DESIGN PROJECT

Important dates

1. Project Proposal Idea: **November 9.** 23:59 hrs (CST)
2. Design Meeting: **week-12.** 21hrs (CST)
3. Activity Analysis: **November 20.** 23:59 hrs (CST)
4. Design Meeting: **December 4.** 9-12hrs (CST)
5. Final Paper: **December 11.** 23:59 hrs (CST)
6. Final Presentation: **December 11.** 09:00 hrs (CST)

Important links

LSRC594-2020 Final-Project Document Reference

Universum proposal

AR Universum site

ACM Master Article Templates AND Publication Workflow

Appointment page for meeting with Brenda

UNIVERSUM

Project description

Universum is an AR application planned to function as a support in the teaching of topics related to the solar system and its various complements through more visual and interactive supports than those offered in traditional methods.

The application will use a plane of the solar system in A4 size to show the operation of the entire system and its appearance in 3D models, it will also work in conjunction with A6 size cards to show the different elements of the solar system such as stars or planets in a more specific way.

Targeted age

- Kids 8-11 years old
    - 3rd grade-6th grade

Activity Analysis

The application will serve as support to traditional teaching methods, representing an addition of new techniques that include the use of mobile devices, like tablets or cell phones, which are already part of the technological objects commonly used by people, including children.

Beside, it will incorporate ludic and didactic tactics in order to attract most of the attention from kids, creating some sort of recreational and playful environment, making the learning process more fun and interactive.

Therefore, for its main characteristics the application can be described as a ludic AR atmosphere for kids among 8-11 years old. These characteristics were chosen based on what was said for different authors over the years. In first instance, is is set that from childhood to maturity, play has a central place at each stage of development in its different forms, styles and meanings (Erikson, 1950; Piaget, 1962; Vygotsky, 1978; Wolf, 1984), and in Mainemelis et al (2010), is established that:

> …play exemplifies one of the highest forms of experiential learning in three fundamental ways: first, it encourages learners to take charge of their own learning based on their own standards of excellence. In play, learners achieve authentic and higher order learning by creating their own game rules and conduct. Second, an equal value is placed on the process and the outcome of learning. Play does not happen staring at the scoring board. Outcome acquires meaning only if equal attention is paid to the experience and the process of play. As Dewey (1997, p. 167) says, a truly educative experience sees no difference between utility and fun, the process and outcome. Third, in play, the experiential learning cycle is fully engaged by allowing players to come back to the familiar experience with a fresh perspective. The recursive nature of the play activity gives continuity for the individual's experience to mature and deepen, moment-to-moment, and stage-by-stage. Taken together, these three factors are the key principles of a learning space conducive to deep learning.

In addition, James and Swain (cited in Johnson-Glenberg, 2017: 196) point out that «when 5- to 6-year-old children actively manipulated an object while hearing a new label and then heard the label again, motor areas of their brains were more likely to be activated upon subsequent viewing compared with when they were only allowed to passively watch an experimenter manipulate the named object» (James & Swain, 2011).

«Augmented reality refers to technologies that project digital materials onto real world objects» (Cuendet, Bonnard, Do-Lenh, Dillenbourg, 2013: 557).

«Squire and Jan (2007) describe AR as:

> …games played in the real world with the support of digital devices (PDAs, cellphones) that create a fictional layer on the top of the real world context… Place-based augmented reality games are played in specific real-world locations (historical, geographical sites) and use handheld computers with global positioning systems to augmented users' experience of space with additional data (text, numerical data, audio, video). (p. 6)

» (Dunleavy, Dede, Mitchell, 2009: 9).

«By overlaying media elements into the users' real-world context, Augmented Reality can provide cognitive support for difficult tasks» (Bower, Howe, McCredie, Robinsons, Grover, 2014: 3).

