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22nd May 2024

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22nd May 2024

Augmented Reality

The Epic Impact Of Augmented Reality In Primary Science

A new project sponsored by the creators of Fortnite aims to explore the impact of augmented reality (AR) in primary school science. Warren Fearn and Dr Katy Bloom discuss its findings.

Primary science education has faced significant challenges since the 2009 disapplication of KS2 Science SATs, which has resulted in the teaching of science at primary level becoming more fragmented, despite it still being a core subject. This has coincided with a sea change in the information consumption habits of children, who now have vast amounts of information at their fingertips through smartphones and platforms like TikTok and Instagram, which deliver content in short, digestible bursts. But how critical are they of the information they receive through these channels?

In response to these challenges, the EPIC AR PROJECT secured an Epic Mega Grant, sponsored by the creators of Fortnite, with the aim of fostering innovation among smaller teams, solo developers and innovators. With this funding, the project aims to pioneer an immersive educational AR experience using the Unreal Games Engine. Through collaborative efforts, a pop-up AR exhibition focused on science relating to 'climate change' was designed to be implemented in schools across York and is currently being piloted in some York schools.

What is augmented reality?

Augmented reality (AR) is a technology that overlays digital content onto the real world, enriching a user's perception of their surroundings. Unlike virtual reality (VR), which immerses users in entirely virtual environments, AR seamlessly blends digital elements with the physical environment in real time. Mixed reality (MR) combines aspects of both AR and VR, allowing digital objects to interact with and respond to real-world elements. Extended reality (XR) encompasses all immersive technologies, including AR, VR and MR, along with other emerging digital experiences. While these terms share some similarities, they offer distinct experiences and applications.

AR's ability to superimpose virtual objects onto physical environments facilitates the visualisation of intangible concepts, aiding learners in understanding abstract ideas or unobservable phenomena (Wu et al., 2013). This immersive experience allows users to interact with digital content within their physical surroundings. Examples of AR applications include popular social media platforms such as Facebook, Instagram and Snapchat, where brands leverage AR features to engage audiences through interactive and entertaining activities.

Service design approach

The Epic project adopts a service design approach, recognising that AR technology necessitates consideration of various factors beyond just screen interaction. Tim Brown of IDEO highlighted in 2009 that everyday devices, like mobile phones, are essential services connecting users to communication networks. Therefore, to enhance services and overall customer experiences, service design employs a pragmatic process with four iterative steps: Exploration, Creation, Reflection and Implementation.

The project commenced with an exploration stage (questionnaires, interviews, observations and focus groups) with primary school teachers and Key Stage 2 pupils to gather user feedback. Subsequently, in the creation stage, a practical response was delivered in the form of a pop-up AR science exhibition based on the insights obtained, where science weeks provided an opportunity to deploy AR as an activity.

Currently, in the implementation phase, the project is evaluating the impact of the AR exhibition on pupil engagement in schools across York, aiming to assess its effectiveness in enhancing primary science education. As the project progresses towards its conclusion, ongoing testing is being conducted to determine how augmented reality can effectively engage young people and teachers in this educational context, ensuring continuous refinement and reflection of the approach based on user feedback and outcomes.

Reflecting on prior research regarding augmented reality for primary schools (Fearn and Hook, 2023), there's a need to explore why developers may overlook meaningful AR interventions in educational settings. There is common evidence from previous studies (Akcayir 2017; Wang 2017; Radu 2014 & Yuen 2011) that educators and learning designers need to collaborate in terms of creating sound pedagogy to develop AR applications that maximise learning outcomes.

Consequently, the EPIC project involves co-creation with key stakeholders. This collaboration extended to partnering with a blueprinting coder (GDXR Learn), utilising educational videos (ClickView), engaging a sound artist (Sonas Audio) and working with the Centre for Industry Education Collaboration to develop a functional AR prototype.

What did we initially learn about the barriers and opportunities for using AR in primary schools?

Primary schools face significant challenges related to budget constraints and disparities in resource allocation, with variations in device sharing among students posing a significant hurdle for adopting AR. Investment in portable devices is often determined by senior leadership teams, highlighting the need for strategic decision-making in resource allocation.

Additionally, shifting teacher mindsets towards embracing new technologies like AR is essential, especially for educators who may feel apprehensive or lack digital literacy. Continuous professional development is crucial to support teachers in integrating AR into their teaching practices effectively, ensuring alignment with individual styles and needs. However, challenges such as limited access to devices, reliable Wi-Fi, time constraints and IT restrictions further complicate the implementation of AR in primary classrooms.

Despite these obstacles, teachers have explored the integration of AR and VR experiences using applications like Google Expeditions, Aurasma and Merge 3D. While AR is recognised as state-of-the-art technology, its use is often perceived as limited to 'one-off' engagements rather than a mainstream educational tool. To promote wider adoption, AR applications must align with the national curriculum framework in England, emphasising clear pedagogical goals and assessment criteria.

Teachers envision AR as a powerful medium to connect science concepts to students' everyday lives, offering visualisations for abstract concepts and enhancing pupil engagement in STEM-related activities. Furthermore, AR presents opportunities to enrich science weeks and career fairs by creating interactive exhibitions that promote pupil engagement and contribute to the development of science capital among students.

Engaging and learning through AR

There are undoubtedly concerns about the ethical implications of using augmented reality. Southgate et al. (2017) argue there is a strong and moral case for commercial developers, educators and scientists alike to be accountable for the development and integration of ethical issues when designing VR and AR products for young consumers or engaging with children.

