning to the learner, and explain why it will be useful.
- Describe the outcomes and share the success criteria
- Create and develop the learning environment.
- Connect to what has been learnt previously and what is known.

2. Activation

- This is where learners find the information and begin to make sense of it.
- They will need to use a variety of intelligences and tools to assist.
- Use VAK learning to cater for different learners.
- Activities such as description, reflection, & speculation.
- Solve problems in variety of situations and allow learners to construct own meanings.

3. Demonstration

- This is where learners have the opportunity to show that they have understood what they have learnt so far in the lesson.
- Learners are to demonstrate what they know.
- Learners to share what is being learned.
- Feedback on improving and moving forward.

4. Consolidation

- In the final stage of the cycle, students have the opportunity to consolidate their learning through meaningful review.
- Reflect on what has been learned and where to go next.
- Combine paired, small group and whole class activities.
- Preview what will come in the next lesson.

VAK learning styles form a model of learning designed by Walter Burke Barbe and later developed by Neil Fleming.

<https://engage-education.com/aus/blog/vak-learning-styles-what-are-they-and-what-do-they-mean/#!>

The VAK learning model divides people into three categories of learner:

1. Visual learners – absorb information by sight
2. Auditory learners – absorb information by sound
3. Kinaesthetic learners – absorb information by moving

VAK learning styles: visual

Visual learners absorb information primarily by seeing it, or by visualising it mentally. They:

- Are imaginative and can easily picture complex scenarios, images or ideas without reference
- Enjoy art, aesthetics and the written word
- Are excellent at spelling
- Take frequent notes
- Revise well using colour coordination, mind maps and flashcards

Appendix 4 - continued...

- Love graphs, maps, diagrams, flowcharts and written instructions
- May struggle with verbal instructions
- Find themselves easily distracted by visual stimuli such as sitting beside a window or being bombarded with pop-ups on a computer

VAK learning styles: auditory

Auditory learners absorb information primarily by hearing it.

They:

- Love verbal instructions and follow them easily
- Are sensitive to tone of voice, pitch and rhythm
- Understand and process information by talking it through
- Would rather record a lesson or lecture than take notes
- Are good at oral presentations
- Learn better with music on, provided that it is not distracting
- Thrive in group and panel discussions
- Are easily distracted by auditory stimuli such as background noise or being spoken to

VAK learning styles: kinaesthetic

Kinaesthetic learners absorb information primarily through movement in a physical way. They:

- Are good at hands-on problem solving
- Are physically coordinated and good at sport
- Enjoy expressing themselves physically and may engage in performing arts or dance
- Struggle with overly abstract or conceptual topics
- Have a good sense of direction
- May learn by drawing and doodling
- Excel at practical subjects such as construction, cooking and engineering
- May be restless or fidgety in the classroom

According to the VAK model the best way of lesson planning for a successful class should ideally incorporate activities that facilitate all three learning styles to cater to the needs of all pupils.

Appendix 5: Finding papers with keywords to see if any other evidence has been written on my specific topic question.

Search Criteria ^

Search for: ☒ Everything ☐ Physical Items ☐ Articles ☐ Special Collections

Search filters

Any field contains Augmented reality, virtual reality, mixed reality

AND Any field contains UK schools

AND Any field contains KS1 & KS2

Material Type: All items

Language: Any language

Start Date: 01 01 2014

End Date: 31 12 2022

+ ADD A NEW LINE CLEAR

Any field contains Augmented reality, virtual reality, mixed reality AND Any field contains UK schools AND Any field contains KS1 & KS2

SEARCH

No records found

Narrow your results

‘Augmented Reality primary schools england’ my search term on Accademia.

edu

This paper dated 2009... working on a project called ARISE,

(Augmented Reality in School Environments), seems to be the

closest fit to my question.