«A key pedagogical affordance of Augmented Reality is the ability to rescale virtual objects, from molecules to planetary bodies, allowing students to better understand through manipulation the properties and relationships of objects that would be either too small or too large to examine effectively in their normal day-to-day lives (Johnson et al., 2010). Though other technologies may perform the same function, rescaling in Augmented Reality systems provides the user a clear representation of spatial and temporal concepts as well as the extra advantage of contextualizing the relationship between the virtual object and the real-world environment (Sin & Zaman, 2010)» (Bower, Howe, McCredie, Robinsons, Grover, 2014: 5).

«These are important functions of Augmented Reality – to offer knowledge in a way that is more closely and immediately related to the world around us» (Bower, Howe, McCredie, Robinsons, Grover, 2014: 12).

«Inducing a participant's symbolic immersion involves triggering powerful semantic, psychological associations by means of the content of an experience» (Dede, 2009: 66).

«Immersive interfaces can foster educational experiences that draw on a powerful pedagogy: situated learning. Situated learning requires authentic contexts, activities, and assessment coupled with guidance from expert modeling, mentoring, and "legitimate peripheral participation (*6, 7*)"» (Dede, 2009: 66).

«Interactives games and simulations of science phenomena are increasingly being used to supplement education, designers need to know how to create optimal interactive content» (Johnson-Glenberg, 2017: 194).

«Tang et al. [29, 30] observed college-age students performing a similar object assembly task. Users were split into four groups: paper-based 3D diagram, monitor-based 3D diagram, head-mounted display (HMD) 3D diagram, and HMD AR display. Users in the AR condition had the fastest task completion times and lowest amount of errors (this result was significantly different than the paper-based group, but not significantly different compared to the other groups). Users in the AR condition also had significantly lower cognitive load compared to the other conditions, measured through NASA TLX» (Radu, 2014: 1536).

«These affordances for learning are not limited to AR systems, and they can be present in any computer-based simulation. The benefit of AR specifically is that it allows users to be immersed in the simulations [47], to easily collaborate with others around simulations by leveraging nonverbal cues [32] and to leverage the benefits of simulations in understanding complex 3D phenomena that would be difficult to comprehend through other media [48]» (Radu, 2014: 1540).

«Emerging technologies such as Augmented Reality (AR), have the potential to radically transform education by making challenging concepts visible and accessible to novices» (Radu, Schneider, 2019: 2).

«The AR applications compared to non-AR show improvement in student abilities to visualize structural phenomena [5, 6] reduced cognitive load [22], improvements in motivation and self confidence [19, 6]» (Radu, Schneider, 2019: 3).

«Furthermore, the interaction of student learning and human developmental factors should be taken into account, such as investigating how student's developing cognition, motor, and spatial skills influence their ability to use and understand AR-based educational content. An initial step in this research direction is addressed by the author's previous work in [51], which discusses how yoin children's psychological and physiological development influence their ability to use AR applications» (Radu, 2014: 1541).

«Scientists and students have used physical models for many years to help understand the three-dimensional structure of molecules. Tangible interfaces built to support learning in these domains have augmented existing physical models by overlaying augmented-reality representations on top of the physical models to provide extra or dynamic structural detail» (Marshall, 2007: 164).

«Additionally, embodied cognition research indicates that mixed reality technology can be designed such that students physically enact an abstract concept, such as the concept of balance [43] or mathematical ratios [44], and that these experiences have the power to change student understanding» (Radu, 2014: 1539).

«Affect is exploited by creators of computer games to keep students engaged with their products for extended periods. Cognitive strategies for engaging students in learning environments are aimed at bringing about conceptual change, usually through problem solving or discovery learning» (Richards, 2017: 15).

«It is important for apprentices to play with multiple representations of the same phenomenon. The teacher may decide to use multiple representations, but this has not been imposed to teachers by inventing problem representations that are not the standard ones» (Cuendet, Bonnard, Do-Lenh, Dillenbourg, 2013: 562).

«The term 'embodied' can mean many different things, here it means that learners are moving their bodies in a mediated environment in a manner that aids in comprehension; it encompasses using representational gesture as well as constructing models with virtual and real manipulables» (Johnson-Glenberg, 2017: 193).

«In particular, Ainsworth [2] provides an accessible framework of the design factors associated with learning with multiple representations, the functions that these representations can play, and the cognitive tasks that have to be carried out by learners when interacting with them» (Marshall, 2007: 166).

