i-Tech: Empowering Educators to Bring Experimental Learning to Classrooms

A 360° Content Creation Tool

Amani Alqarni[1], Jieyu Wang[2], Abdullah Abuhussein[3]
Information Technology and Security Department, Jazan University, Jazan, Saudi Arabia[1]
Department of Information Systems, Saint Cloud State University, St. Cloud, MN, USA[2, 3]

***Abstract*—The integration of technology in education has gained significant attention, with Virtual Reality (VR), Augmented Reality (AR), and 360° VR emerging as transformative tools for enhancing student learning experiences. Despite their potential benefits, these immersive technologies have not achieved widespread adoption in education. Educators face numerous challenges in finding suitable 360° content for their courses and integrating complex content creation tools. Creating educational 360° content often involves hiring programmers or mastering intricate programming techniques, which can be time-consuming and daunting. Educators also struggle with finding platforms to host, edit, segment video content according to topics, and add subtitles and translations to their 360° videos. To address these challenges, this paper presents the implementation and evaluation of a user-friendly prototype tool with a step-by-step graphical user interface. This high-fidelity prototype assists educators in uploading 360° content, segmenting it into chapters or topics, incorporating questions or requirements within video segments, adding subtitles and translations, and facilitating content sharing among educators. This design aims to assist teachers in publishing their 360° content while reducing the complex VR programming for them. It enables them to integrate immersive learning in their classrooms with ease. The final goal is to promote greater adoption of 360° VR content in education and enhance learning outcomes.**

Keywords*—*Virtual reality; 360° video; user behavior analysis; content delivery; immersive media; education; technology in education; instructional design; human-computer interaction

I. Introduction

Now-a-days, video content is employed in various forms to enhance the learning experience. As the barriers to accessing 360° video technology diminish, it has become increasingly effortless to engage with 360° content. In contrast to traditional media, 360° media offers a fully immersive and interactive simulated environment, providing students with a unique experiential perspective. Furthermore, this immersive approach helps minimize or even eliminate distractions that students may encounter.

While the use of 360° technology in education is gaining momentum, there is still ample room for improvement in this domain. The complexity involved in creating, processing, and disseminating 360° educational content, and making it accessible and beneficial for public consumption, contributes to this ongoing need for refinement. Undoubtedly, the integration of 360° technology in education presents educators with numerous challenges that may deter them from fully embracing this otherwise valuable tool. These challenges encompass both pedagogical and didactical aspects, such as effectively planning and designing virtual classrooms. Additionally, educators encounter various technical hurdles that impede the widespread adoption of 360° technology. These technical challenges include: (1) locating reliable resources that provide guidance on creating and publishing 360° media, (2) navigating the intricacies of these tools, particularly for novice computer users, (3) grappling with the time-consuming and labor-intensive process of designing and publishing content using multiple tools and frameworks, (4) addressing issues pertaining to subpar sound or image quality in the published media, (5) limited access to appropriate hardware and devices for capturing and viewing 360° content, and (6) insufficient bandwidth and network infrastructure to stream high-quality 360° videos in educational settings. (7) Moreover, concerns about data privacy and security when using immersive technologies in educational settings further add to the challenges educators face in adopting and implementing 360° technology.

This paper presents a prototype tool called i-Tech that aims to enable educators to process and publish their 360° content and share it with their students in one place. The tool provides a user-friendly step-by-step graphical interface, assisting educators in uploading their 360° content, segmenting it into chapters, incorporating questions/requirements before video chunks, adding subtitles to the video content, and making their content available to other educators in the field. This work aims to increase educators' adoption of 360° VR content in education and improve learning outcomes. While i-Tech is currently in the prototype stage, its purpose is to demonstrate the potential of such a tool and its impact on educational practices.

II. Literature Review

The utilization of VR, 360°, and mixed reality content in the field of education is not a new domain; it has been extensively explored in various research studies using different methodologies. In this section, we will delve into the concepts and applications of 360° media, as well as the incorporation of virtual reality (VR) and augmented reality (AR) technologies in educational settings. Furthermore, we will examine the challenges encountered in the design and development of 360° technology and explore existing endeavors aimed at providing

educators with tools to facilitate the creation and dissemination of their 360° content online.

A. Background on 360° Media

The demand for enhanced immersion in virtual simulated environments has spurred the advancement of immersive technologies, leading to the emergence of novel forms of virtual reality (VR), augmented reality (AR), and 360° technologies. These technologies have revolutionized training programs by providing learners with engaging experiences that utilize multiple senses, such as sight, hearing, and touch, thereby facilitating effective knowledge acquisition. Among these advancements, 360° video technology has emerged as a promising and cost-effective solution for creating interactive virtual reality applications with immersive capabilities.

