Journal of
Design Studio
v:1 n:2 December 2019

Teaching Virtual Reality and Immersive Design

How should immersive design be taught ?

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Received: December 15th 2019, Accepted: December 27th 2019
Refer: Sezer, C.B., (2019), Teaching Virtual Reality and Immersive Design, Journal of Design Studio, V.1, N.2, pp 5-11,

Abstract: This Study aims to develop an elective Virtual Reality and Immersive Design Course (VR & Immersive Design) for the spring 2019 term by the Architecture and Design Faculty, Communication Design (COD) Department in Istanbul Özyeğin University. The Communication Design department has an optional Game Design path for its Final year - senior students and this course aligns with the said path. The research mainly focuses on the interdisciplinary aspects of creating virtual worlds and defines teaching methods, course content and course goals along with assigning individual tasks to different students with various interdisciplinary backgrounds as team members. Overall this paper examines the following questions;

How immersive virtual environments are designed? How should Immersive Design be taught?

Keywords: Education, Virtual Reality, Immersive Design, Interdisciplinary, Game Engines

Why a Virtual Reality Design course is necessary?

Oxford dictionary defines Virtual Reality (VR) as "the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, like a pair of glasses with a screen inside or gloves fitted with haptic sensors."

Currently VR is quickly becoming a huge area of technology, with giants like Apple, Facebook, Microsoft and Google competing to provide the next big VR experiences. Statista predicts that the worldwide user base for VR will reach 443 million by 2025, meaning that it is becoming increasingly important for designers and Design students to know how to create VR experiences. Creating Virtual immersive experiences require completely new ways of thinking about design and questions how well we are equipped to tackle this new field of design? Businesses are already hunting for people who understand how to design technology and experiences for the new VR medium. This course will make it possible for students to gain skills and become leaders in applying VR in near future. With filmmaker Steven Spielberg's science fiction and adventure movie "Ready Player One," narrating an immersive virtual universe (March 2018), Virtual Reality has finally passed to popular culture. Furthermore, statistics regarding VR usage in Universities show that; In our present day 18 Students share one VR headset compared to 6 months earlier when 51 students shared one VR headset. The amount of VR headsets per university has folded 4 times regarding this time frame. Every 4th university is collaborating in VR projects regarding Psychology, History, Cinema and Healthcare along with the predominant gaming and education fields. 79 percent of universities own at least one headset. (vrfirst.com, 2017)

VR and interdisciplinarity

VR and Immersive design is an interdisciplinary territory. Addressing modern academia it mainly covers the fields of Architecture, Industrial design, Communication Design and Computer engineering. Basically, Immersive environments require *space* to move in, *objects* to interact with, *3D interfaces* and *programming* to function.

The interdisciplinarity of VR is parallel with a similar trend in the design practice itself. Pares (2001), a well recognized VR researcher, puts forward that there are three basic forms involved in VR activities: The first one is *explorative*, the activity of navigating in virtual environments. The second activity is *manipulative*, the action of interacting with virtual elements and objects and the third activity is *contributive*, the ability of modifying and constructing the surrounding environment. These three basic forms of virtual activities correlate directly with the Spatial (space), material (object) and Visual (image) manifestations of the design domain. The design artefacts of Spatial, material and Image are of course related to Architecture, Industrial Design and Communication design with the exception that Communication Design is not

only responsible for the "Image" as in Graphic Design but also represents building "interactions". All these departments exist under the Architecture and Design Faculty and offer a value to the course creating an absolute productive platform

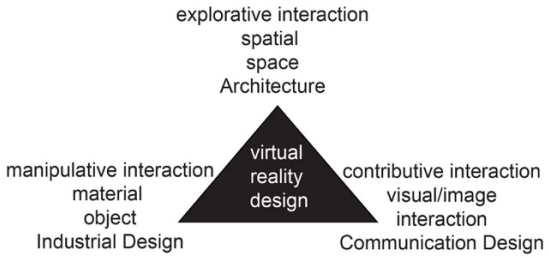

Figure 1. Virtual Reality Design Course and its relation with design departments.

Besides the Architecture and Design faculty, VR has a relation to the Computer Science under the Engineering Faculty as well since the creation of Virtual Environments include advanced programming.

Related literature on Teaching VR design emphasising Interdisciplinarity

Following extended research for papers concerning teaching virtual reality, a trajectory of the topic of developing VR courses surfaced. Literature shows that one of the first papers related to the interest of teaching VR belongs to Bell (1996) who was the first to study the creation of a VR course. His course focused on teaching VR concepts more than implementing VR applications due to the lack of expensive VR hardware at the time. After this came Burdea (2003) who refers to limitations like; scarce literature surrounding the topic, the lack of specialised VR Labs and inexperienced lecturers. He remarks the upcoming market for the utilisation of VR technologies and points out to the demand for such a course in relation to the expanding job opportunities regarding VR specialists. Claiming VR education has been deficient at the university level Burdea also stated that it cannot be taught adequately without specialised laboratories. The international survey Burdea did in 2003 showed that only 148 of universities offered a virtual reality course and 273 universities later in 2008. Today with the advancements in technology many more VR courses have been established mostly taking the form of lectures and practical approaches. A high percentage of the existing courses are provided to computer science students with the intention of consorting computer vision. However, it is solemnly understood that in recent years this teaching methodology is changing towards a more interdisciplinary trend for its better project outcomes.

