Module 3. Developing Virtual Reality Content for Education

Introduction

Classroom teaching and learning is undergoing unprecedented change with time. Various theories of education play their best role in the teaching/learning process, and Educational Technology provides an extra edge in implementing the same. Although we may not always realise but technology is an integral part of our daily lives. It influences how we communicate, socialize, connect, play, and learn. Technology augments its presence in our daily lives; it would be imperative to ensure the presence of the same in the classroom.

Gradually, technology has been making its way to revolutionizing the methods of teaching and learning. Technology has made its way to the classroom, increasing the engaging and interactive elements; many students benefit from it, right from Audio, Video, Graphics, and Simulations. In today's context, learners are already familiar with various technologies, which help modernize the classroom with computerized tools and apps that make sense in a classroom setting.

As we are moving into the next generation of the media revolution, "immersive" technologies like Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) are becoming the center of discussion in educational technologies. You must have seen sci-fi movies, where all data capture and interpretation is happening in front of glasses or goggles. With the advancement of science, all these technologies are available now, although primarily for commercial purposes. But these technologies equally can change the field of education if employed meticulously. So, before we understand developing content for such immersive technologies and their implication in education, let's first discuss what these technologies are.

1. Augmented Reality: Augmented reality (AR) is a view of the real and physical world in which users find elements enhanced by computer-generated simulations; by overlaying graphics, music, animations, GPS markers/logs etc. to augment the user environment.
   Literary, the word "Augment" refers to the action of adding to something to make it more substantial. Currently, Augmented Reality is being experienced by using a mobile/tablet device and/or AR glasses.

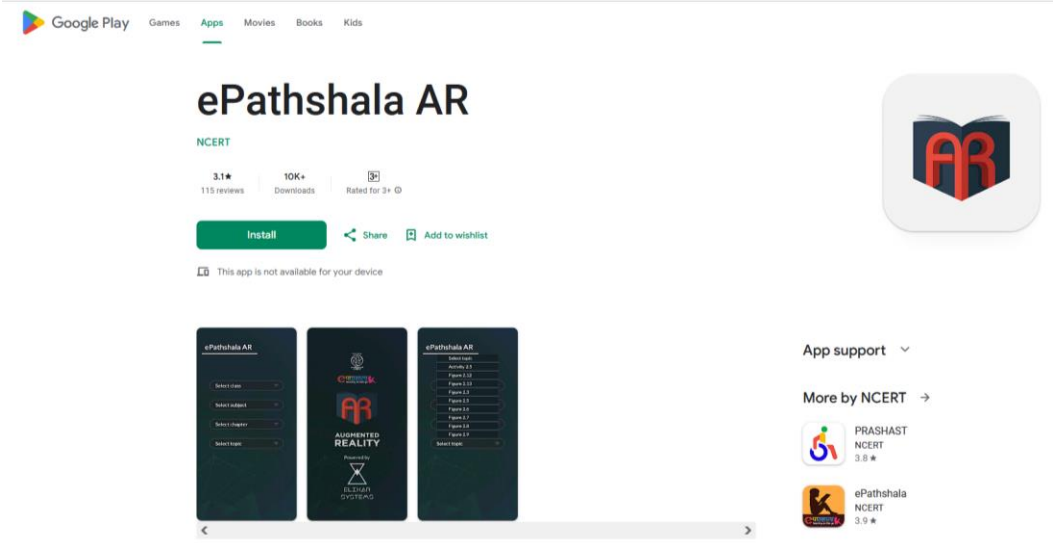
For example, pointing your device towards a building and all information popped out in front of you (building). You are in a place where you are unable to read the language and just by pointing your device, the entire content will be translated into your known language (lens). Or a dinosaur might be landing in front of you (dinosaur), etc.

So, with the help of software AR technology, add to the real environment to make it more enriched, helpful and user friendly. With advances in AR technology, all these examples might already be available in your smartphones through various apps.

"Augmented Reality may be defined as a system that performs three essential criteria: combining virtual and real-world, real-time interaction, and 3D effects of virtual and real objects. The projected sensory information may be additive to the natural world or destructive to the natural world. The AR experience is do intermingled with the physical environment so that it feels to be immersive as per the real world."