360° videos also referred to as immersive or spherical videos are filmed using a specialized camera that captures a panoramic view spanning 360 degrees. These cameras feature lenses positioned either on the top to capture the entire surroundings or on multiple sides to capture a comprehensive view from top to bottom and left to right. The captured images are then stitched together to create a seamless and immersive video experience. In contrast to traditional videos, which are limited to the camera's focal point, 360° videos provide viewers with the ability to explore and observe everything within the camera's range, resulting in a fully immersive viewing experience.

360° videos can be obtained through two main approaches: capturing real-life landscapes or creating computer-generated panoramas using 3D computer graphics software tools such as Blender [16], [1]. In the first approach, a specialized camera captures the entire 360° view of a physical environment. This allows for an immersive representation of real-world locations and events. Alternatively, in the second approach, 360° computer-generated panoramas are generated using software tools like Blender. These panoramas are created using 3D modeling and rendering techniques, providing the flexibility to design and visualize virtual environments with complete control over the content and scenery. Both methods contribute to the production of captivating 360° videos that offer viewers a rich and immersive visual experience.

The popularity of the 360° video format surged in early 2015, primarily due to its integration with YouTube. YouTube introduced support for importing and viewing VR videos in March 2015, making it accessible to a wider audience. Following in YouTube's footsteps, Facebook also embraced 360° videos and launched support for this format in September of the same year. In March 2017, Facebook revealed that over one million 360° videos had been uploaded to its platform, highlighting the growing interest and engagement with this immersive video format. Additionally, Vimeo, a prominent video-sharing website, joined the trend and introduced support for 360° videos in March 2017, providing another platform for creators to showcase their immersive content. These developments have contributed to the widespread adoption and availability of 360° videos across various online platforms.

In a 360° video, viewers are no longer limited to a fixed frame; they have the freedom to control the camera angle and explore the entire environment. This interactive viewing experience allows viewers to watch the video from multiple perspectives, offering an active engagement rather than a passive observation limited to the director's point of view. To enjoy a 360° video, viewers can use various devices such as personal computers, smartphones, or dedicated head-mounted displays. On computers and touch screen devices, viewers can navigate within the video by using a mouse or touch gestures. Smartphones equipped with internal sensors like gyroscopes allow users to pan the video based on the orientation of their device. For a more immersive experience akin to virtual reality, viewers can use stereoscope-style enclosures like Google Cardboard or Samsung Gear VR. These enclosures hold the smartphone and incorporate lenses that enable viewers to view the 360° video in a more immersive and engaging manner, utilizing the phone's display rather than a dedicated display found in virtual reality headsets.

B. Benefits and Challenges of 360° Videos in Education

The following literature review provides a comprehensive overview of the use of 360° videos, virtual reality (VR), and augmented reality (AR) in education. It explores the existing research and empirical studies to understand the potential benefits, challenges, and implications of integrating these immersive technologies in educational settings. Several authors have made significant contributions to the field of 360° videos, virtual reality (VR), and augmented reality (AR) in education. Their works have shed light on the potential benefits and challenges of integrating these immersive technologies into educational settings. Some important works include "If and how do 360° videos fit into education settings? Results from a scoping review of empirical research" [2] which presents a comprehensive examination of the integration of 360° videos in educational settings. Through a scoping review of empirical research, the study explores the various ways in which 360° videos are utilized and their effectiveness in enhancing educational experiences. The findings reveal that 360° videos have the potential to enhance student engagement, information retention, and the overall effectiveness of the learning process. However, the review also highlights certain challenges such as motion sickness and the limited availability of specialized 360° videos for educational purposes.

This work, titled "The Potential of 360° Virtual Reality Videos and Real VR for Education—A Literature Review" by [3], explores the potential of 360° virtual reality videos and real VR in education. It examines existing research and highlights the benefits and applications of these immersive technologies in educational settings.

The authors of [4] conduct a comprehensive examination of the research conducted on 360° video and its applications within the realm of education. Their work offers valuable insights into a wide range of studies carried out in this area, shedding light on the diverse potential uses of 360° video technology in educational settings.

Authors of the paper "Educational 360° Videos in Virtual Reality: a Scoping Review of the Emerging Research" [5] offer a comprehensive overview of the current research landscape surrounding educational 360° videos in virtual reality. The paper delves into the effectiveness and impact of these videos

in enhancing learning experiences while examining the associated benefits and challenges. With its valuable insights, the paper serves as an essential resource for educators, researchers, and practitioners seeking to integrate immersive technologies, such as 360° videos, into educational settings.

Collectively, these works contribute to our understanding of the potential benefits and challenges associated with the integration of 360° videos, VR, and AR in education, providing valuable insights and guidance for educators and researchers in this field.

C. 360° Videos Challenges

360° videos pose a range of challenges for developers and users alike. Developers face the primary challenge of complexity when producing high-quality 360° videos. This complexity arises from the need for specialized equipment like multi-camera rigs and intricate post-processing techniques, adding both intricacy and cost compared to traditional videos [6].

