Teaching Immersive Media at the “Dawn of the New Everything”

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ABSTRACT

In this paper, we discuss the design and implementation of a college-level course on immersive media at a performing arts institution. Focusing on the artistic applications of modern virtual reality technologies, the course aims to offer students a practice-based understanding of the concepts, tools and techniques involved in the design of audiovisual immersive systems and experiences. We describe the course structure and outline the intermixing of practical exercises with critical theory. We provide details of the design projects and discussion tasks assigned throughout the semester. We then discuss the outcome of a course evaluation session conducted with students. Finally, we identify the main challenges and opportunities for educators dealing with modern immersive media technologies with the hope that the findings offered in this paper can support the design and delivery of similar courses in a range of music and arts curricula.

CCS CONCEPTS

• **Applied computing → Sound and music computing**; • **Human-centered computing → Virtual reality**; *Mixed / augmented reality*.

KEYWORDS

Immersive Media, Virtual Reality, Spatial Audio, Education, Evaluation

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1 INTRODUCTION

As modern immersive media platforms continue to spread into general use, artists, researchers and educators across a broad range of disciplines utilize these platforms to develop cutting-edge applications. Today, many academic institutions allocate considerable resources to the integration of virtual, augmented and mixed reality technologies into research and instructional activities.

However, given the novelty of the platforms introduced in the most recent wave of immersive media technologies, the domain of experts and skilled content creators is relatively limited. It is therefore necessary to develop curricula that will train the new generation of experts who are equipped with the interdisciplinary skills to explore the unique affordances of these new technologies for multimodal immersive experiences.

Accordingly, there is a growing trend to bring immersive media tools into existing curricula or to develop new courses that investigate immersion in and of itself. In response to the slew of new tools and techniques in this domain, many educators have already theorized about the potential impact of immersive media on education and the use of VR in constructive and experiential learning scenarios [1, 10]. Furthermore, courses that investigate the intersections between the arts, sciences and simulation have already made use of these modern tools [8, 9].

In his book “Dawn of the New Everything”, Jaron Lanier, who is considered one of the progenitors of Virtual Reality (VR), describes that, despite his decades of experience in this field, he still has a particular appreciation for the virtual worlds built by young designers [6]. It is indeed through the work of these young designers that new immersive media technologies will find their foothold in society.

In this paper, we offer a detailed discussion and evaluation of the author’s college-level course on immersive media at a performing arts institution. In particular, the course adopts a multimodal approach, placing an equal emphasis on the audio, visual and interactive aspects of immersive media and exploring musical and performative applications of VR. We also identify the challenges and opportunities in offering such a course with the current VR technologies. In doing so, we hope to support the development of new learning experiences for the next generation of immersive media artists.

2 COURSE STRUCTURE

The author’s course, titled Immersive Media, offers a practice-based investigation of modern immersive media technologies, including virtual reality platforms, game engines, spatial audio systems and techniques, and 360° media production tools. Offered to a mixed cohort of undergraduate and graduate students over the course of 14 weeks, the course is structured around an equal number of instruction and workshop sessions. The class size is capped at 12 to ensure each student’s access to hardware throughout the semester.

2.1 Instruction Sessions

The instruction sessions are designed to provide the students with a critical understanding of immersive media theories and practices. The progression of topics in these sessions is as follows: history of immersive media; game engines; game mechanics, rule systems and scripting; senses, stereoscopy and modern VR platforms; best

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practices and workflows in VR; binaural and Ambisonic audio; interaction design for immersive systems; virtual interfaces for musical expression; VR storytelling; 360° media production.

While some of these sessions take the form of traditional lectures and group discussions, others offer implementation exercises, where the instructor develops a system with input from the students, materializing ideas from the class discussions. The products of these exercises are shared with the students after each class, functioning not only as documentation of class sessions but also as software scaffolding for students to use in their own projects.

The lack of well-established standard practices in an emerging field, such as modern VR, can make it challenging for students to gauge their progress. With these exercises, the instructor aims to both ground conceptual aspects of immersive design in practice and demystify the development processes involved in building immersive systems. Furthermore, the progression of these exercises mimic that of the course assignments, giving the students a measure of success for when they are developing their own systems.

2.2 Workshop Sessions

These sessions are intended to give the students hands-on experience with immersive media platforms under the guidance of the instructor. They are designed to exemplify the theories and techniques presented during the instruction sessions through rapid prototyping projects, group design challenges and demonstrations. In group projects, the students start with an elevator pitch to receive feedback from their peers prior to implementation. At the end of each session, each group gives a demo of their design. Some of the design challenges extend over multiple workshop sessions.

3 ASSIGNMENTS

5 major design projects and 10 discussion tasks are assigned throughout the semester. These assignments are designed to promote a constructivist learning experience where students can apply their preexisting conceptions and goals to the subject matter [7]. Additionally, each student prepares a final portfolio composed of the project reports and discussion tasks they submitted throughout the semester. While each project poses unique goals, there are 4 common evaluation criteria. Concept and aesthetics gauges attention to detail and the effort put into formulating an original concept. Implementation gauges how well a project incorporates the standard practices and techniques introduced in class. Completeness gauges how operational a system is and how successfully it meets the goals set out by the student. Finally, documentation gauges how well a system is documented with inline comments and a final report that evaluates the end result. With each assignment, an extended project description and an evaluation rubric is provided.

