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Augmented Reality at Classroom Setup of State Universities and Colleges in the Philippines: A New Perspective

Journal of Electrical Systems

Abstract: - This study provides an examination of the viability and possible implementation of augmented reality (AR) applications inside the Quirino State University academic setting. The potential of augmented reality to seamlessly merge digital material with the actual environment opens up interesting possibilities for improving learning and easing administrative procedures. It thorough mixed-methods approach, evaluating the important elements using surveys, interviews, observations, data analysis, and Design Thinking methodology. The study examined stakeholder views' knowledge, attitudes, and expectations of augmented reality technology in the academic setting. An understanding of the actual application of this technology and its efficacy in educational contexts may be gained from observations of existing AR efforts inside the institution. With an emphasis on improving teaching, student outcomes, and administrative processes, specific demands and potential for integrating AR applications are investigated. The study provides useful suggestions and insights based on the research findings to direct future choices about the use of AR technology at Quirino State University. This study attempts to connect academic practices at Quirino State University with the changing expectations of its diverse population and the larger educational environment by methodically evaluating the potential of AR technology.

Keywords: *AR Integration in University, AR Technology in Education, Augmented Reality (AR), Design Thinking, Empathy Map*

I. BACKGROUND

Modern society is increasingly influenced by parallel realities, including virtual reality, which has become an integral part of daily habits and activities. Virtual reality (VR) is closely related to the concept of augmented reality (AR), a technology that, while still rapidly expanding, was envisioned several decades ago [2]. AR is gaining popularity, with projections showing 2.4 billion global Augmented Reality mobile users by 2023, a significant increase from the 200 million in 2015. While many are familiar with Augmented Reality through mobile games like Pokémon Go and social media platforms like Snapchat, education represents another critical area where this technology has the potential to make a significant impact [23]. AR is an interactive technology that overlays computer-generated information onto the real world. Utilizing software, apps, and devices such as AR glasses, enriches user experiences by adding digital content to real-life environments, creating interactive learning scenarios [4]. AR enhances design, curating, and instruction by blending digital and physical worlds, enabling real-time interactions, and precise 3D object identification, improving work settings. When a business grasps the concept of AR and knows how to effectively implement it, it enables remote work and efficient collaboration for all team members [26].

AR promotes interactivity and engagement in the real world, allowing students to focus on learning subjects while minimizing learning time. It can inspire empathy and enhance memory, leading to faster information and skill acquisition. AR can deepen knowledge in various areas, including reading, number work, spatial concepts, and teamwork. It could also be used in the workforce, providing new opportunities for communication and collaboration [22]. AR has its most significant impact in education, offering numerous benefits that have increasingly drawn the attention of educators. AR technology provides flexible and engaging learning environments, creates excitement, boosts motivation, facilitates active observation and hypothesis formation, improves learning performance, fosters social interactions, bridges formal and informal learning, encourages collaboration, and promotes a sense of independence and personalization in education. Within educational AR, wearable technologies stand out. These devices, equipped with smart sensors, use Bluetooth, Wi-Fi, and mobile internet to sync with smartphones. Constantly with the user, wearables offer important services in entertainment, health, work, information, education, socialization, and security [27]. AR and VR technologies are transforming education by providing immersive experiences for students to interact with their environment. As hardware costs decrease, these technologies become more accessible, enhancing engagement and comprehension. Research

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shows that integrating AR and VR in classrooms leads to higher motivation, improved academic performance, and improved learning outcomes. These technologies are also used in various educational settings, particularly museums, libraries, and science centers, benefiting younger students and aiding their understanding of complex concepts [1].

Research on AR-based education projects shows its effectiveness in contextual learning, abstract concept representation, interaction, and motivation. However, challenges like lack of digital skills, technological support, and device integration remain. Improved training and modern methodologies are needed to effectively use AR in the classroom [9]. Digital technologies are revolutionizing education, with 65% of U.S. public school teachers using them daily. Educators are exploring innovative ways to incorporate digital solutions into classroom experiences, such as augmented reality and virtual reality (AR/VR), which reduce physical barriers, enhance collaboration, and provide individualized learning approaches for students at all levels [7].

Ryan Johnston [15] highlights the growing importance of AR/VR technologies in advanced learning environments, with educators incorporating immersive technologies into their courses, highlighting their potential to enhance teaching and learning experiences. AR/VR is a rapidly growing market in educational settings, used for virtual field trips, science experiments, and simulations. It's compatible with mobile devices and advanced headsets, improving quality and decreasing costs. This multimillion-dollar market has transitioned from small-scale experimentation to a multimillion-dollar market. The technologies necessary to develop and access immersive content are also becoming easier to use and more affordable [3].