Another challenge developer's encounter is the increased bandwidth and storage requirements of 360° videos. Due to the expanded field of view, these videos typically have larger file sizes, demanding higher bandwidth for streaming or downloading. Managing encoding and compression is crucial for developers to ensure optimal streaming and playback experiences while maintaining video quality and reducing file sizes [7].

Platform compatibility poses an additional challenge for developers. Ensuring seamless performance across various platforms, devices, and operating systems is demanding. Developers must account for different video codecs, players, and technical specifications to provide a consistent experience to users across diverse environments [8].

From a user's perspective, in addition to compatibility issues, internet speed, device limitations, and bandwidth constraints, one of the significant challenges of 360° videos is the hardware requirements. Enjoying a high-quality 360° video experience often demands specialized hardware like virtual reality (VR) headsets or powerful smartphones. This requirement may limit accessibility for users who lack the necessary equipment.

Motion sickness is another challenge users may encounter when engaging with 360° videos. The immersive nature of these videos and continuous camera movements can lead to discomfort or motion sickness, resulting in shorter engagement durations and potentially impacting the overall user experience [9].

Limited availability of diverse and high-quality 360° video content compared to traditional videos poses another challenge for users. Finding compelling 360° videos on preferred platforms can be difficult, hindering overall enjoyment of the medium [10].

Interacting with 360° videos presents a learning curve for users, especially those unfamiliar with the technology. Understanding navigation controls and effectively exploring the content may require time and patience to fully grasp [11].

Users may also have concerns regarding processing power and battery life [11]. Rendering and playing back 360° videos demand more processing power, potentially impacting device performance and battery life. This concern is particularly relevant for users utilizing battery-powered devices such as smartphones or VR headsets.

Despite these challenges, continuous technological advancements, improved production workflows, and the growing adoption of 360° video content can help mitigate these obstacles and provide a more seamless and accessible experience for both developers and users.

In addition to the aforementioned challenges, adopting 360° video technology in education is faced with the following challenges:

Pedagogical integration: It is essential to integrate 360° videos into the curriculum in a meaningful and pedagogically sound manner. Teachers need to identify the appropriate learning objectives and design activities that align with the content of the videos [12].

Assessment and evaluation: Assessing student learning and evaluating the effectiveness of 360° videos as an educational tool can be challenging. Traditional assessment methods may need to be adapted or augmented to incorporate the unique aspects of 360° video experiences, such as student interaction and exploration within the video environment [13].

Teacher training and support: Integrating 360° videos into the curriculum requires teachers to have the necessary skills and knowledge to effectively utilize this technology. Providing comprehensive training and ongoing support to educators is crucial to ensure they can maximize the educational benefits of 360° videos and incorporate them seamlessly into their teaching practices [14].

These challenges highlight the importance of addressing pedagogical considerations, developing appropriate assessment methods, and providing adequate training and support to teachers. By tackling these challenges, educational institutions can harness the full potential of 360° videos as a powerful educational tool for immersive and interactive learning experiences.

Therefore, the design aims to alleviate users' time and effort regarding technical challenges and streamline the process of creating VR classes. We also evaluated our prototype platform, aligned with Norman's usability goals concerning effectiveness, efficiency, learnability, memorability, error prevention, and user satisfaction. We aimed to gain a comprehensive understanding of the participants' experiences with our platform and identify areas for future software production improvement.

III. I-TECH DESIGN AND IMPLEMENTATION

A. Design of the Platform

Our design goal for i-Teach (Immersive Teaching Enabler And Content hosting) is guided by Norman's design principles [15]. The primary objective is to alleviate users' concerns regarding technical challenges and streamline the process of creating VR classes, thereby saving their time and effort. Our

team consists of one investigator who collaborated closely with a recruited programmer to handle the implementation aspect. Additionally, we have two UX investigators dedicated to designing and evaluating the platform. Throughout an entire semester, we conduct weekly meetings to brainstorm, discuss, and refine the platform's design, ensuring it meets the needs of educators and enhances their immersive teaching experience.

Our prototype platform offers a streamlined procedure comprising five steps to facilitate the uploading, editing, and publishing of 360° videos. Fig. 1 provides a visual representation of these steps. The sequential process is as follows:

- Get started: Users initiate the process by accessing our platform and starting the video upload procedure.
- Choose the video: Users select the desired 360° video file from their local storage or designated location.
- Entitle the video: Users provide a title or description for the video, furnishing relevant information to enhance its visibility and searchability.
- Video segmentation: As needed, users can opt to segment or divide the video into smaller segments to facilitate easier processing and management.
- Upload the video: Users finalize the process by uploading the 360° video file to our platform, ensuring its availability for subsequent editing or publishing.

By following these user-friendly steps, our platform empowers users to efficiently manage and publish their 360° videos, providing them with a seamless experience.