«AR improves student understanding of structures that are either spatially complex or invisible to the naked eye [15, 16, 10]. Benefits come from visualization of otherwise inaccessible representations, and from permitting students to perform low-cost and low-risk experiments [7], providing information in the most educationally-relevant context [4], allowing physical practice for learning of tacit knowledge [11], providing motivation for students to engage with content and peers [5, 23], encouraging collaboration by equalizing access to information [17], and facilitating reciprocal teaching and authentic cooperative inquiry [16]. From an educational perspective, learning scientists have formulated theories about the benefits of Multiple External Representations (MERs) [32]. MERs support conceptual understanding by encouraging the use of multiple strategies, offering different perspectives on a problem and taking advantage of users' familiarity with one representation to help transition toward a more complicated representation [32]» (Radu, Schneider, 2019: 2).

«Providing such dynamic representations aligned in a physical context through AR, allows learners to easily keep track of relevant information while exploring the dynamic nature of relationships between important variables» (Radu, Schneider, 2019: 10).

«Finally, I examine how immersive media such as virtual reality, augmented reality, mixed reality, and multi-user virtual reality can work as supplemental digital materials for instruction and assessment» (Richards, 2017: 89).

«Artificial environments can use computer technology to create metaphorical representations in order to bring to students concepts and principles that normally lie outside the reach of direct experience» (Winn, 2002: 9).

Requirements analysis

- Design specification: laying out particular design decisions in creating the learning environment.

Design Specification

Objectives

General objectives

- The AR application will be designed to work for different scholar grades (from 3rd to 6h). That's why it should be adaptable in order to offer the required information according to each grade.
- It is not planned to be used as a complement for traditional methods, but as an aiding resource focused on interactive and collaborative methods for children.

Learning objectives

The learning objectives respond to expected learning established on the study programs from the Public Education Secretary (SEP, Secretaría de Educación Pública) in Mexico. According to them, children in elementary school, among 3rd and 6th grade take the Natural Science course where it is taught about the solar system through different readings and practices outdoors.

Specific objectives

- Describe the characteristics of the components of the solar system.
- Represent the regular motion of the planets and some of their characteristics.
- Describe the Sun's movement.
- Explain the Moon’s eclipses and phases in a Sun-Earth-Moon system.
- Decide flashcards visual design.
- Start modelling the 3D objects.

Resources

- Adobe Photoshop & Illustrator - Design of the A4 map and A6 cardboards
- Sketch-Up - 3D Modeling, Application of textures and materials
- V-Ray - Rendering
- Sketchfab, clara, archive3d, 3dwarehouse.sketchup, turbosquid, cgtrader, quixel, mixamo, free3D, poly, solar system scope - 3D models in .fbx, .obj, etc.
- video1, video2, video3, video4, video5, video6, video7 - Video tutorials.
- Unity with 2019.4.9f1 version - Exporting of 3D models, addition of text and other features, and creation of mobile application (.APK file)
- AR FlashCards (planets and star)
- We will look up flashcard images online first
- Otherwise, we will need to design our own flashcards.

Key design decisions

The main decisions were taken in face of making an AR application for kids, since in many of the course’s readings was mentioned that engagement and immersion highly increases when these technologies are implemented (Dunlevy, 2009; Radu, 2014).

Opportunities for data collection

Interviews with both type of users: teachers and students

Ways to assess learning outcomes

Beside the visualization of the components of the solar system, the application can include some after questionnaires whose results can be sended to the teachers.