3.1 Mini-Game Design

Students use Unity 3D to design a navigable interactive environment in the form of a mini game that employs a simple rule system. An in-class implementation exercise involving a game of a similar scale is provided to the students as a model. The goal of this assignment is to introduce the students to development workflows in game engines and relate the class discussions on game mechanics and rule systems to practice.

3.2 Porting Mini Games to VR

Students port their mini games from the first assignment to VR. This assignment mirrors another in-class exercise where a mini game is ported to VR. The assignment challenges the students to think critically about best practices in VR in terms of user perspective, navigation, multimodality, storytelling and interaction design. Their design decisions from the first assignment are often in conflict with these best practices and require students to find creative solutions to adapt their games to VR.

3.3 Immersive Sonic Environments

Students design two immersive sonic environments based on their everday experiences: one with a browser-based rapid prototyping tool for spatial audio called *Inviso* [3], and another with Unity 3D using Google Resonance Audio. In doing so, they learn fundamental concepts of immersive audio such as directionality, distance modeling, occlusion and room effects. This assignment encourages students to think critically about spatial sound, which is essential for a convincing sense of immersion in VR. Furthermore, they are expected to comment on the individual features of different creativity-support platforms and identify ideal workflows for immersive audio design.

3.4 Virtual Interface for Musical Expression

Students explore interaction design for VR in groups of 3 by designing Virtual Interfaces for Musical Expression (VIMEs) [4]. Each group is expected to design a VR system in one of the following categories:

- Reimagining a traditional instrument
- Imagining an entirely new instrument
- Designing an instrument in the scale of an environment
- Designing a musical Rube Goldberg Machine

The groups are expected to organize 3 meetings over the course of 3 weeks as part of an iterative design process that involves prototyping, implementation, evaluation and optimization. This assignment is designed to have students work in groups on designing user interactions in VR with musical expression as the application domain. The four categories encourage students to design complete musical systems while thinking critically about design challenges such as transferring learned behavior to an immersive context and exploiting the unique affordances of immersive platforms for interaction design.

3.5 360° Media Production

Students work in groups of 6 to create an immersive and interactive concert experience using a 3D 360° camera and Ambisonic sound. The resulting system is intended to allow the user to interact with a music performance similar to how a mixing engineer can manipulate a track using a digital audio workstation (DAW). The groups are split into separate crews dealing with video production, audio recording, post production and interaction design aspects of the project. Once the group agrees upon a design concept, the production crew creates an immersive documentation of a music performance, which is then sent to the interaction design crew for a user interface layer to be added.

3.6 Discussion Tasks

Each week, the students are also given a discussion assignment, where they are asked to respond to a prompt provided with a range of supporting materials including readings, videos, and links to applications or artistic projects. These are designed to facilitate the students' critical and continued engagement with the course content. Whereas some of the discussion prompts are based on the instruction or workshop sessions, others invite students to explore topics that are not explicitly covered in the curriculum.

4 EVALUATION

In addition to conducting traditional student course evaluations, the instructor has worked with the Center for Research on Learning and Teaching (CRLT) at the University of Michigan to administer an extended review session. The session was administered by a CRLT staff member without the involvement of the instructor. 12 students participated in the evaluation. They were asked to work in groups of 3 to prepare a written report on the key strengths of the course and potential areas of improvement. Each group then shared their responses with the rest of the class followed by discussions.

4.1 Key Strengths

The students found the pairing between the lectures and the demonstrations to be conducive to their learning. The class implementations done by the instructor were found to be useful; students particularly appreciated being able to contribute to these implementations by making suggestions and asking questions.

They described that the course offered a good balance between theory and practice, and that the class discussions provided a necessary amount of history and background. The hackathon-style design challenges in the workshop sessions were found to be especially favorable.

The assignment progression with standalone projects as well as those that build up on each other was described to be effective. This supports the understanding that frequent, lower-stake assignments that build up on each other can help with student performance and mental health [5]. Group projects were characterized as being productive by way of allowing individuals to bring their own expertise into larger-scale projects.

4.2 Areas of Improvement

Students described that, in an ideal scenario, the workshop sessions would be conducted in a lab environment with individual VR stations allocated to each student.

While half of the students preferred the open-ended nature of some of the assignments, the other half suggested that these could be broken down into smaller projects with more scaffolding provided.

Programming proficiency has been described as one of the bottlenecks in developing immersive systems. Some students therefore requested additional programming instruction to be incorporated into the course.

In the next section, we relate these and other areas of improvement to developments in the industry, current workflows and practices in immersive media design, and broader educational considerations.

5 CHALLENGES AND OPPORTUNITIES

Working with emerging immersive media technologies in an instructional context brings about technical and logistical challenges as well as new learning experiences and creative opportunities.