The landing page of i-Tech offers users a convenient file upload feature, enabling them to effortlessly upload their 360° videos for processing. Once uploaded, users are guided to define both the number and the duration of segments, as visually demonstrated in Fig. 2. Upon completing this step, users can proceed by clicking the "Upload" button to initiate the processing of their video content. Once educators have uploaded their videos, they will need to allow some time for the platform to process the data. During this processing period, educators can access their platform accounts and utilize the available YouTube functions, as shown in Fig. 3. It is important to note that user registration is not currently supported in our initial platform version, but it will be incorporated in future updates. However, in the meantime, educators can take advantage of the platform's integration with YouTube, enabling them to publish their 360° videos directly on the YouTube website. This seamless integration allows students to freely access and views the videos with ease, as depicted in Fig. 4.

B. Tool Evaluation: A Usability Testing

The primary objective of this study is to enhance the learning experience of students through the utilization of 360° immersive educational videos. To achieve this goal, we have developed a comprehensive prototype platform that empowers educators to seamlessly upload, edit, and publish their own 360° videos. One of the key advantages of our platform is its user-friendly interface, which eliminates the need for programming skills. This accessibility feature significantly reduces the time and effort required for educators to create their own educational VR content, allowing them to focus more on delivering impactful learning experiences to their students.

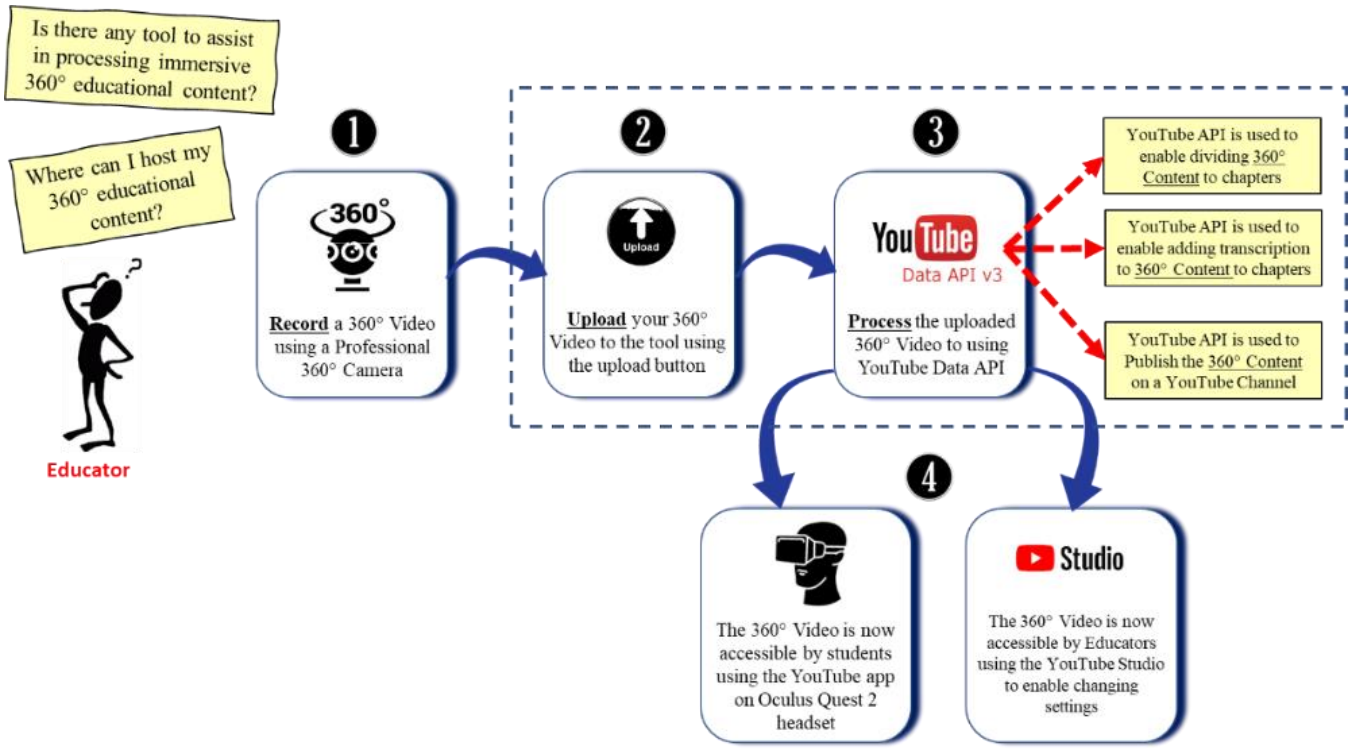

Fig. 1. Basic i-Tech structure and operation.

Fig. 2. Video segmentation facility i-Tech.