There are several factors involved in VR besides computer science; Physiological responses, usability, UX design, and interaction design are some of them. In this light, technicality, human characteristics and design should be treated with equal importance in VR education. All of the following researchers indicate the importance of interdisciplinary teamwork;

Miyata et al (2010) have put in place an educational framework to develop VR applications in which graduates work in interdisciplinary groups to create VR environments. Besides improving collaborative skills, students are motivated to learn more given the competition among groups. The application ideas to be worked on are asked to be thought by the students themselves. This way each project has a different focus point. This method seems to have excellent results in student learning and creativity. Häfner et al. (2013) also presented the formation of their VR course stating the importance of different skills working together and emphasising interdisciplinary teamwork within VR projects. Häfner et al. expressed that student group formation and task specification design are key factors for a successful VR course project, and that students should have the freedom to be creative.

Zimmerman and Eber (2001) one of the first among suggesting interdisciplinarity among VR courses, describe the course as giving lectures on both programming and artistic topics, group laboratory sessions, research arrangements and demo presentations. Over the course, each group becomes responsible of creating a collaborative virtual environments using special software and Headsets. Herbelin and Cíger (2008) also argued that most of the courses labelled as virtual reality systems are almost exclusively on visual computer graphics and design and so besides the technical development, their student workshops about VR almost always focuses on immersion design rather than computer programming only. Stansfield (2005) offered her VR course as an elective 400-level capstone course. She argued since Virtual Reality is such an extensive field of study, the planned course should provide a multidisciplinary environment ideal for the incorporation of capstone students, allowing them to joint learned experiences during their undergraduate years.

In summary, the literature relating to teaching virtual reality courses demonstrate the importance of the multidisciplinary nature of VR. The field involves a broad array of technical, human and design aspects. Among the VR courses reported, most include

teamwork in which VR applications are developed by students with different backgrounds.

Lab Space and Equipment, Software and Tools

The current OZU VR Lab (B41) established by the Architecture and Design Faculty established in May 2018, consists of a 50m2 space with 4 MSI Aegis 3 VR compatible computers and a HTC Vive headset. The base stations have been installed correctly as a 15 m2 room scale setting and the headset has been tested and is operating well.

Beside using 3D modelling programs and programming skills Virtual Environments require knowledge for Game Engines. In that respect the newly developing field of Immersive design is dependent on game development platforms because it relies on the tools and software provided by the game Industry. Game developer companies in the video game industry use private, self build game engines. These are software environments designed for video game developers used to create games for various platforms like computers and smartphones. The game industry and the tools they provide are often underestimated by academia's intellectual but it shouldn't be forgotten that in 2017 the game industry has surpassed the cinema industry in size and revenues. Besides that International technology companies use commercially available game engines in most of their projects. Microsoft, for instance, uses the Unity game engine for its augmented reality Hololens projects and National Aeronautics and Space Administration (NASA) relies on Unreal Game Engine for its immersive space simulations applications to study human performance in space.
Only a few commercially available game engines exist for building immersive environments, Here are the most well known commercially available game engines;

1. Unreal Engine founded in 1999 in North Carolina by developers from all over the world.
2. Unity game engine, founded in Denmark in 2004 which moved to San Francisco in 2009.
3. CryEngine by Crytek, established in September 1999 Germany, (founded by Turkish Yerli brothers)

About the game engines OZU VR Lab and other Turkish Universities prefer

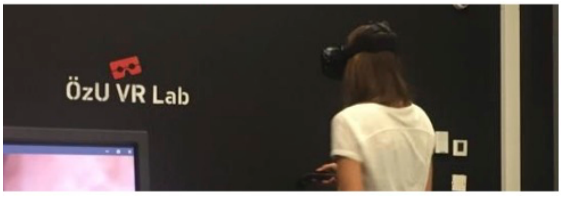

Figure 2. OzU VR Lab

Currently in Turkey (May, 2018) there are 4 academic VR labs in total. All of these labs except OZU VR Lab have been established with the help of VR First. VR First is a subdivision that belongs to the Turkish/German Crytek gaming company promoting facilities for Academic VR Environments. The company provides VR equipment, CryEngine and its knowledge of how its used. Unfortunately, VR first did not respond to Özyeğin Universities application for collaboration.