Pemberton, L. (2009). Collaborative augmented reality in schools. Proceedings of the 9th International Conference on Computer Supported Collaborative Learning - CSCOL'09. [Accessed online] https://www.academia.edu/60950387/Collaborative_augmented_reality_in_schools

Collaborative Augmented Reality in Schools

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Abstract: Augmented Reality as an interactive real-time technology combining real and virtual objects in a real 3D space carries enormous educational potential. We describe a project (ARISE: Augmented Reality in School Environments) that aims to realise this potential by developing a collaborative, robust and affordable Augmented Reality learning platform for schools. The learning affordances of Augmented Reality are discussed, and an educational application is described that supports remote collaboration between students in a shared 3D workspace, where students from different countries present, discuss and manipulate virtual objects relating to their local culture. The evaluation of the application is based on a distributed summer school project involving students from two European countries. In addition to more conventional evaluation approaches, special requirements for evaluating remote collaboration in a shared Augmented Reality workspace have been met with a customised approach involving synchronised video observations in both locations with subsequent editing of the material into and a single screen giving a comprehensive overview of the collaboration from both ends. The results of the evaluation study are currently being analysed, but preliminary findings suggest that the Augmented Reality learning platform has been well received by students and teachers, and is well suited for remote collaborative learning.

Overview

Augmented Reality (AR) has a range of affordances that resonate with learning theory. Reflecting the early stage of the technology however, much of the research into AR focuses on technical issues while only little research has been carried out to explore its educational potential. One reason for this has been the lack of robust, reliable and affordable AR displays and applications that allow the technology to be evaluated in an authentic educational context. The ARISE (Augmented Reality in School Environments) project tries to fill this gap by developing an affordable AR learning platform suitable for deployment in schools, and creating educational applications that leverage the specific learning affordances of the technology. The main objective of the project is to test the pedagogical effectiveness of AR in the classroom and to facilitate remote collaboration between school students. The resulting AR display Spinnstube is based on off-the-shelf hardware components and open source software, thus keeping costs to a minimum while offering a reliable and high quality AR experience. Up to four Spinnstube devices can be arranged around a table for co-located collaboration, as the system keeps the desktop free from construction parts that might impede natural communication or restrict the movement of hands when sharing real or virtual objects. In a remote collaboration scenario, Spinnstube devices are networked to provide a shared workspace where collaborating students can view and manipulate virtual objects and communicate over an additional audio channel. In order to evaluate the learning platform, from both usability and pedagogical perspectives, three successive educational applications were developed between 2006 and 2008 and evaluated in summer school projects with students from Malta, Romania, Lithuania and Germany.

Learning Affordances

As an interactive real-time display technology that combines and registers real and virtual objects in a real 3D space (Azuma, 1997), AR has enormous educational potential. The presentation of objects in 3D lends itself to the exploration of spatial problems that are difficult to grasp in 2D media (Woods et al., 2004) and supports the development of spatial abilities (Seichter, 2007) as an important component of human intelligence (Gardner, 1983). The combination of real and virtual objects in a real 3D space gives rise to new kinds of tangible user interfaces that eliminate the artificial seam between the real world and the shared digital task space (Iskii et al., 1994) and may be more suitable for younger children (Billinghurst, 2002), a quality that resonates with Piaget's (1970) view that learning materials and activities should involve the appropriate level of motor and mental operations for a child of given age. The ability of AR to offer different views on the same object or situation can be used to facilitate extrapolation by helping learners to go beyond the information given (Bruer, 1973) and to aid cognitive development through adaptation by giving alternative views on already familiar objects or situations (Piaget, 1970). Collaborative AR systems support learning through communication and social interaction (Bandura, 1977; Vygotsky, 1978) where learners develop a deeper understanding of concepts by exchanging ideas with peers engaged in the same activity (Salomon 1993) and reflecting on their experiences (Kolb, 1984). Finally, AR engages and motivates learners (e.g., Hornecker and Dunser, 2007; Lamanaukas et al., 2006, 2008) and can provide a bridge from instruction to construction: the dynamic control of augmentation

[illegible]