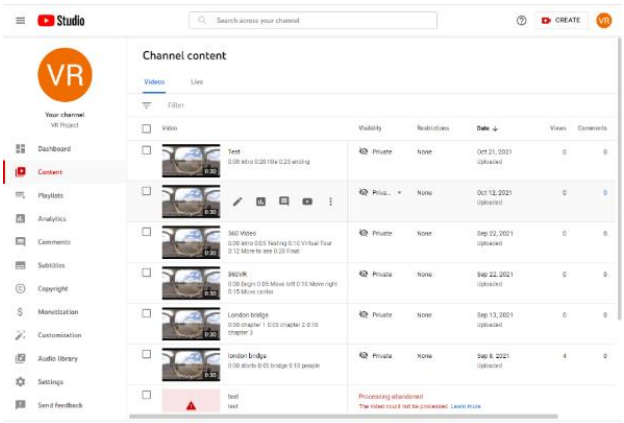

Fig. 3. Results in user's account.

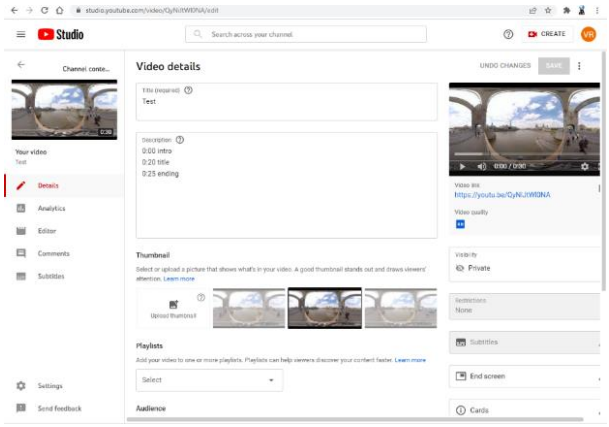

Fig. 4. Published results.

TABLE I. THE EXPERIMENTS OF USABILITY TESTING

Participants' disciplines	Interview questions	Tasks
P1-information systems	Ease of use	Each professor was assigned a specific 360° video. They were required to upload, edit, and publish the video using our platform
P2-information systems	Ease and difficulty	
P3-Finance	Usefulness	
P4-Computer science and engineering	Suggestions	
P5-Geography	prior experience using or not using virtual reality	
P6-Communication	perceptions regarding the ease of generating VR content and integrating it into their teaching practice	

1) Evaluation participants: Nelson's (1993) recommended that as few as five users can effectively identify 85% of the usability issues associated with a particular technology [16]. Therefore, our study invited six full-time professors from a university located in the Midwest region of the United States to evaluate our high-fidelity prototype since our target users will be teachers. The participating professors represented diverse disciplines including information systems, computer science and engineering, finance, geography, and communication (see Table I). Prior to their participation, the study received approval from the Institutional Review Board (IRB), and the professors were invited to join the experiment after providing their informed consent by signing the consent form.

2) Evaluation tasks: To ensure the authenticity and naturalness of user interactions, the experiments were conducted in the participants' natural environments. This approach provided the advantage of observing the participants' natural process of interacting with our platform. The participants were initially instructed to perform various tasks using our platform, and their interactions were recorded using the Zoom share screen function. Following the task completion, the participants were then interviewed about their experiences, and these interviews were also recorded via Zoom. By conducting the experiments in this manner, we aimed to capture a comprehensive understanding of the participants' interactions and gather valuable insights from their firsthand experiences.

Prior to the experiment, each professor was assigned a specific 360° video and tasked with completing the upload, editing, and publishing tasks for that video using our platform (see Table I). The participants were required to go through each step of the platform, providing their insights and thought processes using the think-aloud method during the task execution. This approach allowed the investigator to gain a deeper understanding of how the participants performed the tasks and their decision-making processes.

Following the task completion, follow-up interviews were conducted with each participant. These interviews lasted approximately half an hour, during which the participants shared their experiences, thoughts, and feedback on the platform. Transcripts of the interviews were created to capture the details of the discussions.

The data collection process involved taking notes and recording videos of both the think-aloud sessions and the interviews. This comprehensive approach ensured that valuable information was captured and provided a rich dataset for further analysis and evaluation.

During the experiments, participants were prompted with think-aloud questions to elicit their thoughts and observations as they performed tasks on the platform. These questions included inquiries about their visual focus, the ease or difficulty of locating the next step, their understanding of video editing techniques, and any challenges encountered during the uploading process.

3) The interview sessions: Subsequent to the experiments, follow-up interviews were conducted to gather additional insights. The interview questions encompassed topics such as the participants' prior experience using virtual reality (VR) for teaching, their reasons for not utilizing VR if applicable, and their perceptions regarding the ease of generating VR content and integrating it into their teaching practice (see Table I).