In 2016, Bahçeşehir University established the first Academic VR lab in Turkey, ODTU and Hacettepe both followed in the year 2017. After research and careful examination, the OZU VR Lab has chosen to further its studies with the Unity Game Engine and stands as a 4th independent academic VR Lab among universities in Turkey.

Projects by the OZU VR Lab (vr.ozyegin.edu.tr)

1. OZU-X Innovation Center in VR
In Collaboration with the Basel University we have used the matterport camera brought from Switzerland to 3D scan a Commerce han in Karaköy and The OZU-X innovation center. These Environments can be explored in VR Glasses that hold mobile phones.
2. The Virtual Buddha Temple project: An immersive environment developed using the unity game engine. A photogrammetry project build by scanning a real temple environment in which contributors can explore and interact with objects.
3. The "Applying Activity Theory to Analyse a Virtual Reality Setting" paper:
A case study focused on applying Activity Theory to analyse an immersive environment designed to examine the mechanisms of user interaction design in virtual reality.
4. The New Faculty of Architecture and Design in VR: OZU VR Lab has successfully managed to render the new Architecture and Design faculty building being built. This way the new FAD building can be explored in Virtual Reality and visitors can have an idea how it will feel and look like.

VR as a teaching tool and its benefits

Up until here this paper mainly focused on how to teach Virtual Reality. However, to underline the importance of the technology's supportive qualities in education, the following section is set to describe the benefits of VR as a teaching tool. VR provides a notion of presence, thanks to this, the learning experience can be extended to a level of "learning a subject by living it" Considering the realistic practise VR presents, individuals actually conclude to existing in a special space. This notion employs the mind in a remarkable way. (Babich, 2018)

VR in Architectural education

Traditionally, the education of Architectural design is focused on sharing and discussing ideas between instructors and students. These ideas are communicated via plans, drawings and physical models. During educational discussions, it is difficult for contributors to modify the suggested models and to observe their interior spaces in real-time. As a solution to overcome these difficulties, VR proposes environments where multiple students can contribute to the manipulation of 3D models and explore design discussions within their internal spaces.

Figure 3. Architecture student constructing interior space with Sketchup in Virtual Reality.

By contributing to procedural modeling and the formations of rapid prototypes VR allows students and instructors to emphasize and improve theirs work much faster than traditional methods. For instance, the Fuzor app and certain plug-ins can instantly transform Sketchup and Revit models into immersive virtual reality experiences where adjustments can be applied smoothly.

VR in Industrial Design education

Along with Architecture, VR is also being used in Industrial design. Advanced VR applications support the design of 3D industrial objects in real-time spaces, improving the creativity of industrial design students and enabling them to understand, in a faster pace, how design procedures take place.

Figure 4. Industrial Design Students building a prototype with Gravity Sketch in Virtual Reality.

Overcoming prototype visualisation limitations through VR devices helps industrial design students make better design decisions.

VR in Communication Design education

VR is giving birth to an exclusively novel Arena of collaborative work, marketing, consumerism and especially education. User Experience (XD) scenarios require evolutionary approaches to accommodate these novel capabilities.

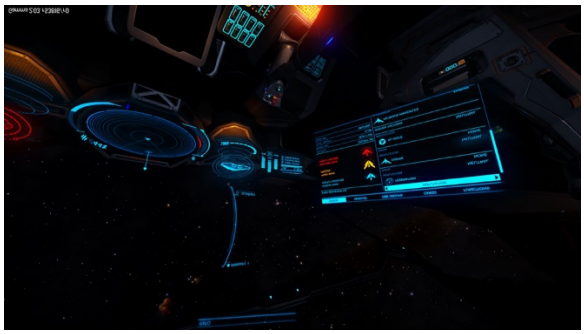

Figure 5. An Interface in Virtual Reality designed for navigational purposes to explore space.

Communication designers are responsible for building believable virtual environments taking account user friendly interactivity and important aspects like ease and comfort.

The Virtual reality and Immersive Design Course

In Mid 2018 with the support of our Communication Design department head Dr Simge Esin Orhun and Faculty of Architecture and Design Dean Prof Dr Orhan Hacıhasanoğlu, the OzU VR Lab was successfully settled. Accordingly, I was asked to form a course for the faculty covering the Virtual Reality topic in the Design context.

The VR and Immersive Design course to be thought in the Özyeğin University is planned to be structured as an elective for third year students. The course will contain multiple parts of VR practise and theory, involving hands-on experience to utilise a specific virtual reality environment.

With these means, an introductory, elective course in "VR and Immersive design" is proposed with the following priorities as learning outcomes;

- Apprehension of the VR discipline, in conjunction with its software and hardware.
- Grasp of the principles and design factors involving the creation of VR applications.

- Gain ground on practical experience by establishing Virtual Reality applications utilising VR environments.
- Utilisation of previous curriculum experiences for attaining the goals previously mentioned.