5.1 Hardware Requirements

VR development today is inherently tied to the use of modern VR systems, which often require more processing power than what most consumer-grade personal computers can offer. As it stands, it is unlikely for the students of an immersive media course to possess their own VR equipment. It is therefore necessary for the instructor to secure a bare minimum of hardware units based on the class size. Taking the workload involved in the second project (i.e. Porting Mini Games to VR) as a benchmark, at least four VR systems would be necessary to support a class of 12 students. The instructor can also formulate assignments in a way that reduces dependency on VR systems (e.g., using 6-DOF first-person camera controllers). Given the growth of immersive media studies over the past decade, it is reasonable to expect academic institutions with necessary means to establish laboratories with VR systems to support instructional activities in this area. However, it is also necessary for the companies operating in the VR industry to offer software solutions, such as emulators and virtual debugging tools, that can facilitate content creation in situations when such means are not available.

5.2 Rapid Iterations in Technology

Immersive media systems are going through rapid iterations with annual or more frequent hardware updates. In the last two years, class discussions pertaining to existing VR systems had to be amended due to the introduction of new techniques or technologies in the course of the semester. Furthermore, unlike the incremental improvements that we observe in more mature domains of technology, these yearly updates bring about major shifts in technology, forcing content creators to upgrade to new systems relatively quickly. While undoubtedly promising for the field, such rapid transformations in technology can render the infrastructure for an immersive media course to be unsustainable without considerable institutional support. Although VR hardware manufacturers engage in academic collaborations, multilateral partnerships between academia and the industry will need to be established to ensure that academic institutions can remain at the forefront of VR research while following environmentally-conscious practices for system upgrades.

5.3 Software Platform Issues

Much like their hardware counterparts, the software platforms that support modern immersive media technologies go through frequent updates. Some of these can be mandatory and require the user to update the software before they can continue with their work. Furthermore, these updates can render hardware devices incompatible with the development tools. While most VR companies provide libraries to integrate their devices with popular game engines, the support they provide for these third-party integration libraries can be lacking or out-of-date. It is therefore necessary for the instructor to identify these shortcomings in advance and provide the students with guidance on how to address them.

5.4 Development Workflow

One of the primary hurdles in developing content with modern immersive media platforms is the current workflow that requires designers to develop a system in one medium (i.e. a desktop computer) and test its operation in another (i.e. an immersive media system such as AR and VR equipment). With VR applications in particular, this workflow involves disjointed design and testing phases unlike other modern design tools, such as DAWs and photo editing software, that afford real-time feedback between the these phases. Accordingly, students have described the current VR design workflows as being counterintuitive and expressed a need for immersive integrated development environments where they could shift part of the creative process into VR, where they can both create and evaluate their work without interruptions. VR content creation within VR is indeed one of the growing areas in VR research [2]. Furthermore, we expect advances in this area to make VR content creation more accessible in general by facilitating the use of standalone VR headsets for development without the need for a powerful computer system.

5.5 Programming Expertise

While game engines support visual design of virtual environments to some extent, giving dynamic properties to these environments or implementing interaction mechanics often require programming. Developing content with APIs provided by hardware developers can demand even further programming expertise. It is therefore necessary to presuppose at least an introductory level of programming expertise from the students when offering an immersive media course with current content creation tools. Even then, it would be reasonable to permit the students to use online examples with a stipulation that they would be expected to explain why and how they utilize such resources with clear references to the source material.

It has been the author's experience that some students, especially those who do not come from STEM backgrounds, can underestimate their skills or overestimate the task at hand. In such cases, the interdisciplinary makeup of the student cohort and the group exercises prove to be particularly beneficial. The support structure among the students not only facilitates skill-sharing but also helps them gain different perspectives towards the problems they deal with. For instance, upon receiving praise for a game mechanic they implemented, a music technology student expressed frustration with the extent to which they had to resort to online forums to resolve the programming challenges involved in their implementation. In response, a computer science major with industry experience explained that this student's experience was common in software development across all skill levels.

5.6 Interdisciplinary cohorts

In its first two years, the course has attracted students with a diverse range of backgrounds including music technology, arts and design, architecture, interaction design and computer science. This interdisciplinary mix of students has greatly contributed to the success of the class for several reasons: the students contributed their domain-specific skills to group projects, supplementing the traditional mentor-mentee structure with peer-to-peer learning experiences. This also allowed resources from different schools across the campus to be incorporated into the group projects in the form of advising capacity, equipment and space. Regardless of the domain specificity of an immersive media course, given the inherent multimodality of the content in immersive experiences, and the multifaceted nature of developing such content, it is advisable for instructors to make their courses available to students from different disciplines as much as possible.

6 CONCLUSION

In this paper, we discussed the implementation of a college-level immersive media course, which aims to equip an interdisciplinary cohort of students with skills to develop creative projects using modern immersive media tools and techniques. We described the instructional motivations underlying different aspects of the course and reflected upon how these translated into diverse learning experience. We also offered the results of an evaluation session conducted with students and related these to ongoing developments in the field. Furthermore, we outlined strategies that could be adopted at instructional, institutional and industry levels to address challenges in bringing immersive media platforms into educational contexts. We hope that the findings offered here can support the design and implementation of similar courses that will train the next generation of artists and researchers working in this field.

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