In addition to these specific questions, we also incorporated usability-related inquiries aligned with Norman's usability goals. These goals emphasize the assessment of effectiveness, efficiency, learnability, memorability, error prevention, and user satisfaction. By addressing these usability dimensions, we aimed to gain a comprehensive understanding of the participants' experiences with our platform and identify areas for improvement. During the follow-up interviews, participants were asked a series of questions to assess their perception of the platform and its usability. Some of the key questions included (see Table I):

- Ease of use: Participants were asked to express their opinion on the ease or difficulty of using the platform to upload, edit, and publish the video. They were encouraged to provide reasoning for their response, highlighting specific features or aspects that contributed to their perception.
- Ease and difficulty: Participants were asked to identify the easiest and most challenging parts of the platform. This allowed them to pinpoint areas where they found the process intuitive and seamless, as well as areas that presented obstacles or required additional effort.
- Usefulness for teaching: Participants were queried about the usefulness of the platform for their teaching purposes. They were encouraged to elaborate on their response, discussing how the platform could enhance their teaching methods, engage students, or improve the learning experience.
- Suggestions for improvement: Participants were asked to provide feedback on areas of the platform that could be improved. This could include specific features, functionalities, or user interface elements that could enhance the user experience. Additionally, participants were invited to share their expectations for additional functions that they would like to see implemented in the platform.

By exploring these questions, we aimed to gather valuable insights from the participants to refine and enhance the platform, addressing their needs and preferences to create a more user-friendly and valuable tool for educational purposes.

4) Pilot study: To ensure the effectiveness of the tasks and interviews, a pilot test was conducted prior to the main study. The pilot test aimed to identify any confusing instructions or questions and to ensure the clarity and relevance of the provided information.

During the pilot test, a single participant was invited to complete the tasks and participate in an interview. The participant's feedback was valuable in identifying areas of confusion or ambiguity in the instructions and questions. Based on the participant's input, minor adjustments were made, such as reordering questions, rephrasing instructions, and removing redundant or similar questions.

It is important to note that the data collected from the pilot participant was not included in the final analysis since their participation was primarily intended to test the clarity and effectiveness of the instructions and questions, rather than to contribute valuable data to the study.

By conducting the pilot test and incorporating participant feedback, the study aimed to enhance the quality and reliability of the data collected from the main study, ensuring that the tasks and interviews provided meaningful and insightful information from the participants.

5) Data analysis: In this study, data were collected through multiple methods, including think-aloud Q&A, screen capture video analysis, and follow-up interviews. The collected data, including notes, videos, and interview transcripts, were analyzed using qualitative data analysis techniques.

The analysis process involved two main coding methods: open coding and axial coding. Open coding was initially conducted by the two researchers to identify preliminary concepts of interest. Printed documents, paper, markers, and a blackboard were used during discussions to facilitate the coding process. Due to the nature of the materials used, measuring inter-coder reliability was challenging.

After the open coding stage, axial coding was applied to identify and group themes in the data. The same two coders continued coding the data using this approach. The method of constant comparison was employed, wherein newly added transcripts were compared to previously identified concepts and categories that emerged throughout the analysis process (Corbin & Strauss, 2008; Merriam, 2009).

Throughout the analysis, the two researchers engaged in discussions to explore similarities and differences in the axial themes that emerged from the data. This iterative process allowed for a deeper understanding of the data and the development of meaningful interpretations.

By employing these qualitative data analysis methods, the study aimed to uncover insights and patterns within the collected data, facilitating a comprehensive understanding of the participants' experiences and perspectives related to the platform and its usage in education.

IV. I-TECH EVALUATION RESULTS

The designed platform was specifically created to provide professors from various disciplines with a user-friendly solution for uploading, editing, and publishing 360° videos to minimize their workload and technical challenges. To assess the effectiveness of the platform and gather feedback, a total of five professors from different disciplines were recruited as participants. These professors were invited to use the platform and subsequently interviewed to obtain their insights and opinions.

The analysis of the collected data focused on multiple perspectives, including task completion time and the occurrence of errors. By examining these factors, the study aimed to evaluate the platform's usability and efficiency in supporting professors with diverse backgrounds in utilizing 360° videos for educational purposes.

Through this analysis, the study sought to gain valuable insights into the platform's strengths and weaknesses, allowing for further improvements and refinements based on the feedback provided by the participating professors.

A. Task Time and Errors

The participants finished their tasks from three minutes to five minutes with an average of three minutes 25 seconds. All of them made no errors since they reported that the steps were simple and clear when they performed the tasks. However, three of them did have hesitations when trying to understand Step Three to segment the video into different chapters. After the investigator quickly asked them to view the example shown on the left of the page, they got the clue and finished the task without difficulties.

B. Themes from Think-aloud and Interviews

1) VR vs 360° videos: During the interviews, participants provided their perspectives on the differences between virtual reality (VR) design and 360° video when applied in their teaching scenarios. They unanimously expressed the belief that using 360° video for educational purposes is easier and more time-saving compared to VR design. Here are some of their responses:

Participant 1: "It is less complex. 3D programming needs lots of coding to do it. This one cuts the time for me to prepare for lessons."