Sources, course material and recommended readings

Me and my colleague Elias Sarantopoulos have been researching Virtual Reality for almost 2 years. Besides the tools and software used, an essential part of teaching Virtual Reality is written books. After wide research on such sources we came along some good material. Many books have been published with respect to VR concentrating on technical and practical aspects. However, since VR technology is developing rapidly it is important to follow the most recent and comprehensive literature possible. Respectively, some academics have extensively researched the subject and have created broad and outstanding novel work. A great example is "Virtual Reality (2017)" authored by Steven M. LaValle, an American computer scientist, and professor in the department of computer science at the University of Illinois. LaValle's main field of expertise is

Robotics, even so, he started working as the head scientist for Oculus in 2012, the start-up which eventually got acquired by Facebook for $2 billion in 2014. Soon after this, LaValle returns to the University of Illinois carrying his new expertise with the educational mission of teaching the fundamentals of VR to a new generation of students. The book focuses on the recent specifics of VR technology with an aim to improve its readers understanding about how VR systems function, their limitations and which direction it is heading. This work can be used efficiently for an elective course by spending around one week per chapter to augment computer graphics, interfaces, and game development for Virtual Reality. In this light, it is planned to cover LaValle's Virtual Reality book during the VR and Immersive Design course.

Weekly Course Schedule

Reviewing the vast literature on teaching Virtual Reality, Hafner's (2013) and Miyata's (2015) methods look most promising. The following schedule is based on an overlapping composition of their work. The course is projected to consist of three parts and merges various curricular methods;

The first three weeks is premised on introducing VR through lectures and demonstrations. Brief presentations on issues like the history and definition of VR followed by Hardware and Software used for the medium, arranged for students to follow the rest of the course easily.

The next part (3rd and 4th week) is designed as lab sessions focusing on task-specific software like free 3D modelling software such as Blender and Google Sketchup, VR Game engines like Unity and Unreal Engine. Task assignments are applied to students who come from different disciplines.

The next nine weeks contain projects for groups via self selected tasks. Teamwork is an essential part of the course. The first two weeks are centered on group formations and assigning tasks to group members. Taking student interests in consideration, the supervisor carefully forms task specifications to meet the goals of the course. Additionally, every group has optional tasks. Subtask distributions are decided by the group members themselves internally. Once the assignment distributions are finalised the teams start to operate on their presentation goals. Inspired by both Hafner and Miyata, the weekly schedule can be found below; Weekly Course schedule is planned as follows:

1st week
Lectures and Demonstrations
2nd week
Lectures and Demonstrations
3D modelling
Task assignment
3rd week
Group formation
Lectures
Introduction to VR Software
4th week
VR Software
Group Project Plan Presentation
5-14th week
Project Group work
Soft Skills evaluation
15th week
Final evaluation

Figure 6. Weekly schedule for the VR and Immersive Design elective course

Why team work?

As mentioned before the course is in elective formation welcoming students from the selected department of Computer Science, Communication Design, Industrial Design and Architecture. A variety of skills are required to create VR applications. Beside development skills, design expertise like the foundation of spaces and objects and creating user-friendly environments is necessary

as well. Teamwork based projects are a convenient way for establishing VR applications due to group members utilising previous expertise within the collaborative setting. Being actively involved in field work and groups discussions has a positive effect on students' learning process. Students' collaborative skills will also improve by the influence of such teamwork projects (Fullerton, 2008).

The formation of teams

The following projections are made for the Grouping and the distribution of assignments to team members. Only one VR compatible computer and one VR headset exist. These will have to be used taking turns during the VR application development. This is why it is best to keep the amount of students around 12. The elective course is planned to allow 3 students from each department if possible. Team formations and distribution of assignments for each team member is planned as follows;

communication design student
~ Interaction Design
architecture student
~ Space Design
industrial design student
~ Object design
computer science student
~ Programming

Conclusion

As VR hardware becomes more affordable, the consumer VR industry is growing rapidly. Once an exotic field of Science now has become an important field for creative designers and programmers. This has his own effects on the education system making it a need to teach the new technology and its utilities.

In this paper it is emphasised why VR is an interdisciplinary field and how it should be learned in an interdisciplinary group environment. A vast amount of literature which argues on teaching Virtual Reality in team formations and by interdisciplinary means is put forward. The most related departments in the university are listed and it is explained how students from these areas can collaborate best. It is discussed how important it is to assign tasks when creating teams according to disciplinary backgrounds. Also, the importance of the game industry and the free software platforms they share are mentioned. The importance of the technology's supportive qualities in education are underlined in Virtual teaching environments. Alongside, course materials and novel sources by experienced teachers are proposed for weekly readings. Finally, a schedule for maximum collaboration for the elective VR and Immersive Design course is projected for best outcomes.

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