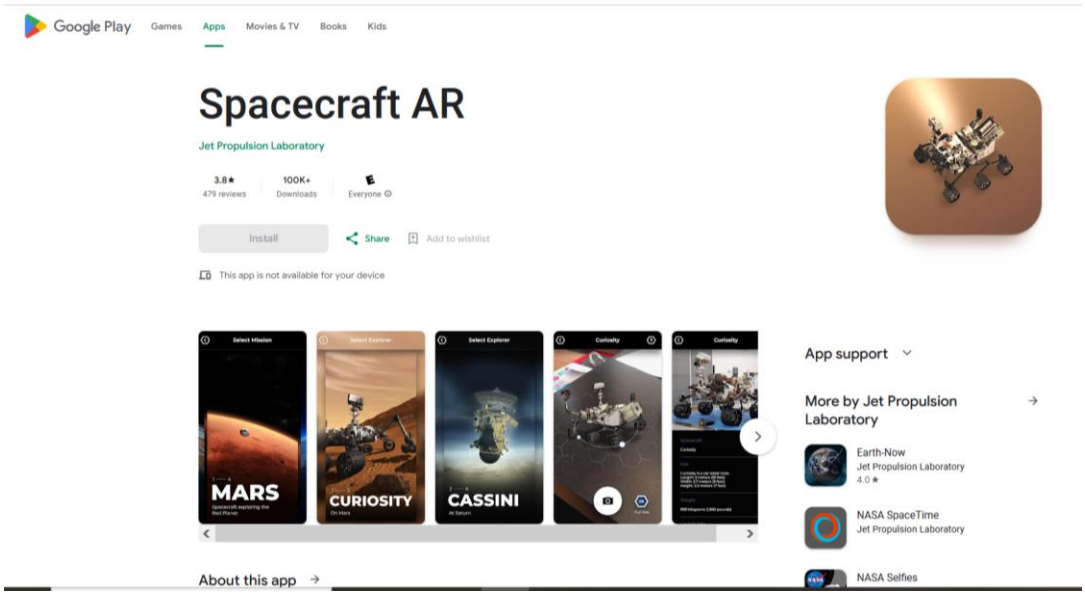
There are many ways to augment the environment around us, and each has its strengths and weaknesses. Generally, an AR experience requires a trigger to start, and this trigger helps the AR application decide to place the AR content. Depending on the trigger, AR content of the following types may be created:

a. **Marker-based AR**: Also called as Image recognition AR. In this case, an image act as a marker to trigger. The camera of the device scans the marker, which is different from the surrounding environment and triggers the application to place the content. Content may be in the form of images, Audio, Video, Animation etc. While rotating the marker camera, the content on the marker moves accordingly, but a deflection from marker may cause deviation in projecting the content. The Marker-based AR mostly handled through mobile apps. So, the users first have to download the app in their device to experience the AR. For example (NCERT AR App; https://play.google.com/store/apps/details?id=com.ncert.ARApps&pcampaignid=web_share).



b. **Markerless AR**: Also called location-based AR. This type of AR is more versatile and it doesn't require any image to cue to deploy the AR content. To trigger the AR content, it relies on the data from various sensors like GPS, gyroscope, accelerometer, digital compass aligned within the camera environment. The data from all these sensors provide input to understand the 3D environment. This process is known as SLAM (Simultaneous Localization and Mapping) and the programming to develop markerless AR is complicated than marker-based AR. SLAM algorithms bring AR to new environment, mostly limited to flat surfaces. Markerless AR may further be divided into location-based AR, Projection-based AR or Superimposed AR depending on the technology used.

   For example, the "Spacecraft AR" app developed by the Jet Propulsion Laboratory, NASA. The students can see and interact with various 3D models of spacecraft and to have a better understanding of probe even without visiting the actual laboratory (https://play.google.com/store/apps/details?id=gov.nasa.jpl.spacecraftAR&pcampaignid=web_share).



2. **Virtual Reality (VR):** As the name suggests, Virtual means "near," and reality means what we experienced. So, literary "Virtual Reality" means "near-reality."

Virtual Reality means feeling the imaginary (virtual) world. It is basically an experience taking place within a simulation, which can be similar to or completely different from the real world. The immersive artificial environment is created by using software and presented to the user so that the user accepts it as a real environment.

Unlike traditional user interfaces and viewing a screen in front of them, users are immersed and able to interact with 3D and the 360-degree world, which can further be simulated by using as many senses as possible, like hearing, touch, vision, and even smell.

Head Mounted Devices (HMD) are required to feel the immersive user experience in Virtual Reality. HMD may be stand-alone like Oculus Rift, HTC Vive, etc. Commonly available HMD with supported mobile devices.

Depending upon the immersive experience, VR content may be developed of the following types:

a. Non-Immersive VR: This type of VR is generally created and disseminated by using the Desktop system or any project screen. Users can see only the VR on-screen, and interaction is possible by using traditional keyboards, mice, and trackballs. To render non-immersive VR, one didn't require high-end devices or specialized hardware; any regular desktop, monitor, laptop or mobile phone can be used. Users can be navigated through various markers and other information in VR.

In some cases, if non-immersive VR be seen with HMD devices, they can provide semi-immersive experience. Like 360 degree VR tours can be seen through simple desktop and through HMD to have a semi-immersive effect.

b. Semi-Immersive VR: This type of immersive effect is created to allow users to experience VR in a three-dimensional world while remaining connected to real-world surrounding visuals like smells, auditory, and haptics. Users can interact with both the real world as well as the virtual 3D world but to maximize the immersion, focus on the digital world.