Participant 2: "There is the use case (360° video). I worked with a camera. It was not that hard, just like put the camera on the tripod and shoot a video. This is very easy…I haven't worked with it (VR programming). But I think it involves some API. That study involves programming. So it's like a learning curve."

These statements highlight the participants' perception that working with 360° videos is less technically demanding and more accessible compared to VR design, which often involves programming and a steeper learning curve. They appreciate the simplicity and ease of use associated with capturing 360° videos using a camera, which allows them to focus more on the content creation and lesson preparation rather than technical intricacies.

The participants' consensus on the advantages of using 360° video suggests that it offers a convenient and efficient solution for incorporating immersive experiences into their teaching, saving time and reducing the complexity typically associated with VR design.

2) Ease of use: During the interviews, all participants expressed their unanimous agreement that the platform was easy to use, which aligns with one of the key usability goals of the project according to (Davis, 1989) [17]. Here are some of their responses:

Participant 3: "Just now, there were not a lot of things to do. From this perspective, I think it is easy...Every step is easy."

Participant 1: "I think it is quite easy and user-friendly to upload the video, and it is quite straightforward. The instruction is quite direct."

Participant 2: "It is easy. You just finish all the steps and then upload."

Participant 4: "It is not difficult. It is easy."

Participant 5: "It is easy to use."

Participant 6: "I think it's easy."

These responses indicate that all participants found the platform to be user-friendly and straightforward in its operations. They highlighted the ease of uploading videos and completing the required steps without encountering any significant challenges. The participants' overall consensus on the platform's ease of use validates the project's aim to create a user-friendly environment for educators to upload, edit, and publish 360° videos without facing technical complexities.

3) Usefulness: During the interviews, participants expressed their views on the usefulness of the platform for their current or future teaching. They recognized the potential value it could bring to their instructional practices. Here are some of their responses:

Participant 3: "I think it is a very good idea (to use this platform for her international business tours)."

Participant 1: "In the future, it might be quite useful for my courses. Students today like interaction, more visual attention to stay longer. It eliminates the explanation, and students could visualize it."

Participant 2: "It could be useful. It provides me with the way to upload and cut. So I do not have to worry about going to Youtube. I know (via) Youtube, or any platform, cutting it, you have to, the interface is just overwhelming. So I think this one is, the simpler, the better."

Participant 5: "Well, for my classes, I think it might be useful. Now I am thinking I can use it in the future."

These responses highlight the participants' recognition of the platform's potential usefulness in enhancing their teaching practices. They acknowledged the benefits of incorporating interactive and visually engaging content through 360° videos to improve student engagement and understanding. The convenience of uploading and editing videos directly on the platform was also highlighted as a significant advantage compared to other platforms that might have complex interfaces. Overall, the participants expressed positive attitudes toward the platform's usefulness, indicating their willingness to incorporate it into their teaching activities.

4) Integration of different functions: During the interviews, participants expressed their appreciation for the

integrated functions of the platform, which alleviated the effort required to create 360° video classes. Here are some of their responses:

Participant 2: "I tried to use 360° video to teach before. So you have to go...Youtube allows some (to upload, edit, and publish), Facebook allows some others. There are some allowing photos, but you have to pay for videos. It is very confusing and useless... That's (the platform) easy and straightforward."

Participant 4: "In this platform, I do not need to learn some kind of new technology or combine different software together. Your platform provides all these required. This can reduce much time for customers."

These responses indicate that participants found the platform to be a comprehensive solution that eliminated the need to navigate multiple platforms or software tools to accomplish their desired tasks. The convenience and simplicity of having all the necessary functions integrated into one platform were highly appreciated. Participants highlighted the time-saving aspect of using the platform, as they no longer needed to spend excessive effort learning new technologies or managing various software tools. This further reinforced their positive perception of the platform's design and it's potential to streamline their workflow in generating 360° video classes.

5) Expectations and improvements: During the interviews, participants shared their expectations for the future design of the platform, highlighting their needs in terms of feedback, display, and information accessibility. Here are some of their responses:

Participant 3: "Every step is so simple. I do not know how to improve."

Participant 1: "Overall, the platform is super easy for users. Maybe when you break down the video, you can immediately see which sections you can break down."

Participant 2: "The improvement is in the setting. For example, Step 1, like a big No. 1 to go next. A big number like the background. So you know where you are at in the process."

Participant 4: "To insert some part, for example, explanation voice or text function. If we have those that would be great."

These responses indicate that while participants found the current design of the platform to be easy and useful, they also expressed their desires for further enhancements. Participants highlighted the importance of clear visual cues and indicators, such as prominent numbers or markers, to provide a better understanding of the current step in the process. Additionally, they expressed a need for additional features like the ability to insert explanatory voiceovers or text, which would enhance the educational experience for both educators and students.