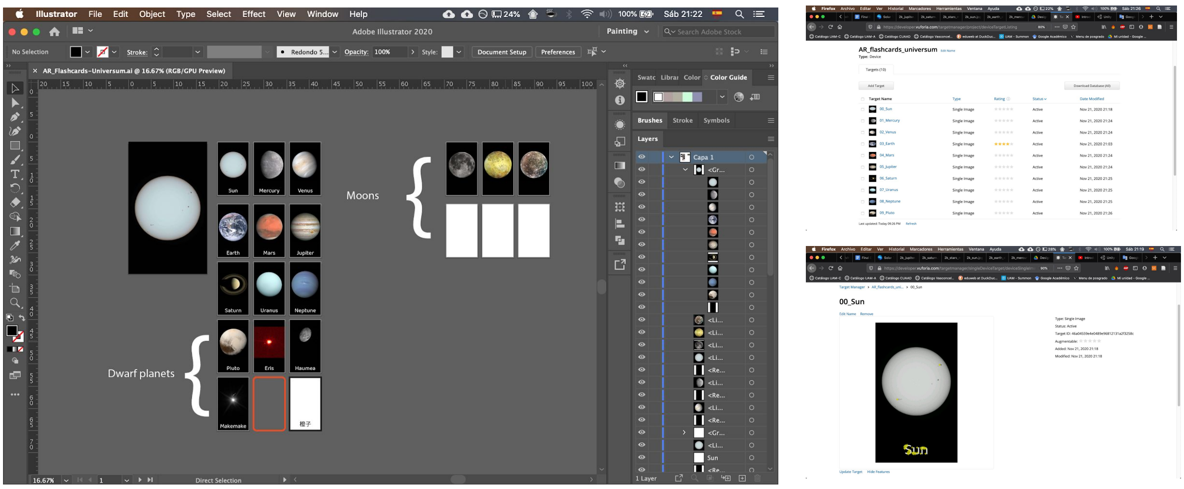
Aside, the functionality of the application can be evaluated through more traditional methods like tests or reports.

Ways to evaluate the design

The results of the questionnaires included after the visualization of the components can be also saved in a server to evaluate which aspects are left behind for the users, apart from it, the feedback from the interviews with teachers and students can also work to see deficiencies on the application.

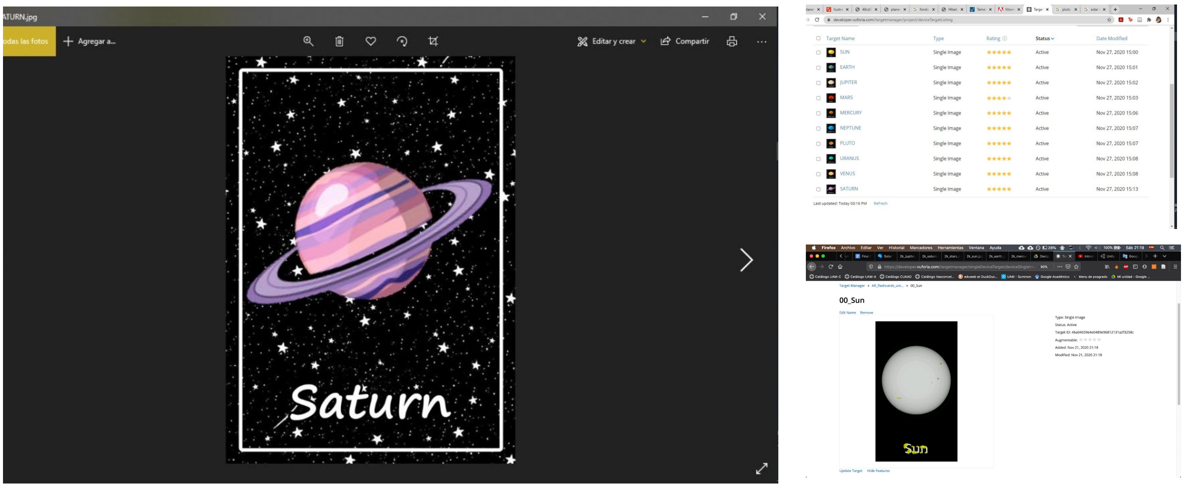
Alpha version of the software

Figura 1. Flashcards versión 0.1



Fuente: elaboración propia

Figura 2. Flashcards versión 1.0



Fuente: elaboración propia

Table 1.