While working alongside young pupils during the Epic project, we used mobile tablets, as only children 13 years and above are considered suitable to use wearable devices for longer periods. Given that the experience was directed at young children, teachers were advised on using instructional methodologies with clear objectives, where the applications were intuitive to understand.

Therefore, the project integrated marker-based AR (Image Recognition) printed onto cardboard platonic shapes to help pupils navigate and understand a sequence of triggered activities for each station (Questions, Video, Watch and Interact). Pupils commented they liked scanning the markers as it was good for direction. ‘We like to scan it because it’s like magic!’ said one.

When observing classroom science activities, it was evident group work supported discussions and given class sizes, the project is designed for groups. Pupils did feedback on preferring to work in groups to support one another. Using smaller groups (maximum of three to one tablet) certainly worked better, with more

ownership of the learning, any larger and we observed pupils disengaging.

Generally, pupils took turns holding the tablet at different station points and worked collectively as a team; however, on some occasions, pupils taller in height held the tablet too high so shorter pupils couldn't view the screen. Occasionally, pupils would place their hands behind the tablet asking 'where does AR come from?' As pupils navigated their way around the exhibition looking for and triggering AR markers, we observed them making natural movements to move the tablets upwards and backwards according to the content on the screen, and at times lying down on the floor and talking about science.

Pupils commented on enjoying moving around the hall space with the tablet – standing in a static position holding the tablet for longer periods made their arms and hands feel quite tired. Movement was interesting in terms of 3D content creation; spatial awareness is something to consider when developing content. Surprisingly, pupils responded positively to watching AR videos, commenting that it was more of an interactive experience, and enjoyed watching in 3D space which enabled them to move around.

On one station, we designed the video in AR (think of a basketball match with screens in the centre from all angles) so pupils could walk around, whilst others floated around, or beamed onto the screen and appeared on a character's face! Pupils expressed preferring this interaction in comparison to TikTok and YouTube.

Pupils didn't question the graphical content and felt the graphics were quite realistic on screen, even as characters made funny noises (something highlighted from our research in relation to the video game Animal Crossing). In fact, pupils were interested in learning how 3D animation works; one remarked that they had: ‘Never been a fan of computing but really enjoyed AR’. Pupils’ feedback comments on the experience Included: ‘This is Sick!’ ‘EPIC!’ ‘Awesome!’ ‘Fun – not something we would do every day’ and ‘Hi-Tech!’

> During the session at Haxby Road Primary, children were fully immersed in climate change learning through various AR stations. This experience perfectly encapsulated the school’s science drivers: ‘hands-on, minds-on,’ ‘curiosity is key,’ and ‘language for learning.’ In summary, AR allowed the children to learn about a critically important topic in a way that was relevant, engaging, and age-appropriate.
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If augmented reality (AR) is to serve as an effective learning tool in future primary classrooms in the UK, designers and teachers must address the challenge of scaffolding children’s explorations and manipulations of AR elements within carefully designed parameters to achieve specific learning aims in a relatively short period. As noted by Kerawalla et al. (2006), AR should focus less on what children can see and more on describing the effects of their actions and what they have learned from them.

Our observations and focus groups with pupils, engaging with all five stations of the exhibition (Habitats, Healthy Eating, Materials, Renewables and Climate), revealed a pedagogical connection linking all stations under the umbrella of ‘climate change’. Pupils demonstrated an understanding of various environmental concepts, such as the non-recyclability of a crisp packet, the detrimental effects of deforestation on carbon dioxide absorption and the environmental impact of beef production. Additionally, interactive markers allowed students to actively participate in activities, such as removing pollutants from water and understanding the key factors for a bee’s survival.

When asked about remote learning using AR, pupils expressed enthusiasm for the idea, viewing it as a fun activity that enabled self-paced learning at home. ‘Mum would like it!’ said one. Thus, demonstrating the potential of AR to encourage science capital among students and engage them in meaningful learning experiences beyond the classroom.

Despite encountering glitches during the development stage – such as scaling issues and tracking loss due to camera-marker connectivity issues – it's important to acknowledge that the AR prototype built with Unreal Engine, utilising blueprint coding, represents an innovative approach. This process has provided valuable insights into both the design and build aspects of AR technology, while also offering the opportunity to deploy the AR experience in primary schools for trial purposes.

These trials aim to assess the impact of using augmented reality in educational settings, highlighting the potential benefits and areas for improvement in integrating AR technology into classroom learning experiences.

What is the future of AR Learning?

Currently, content creation involves using 3D software applications for computer modelling, texturing and animation. However, the growing evolution of AI-driven tools such as KREA and SORA are disrupting pipelines, enabling a broader audience to create graphical content without requiring specialised digital skills.

The advancement of cloud and edge computing presents exciting prospects for location-based augmented reality (AR) experiences. Applications like Pokémon GO have demonstrated how AR can facilitate interaction with our surroundings, hinting at the potential for AR to create immersive learning experiences beyond the confines of a traditional classroom. Spatial computing, which involves mapping environments and integrating virtual assets with real-world objects, offers a powerful tool for engaging young learners in educational science activities.

This evolving technology allows educators to design learning experiences that leverage the physical environment, providing opportunities for hands-on exploration and discovery. Hybrid and 'learn as you go' environments, as referred to by the OECD, can potentially open new doors for learning.

For now, we need to be asking: are schools AR-ready?

For more information and to learn more about the project, please visit Epic Science.

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