In summary, the design of our platform successfully provides educators with an easy-to-use and integrated solution that fulfills their basic needs for immersive educational videos. Through usability testing and participant feedback, we have confirmed that the platform is capable of assisting educators in achieving their educational goals. The participants' suggestions for future improvements provide valuable insights for enhancing the platform's functionality and usability even further.

V. Discussion and Future Work

Despite the increasing popularity of 360° videos and the potential they hold for enhancing educational experiences, there are certain limitations associated with the tools available for teachers to develop these videos and publish them. It is important to acknowledge these limitations in order to understand the current state of the technology and the areas that need further improvement.

One of the limitations lies in the complexity and accessibility of the tools used to create 360 videos. While there are software applications and platforms available that facilitate the creation process, they often require a certain level of technical expertise and can be daunting for educators without a background in video production or immersive technologies. Additionally, the cost of specialized equipment, such as multi-camera rigs or high-end cameras, can pose a barrier for schools and educators with limited resources.

It is important to highlight the significant advancements made in immersive technologies by devices such as the Facebook Quest 2 [18] and the Apple Vision Pro [19] Gear. The Facebook Quest 2 has gained popularity as an accessible and affordable virtual reality (VR) headset. It allows users to easily experience 360° videos and other VR content without the need for external sensors or a high-powered computer, thanks to its wireless and standalone design. On the other hand, the Apple Vision Pro Gear, although not yet released, is anticipated to be a device merging both virtual reality and augmented reality (AR) capabilities. By overlaying virtual objects onto the real world, it creates a mixed reality experience, enabling users to interact with digital content in their environment. These advancements in hardware technology are proving to be valuable for educators and students, as they make immersive experiences more readily accessible for educational purposes.

The metaverse [20] is a term used to describe a collective virtual shared space where people can interact with each other and digital content in real time. It combines elements of the physical and virtual worlds, creating an immersive and interconnected environment. In the metaverse, individuals can engage in various activities, such as socializing, working, learning, and exploring, using virtual reality (VR), augmented reality (AR), and other immersive technologies.

The concept of the metaverse has gained significant attention in recent years, fueled by advancements in technology and the growing popularity of VR and AR experiences. It represents a vision of a fully realized digital realm where individuals can transcend physical limitations and immerse themselves in limitless virtual experiences.

In the field of education, the metaverse holds great promise for transforming the way students learn and engage with educational content. By creating immersive and interactive virtual environments, the metaverse can offer new possibilities

for experiential learning, simulation-based training, and collaborative problem-solving and global connections.

However, the full realization of the metaverse in education is still in its early stages. Technical challenges, such as creating seamless interoperability between different platforms and devices, ensuring data privacy and security, and developing user-friendly interfaces, need to be addressed. Furthermore, ethical considerations related to virtual experiences and the potential for exacerbating existing social inequalities should be carefully navigated.

Our current work aims to provide educators with a high-fidelity prototype that allows them to easily upload, edit, and publish their 360 videos for their immersive classes instead of using different sources to edit their videos and then find places to publish their videos, which brings lots of challenges to them. Our next step is to refine the prototype and make mature market-oriented software so that all educators can use it.

VI. Conclusions

In this paper, we introduce i-Tech, a novel tool designed to support educators in the creation and publication of their 360 video content. i-Tech offers a user-friendly and intuitive interface that empowers educators to leverage the immersive capabilities of 360 videos for educational purposes. Our main objective was to provide educators with practical solutions for easily uploading, editing, and publishing 360° videos to enhance the immersive learning experience of students. By utilizing video observation, think-aloud protocols, and interviews, we successfully integrated the necessary functionalities into our platform, enabling educators to create 360 class videos efficiently. While the availability of integrated 360° video platforms for educators is currently limited, the positive outcomes of our study offer valuable insights for future research in this field. The implications of our design can extend beyond educators and be applied to other user groups seeking to create 360° videos for various purposes.

However, it is important to acknowledge the limitations of our study. We conducted usability testing with a relatively small sample of seven professors from different disciplines. Despite the modest sample size, it aligns with Nelson's suggestion that even a small number of users can effectively identify a significant portion of usability issues in a technology. Additionally, our platform is currently in its initial version, focusing primarily on streamlining the process of cutting, uploading, and publishing 360° videos for educators.

In future studies, we plan to enhance the functionality of our platform to minimize technical challenges and provide a user-friendly experience for educators and other users. We believe that our study has made a valuable contribution to the understanding of integrated 360° video design, considering the limited existing research in this area. Our hope is that our findings will inspire designers and researchers to further explore this topic, leading to the development of innovative designs and applications that can benefit a broader range of users.

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Institutional Review Board Statement

The authors of this research study obtained the necessary approvals and/or waivers from the Institutional Review Board (IRB) at St Cloud State University for the project. The study was conducted in accordance with the ethical guidelines and regulations set forth by the IRB. Necessary measures were taken to ensure the protection of participants' rights, privacy, and confidentiality throughout the research process.

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