Sample development process

Milestones	Description	Due date
#1	Prototype the ideas, prepare a storyboard, and try to enact it before any development	
#2	Implementation of AR Project submission	
#3	Images references for the AR flashcards	
#4	AR targets testing and design Project presentation & report	
#5	Card design, audio, 3D models	
#6	Check platforms OS	
#7	Implementation of AR	
#8	AR targets testing and design	
#9	Project Development and release/submission	
#10	Webpage reporting results	

Tip: This is good opportunity to catch yourself if you're being too ambitious

Don't worry: This is just a best guess right now, if you want to change your project completely next time, you could.

Table2.

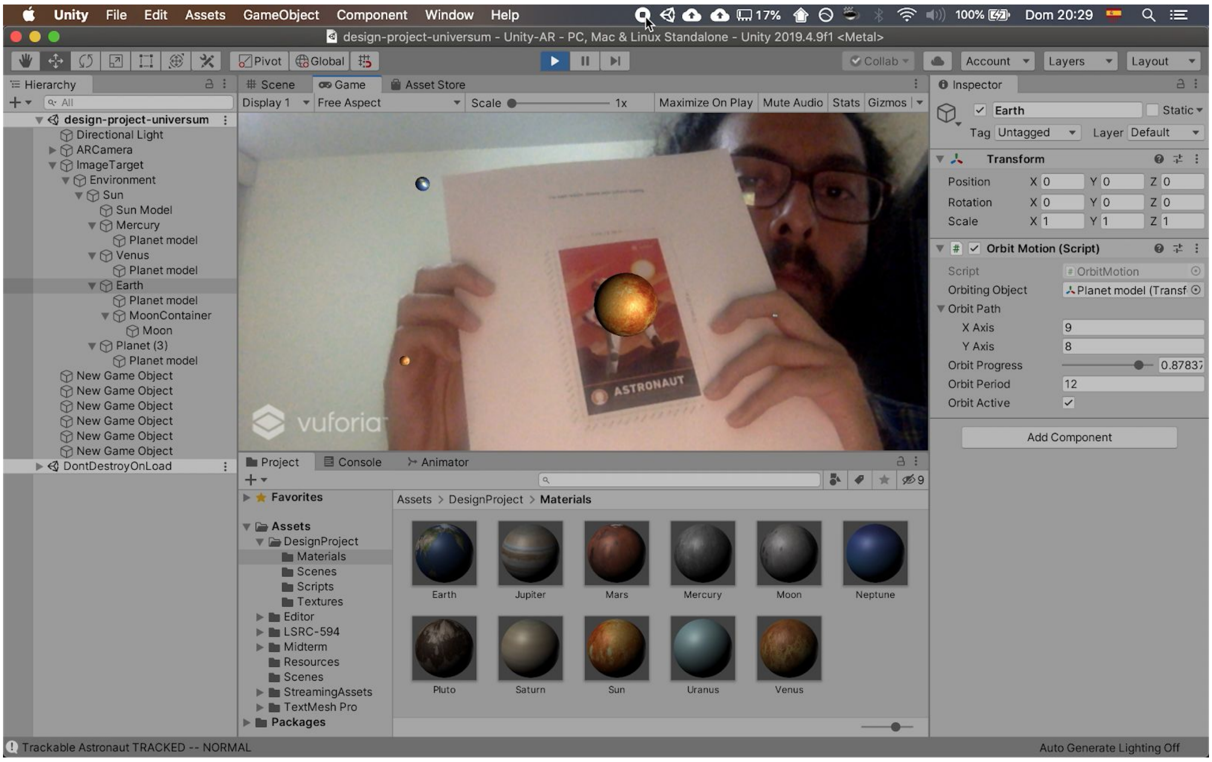
Storyboard

Time	Image	Audio	Description
00:00-00:05		-	The kid approach to the AR flash card
00:05-00:10		-	The kid hold the mobile device and aim it to the card
		-	The AR application shows the content assigned to the card

Note: add images of how you envision the experience. Consider the user, objects of augmentation, and digital content.

Video figure

- The video must be no longer than 30-45 seconds
- video must include an opening title



Still image

You are required to upload a still image of at least 1500 x 1200 px that represents your work.