Semi-immersive VR set requires specialized hardware and high-end software to render 3D imaginary. In most of the cases following crucial elements are required:

- 3D virtual environment to generate a realistic effect.
- High-quality Dolby sound to sync with the 3D environment.
- Simulator hardware.
- Haptic feedback

You can view this video https://youtu.be/mcqXZI6VXtk

c. Fully-Immersive VR: Fully immersive virtual reality content is created to all the user to experience full emersion and be unable to differentiate between real-world and virtual world. Compared to semi-immersive VR, in fully-immersive VR; here the users are completely cut off from the real world. They wear Head Mounted Devices, unable to interact with the physical things surrounding them. Simply put, it is a perception of being physically present in a non-physical world.

   Ernest W. Adams separated fully-immersion into further three categories:

   i. Tactical immersion: being experienced when performing tactile processes.

ii. Strategic immersion: When user associated with mental challeneges and feel more cerebral immersion like playing a chess game in VR.

iii. Narrative immersion: When user experience the works like story reading, watching a play or movie.

Depending upon the process of experiencing moveability, VR may be of following types:

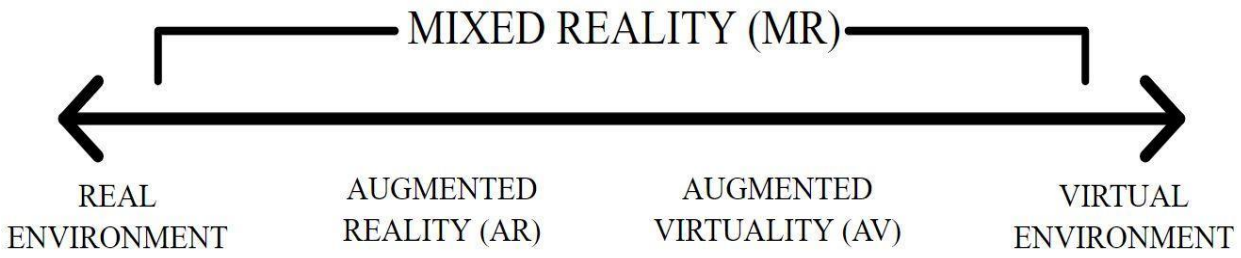
a. Static VR: Static VR can be developed by using 360 “Panormic” images. The images captured stitched together by using software to make a VR tour. The simmmple example is street-view tours available on “Google Map”.

   In this, the user can experience the immersion by sitting or standing at one place and turning their head around.

b. Moving VR: In this case, the user can move to experience the full immersion. He/She feels that they are moving inside the scene.

3. Mixed Reality (MR): It combines the features of Virtual Reality (VR) and Augmented Reality (AR) and also called Augmento-virtual reality. Mixed Reality merges the physical and virtual

worlds, including real and computer-generated objects. A user can navigate the environment and interact with real and virtual objects.



In mixed reality, virtual objects are not just overlaid on the real world, but the user can interact with them.

Mixed reality is a step beyond the Augmented reality. MR combines the physical and virtual world, user can also interact with them as well and blur the perception of what is real and what is not.

3.1. Technology to deploy:

a. Head Mounted Device (HMD) or VR headsets: The foremost necessicity for fully immersive experience till now is Head Mounted Device (HMD) or VR headsets. There are numbers of HMD/VR headset available currently with spcialised configuration and performances. Simplest and cheapest or entry level is Google Cardboard which requires mobile phone as screen. Advance HMD are stand alone, didn't require separate mobile phone like HTC Vive, Oculus Rift, Samsung gear and most advanced Hololens 2 developed by Microsoft Corporation. Some of them requires high end PCs or Laptop to stream high quality content at high frame rate.

   HMD equipped with various sensors like GPS, Gyro meter, Accelerometer, Camera, infrared locators, trackers etc.

b. Computer: Computer assisted devices requires to process heavy data in high speed which requires high end latest generation processors like Intel Core i7. Separate graphics processing Unit (GPU) is required.

c. Important key terms, their description and why it matters to know them while deciding a about deploying MR (Courtesy: Intel):

Term	Description	Why It Matters
Frames per second (FPS)	Frequency at which a system can display consecutive images, or frames	Without a high and constant frame rate (greater than 60 FPS), the motion won't look right, and you could even feel sick
Field of view	The angle of the observable world that can be seen	If the window of view is too narrow, you could end up making unnatural head rotations
Degrees of Freedom (DoF)	The number of directions that an object can move or rotate. The six degrees of freedom are pitch, roll, yaw, left and right, forward and backward, up and down	More DoFs allow you to move more naturally in VR
Latency	The amount of time it takes a system to react/respond to movements or commands	Latency is critical when it comes to the presence inside Virtual Reality—if the system doesn't respond instantly, it doesn't feel real.

So, with the changing time and changing behavior of the learners towards technologies, the teaching-learning process should also change. The immersive technologies like Augmented and Virtual reality will be helpful not only in providing the quality education but also save millions of

rupees for training and developing infrastructures. In next module we will discuss the Mixed reality, its applications and implication of Augmented Reality, Virtual Reality and Mixed reality in education.