The goal of the Philippine Development Plan of 2017–2022, is to reduce poverty and promote inclusive economic growth in order to elevate the Philippines to an upper-middle income nation by 2022. A crucial tactic is human capital development, and new initiatives are meant to raise the standard of education [19]. The Philippines' education system has undergone significant changes to prepare its youth for the modern world. The K-12 program, which extends the basic education cycle from 10 to 12 years, aligns Philippine education with global standards and provides a comprehensive foundation. The program includes Kindergarten, six years of primary education, four years of Junior High School, and two years of Senior High School, providing diverse tracks like Academic, Technical-Vocational-Livelihood, Sports, and Arts and Design to cater to various interests and career paths. Higher education, provided by both public and private institutions, offers undergraduate, graduate, and doctoral programs, with state universities like the University of the Philippines offering affordable and quality education. Vocational training, facilitated by organizations like the Technical Education and Skills Development Authority (TESDA), focuses on equipping students with industry-specific skills. The dynamic between public and private schooling is significant, with improvements in resources and quality seen in public schools post-K-12 reform. Private schools often offer specialized curricula and facilities, catering to different educational approaches and preferences. Overall, the structure and framework of the current Philippine education system underscore the nation's dedication to providing diverse and inclusive educational opportunities, preparing its youth for a globalized future [18].

In the study of Villanueva, *et al.* [25], it examined the education status of State Universities and Colleges (SUCs) in the Philippines. It also investigated various factors such as faculty qualification, student performance, facilities, and financial resources. It was found out that there are disparities in faculty qualifications and student performance among different SUCs, with some institutions facing challenges related to inadequate facilities and financial resources. It reiterated the importance of addressing these issues to enhance the quality of education provided by SUCs and ensure equitable access for all students. Additionally, the study highlights the need for further research and policy interventions to support the development of SUCs and strengthen the Philippine higher education system as a whole.

In the article of Handog [11] and the paper of Espinosa, *et al.* [8], many Filipino students encounter considerable obstacles in accessing the technology necessary for online learning. A significant number of families cannot afford essential devices such as laptops or tablets, nor do they have reliable internet connections. This financial constraint greatly hinders their ability to engage in digital education. The situation is further exacerbated by inadequate infrastructure in rural areas, where poor internet connectivity and inconsistent electricity make effective online learning nearly impossible. Moreover, while there have been initiatives to incorporate technology into education, the emphasis has primarily been on basic computer skills rather than on leveraging digital tools to enhance learning

in specific subjects. As a result, both students and teachers are often ill-equipped to make the most of these resources in the educational process.

Additionally, the transition from traditional classroom environments to online learning requires significant adjustments. Both educators and students find it challenging to adapt to new teaching and learning methods, which negatively affects the overall quality of education. Lastly, the mental health and well-being of students and teachers are pressing concerns. The stress and isolation associated with online learning can lead to anxiety, adversely impacting their academic performance and mental health. Efforts are being made by the Philippine education authorities to address these challenges. Initiatives such as the DepEd Computerization Program and the Public Education Network aim to improve access to technology and connectivity. Programs like flexible learning strategies and mental health support are also being implemented to help students and teachers cope with the new normal in education.

In the study of Koumpouros [17], it examined the characteristics of AR applications in education, focusing on their effectiveness. A systematic bibliographic review of 73 articles was conducted, with a majority targeting university students and physics class and foreign language learning. Most applications were designed using marker detection technology for Android and Unity and Vuforia tools. However, most studies evaluated the effectiveness subjectively, with technical problems and equipment limitations being common obstacles. The study suggests further research is needed to fully understand AR applications' potential in education and develop effective evaluation methods.

The growing interest in augmented reality and its potential to facilitate impactful learning experiences has spurred investigations into diverse learning theories. These theories serve as invaluable resources, offering guidance and insights for educators contemplating the integration of AR technologies into their instructional practices [10]. The academic approaches recorded through the use of appropriate AR educational applications include game-based learning, situated learning, constructivism, and investigative learning, as reported in the literature [5].

Through a comprehensive analysis of pertinent literature and the synthesis of research outcomes, studies have conducted a systematic review which offered invaluable insights into the present landscape of augmented reality applications in education. This examination encompasses delineating the characteristics of AR tools, discerning their functionalities, and elucidating the multifaceted challenges inherent in their adoption across the following various educational domains:

- *Identifying trends and characteristics*: A study can investigate the spectrum of AR technologies employed in education, their specific pedagogical objectives, and the academic fields they target. Such an inquiry offers a panoramic view of the prevailing terrain in AR integration, equipping educators, researchers, and developers with valuable insights into the myriad opportunities and advantages that AR holds for educational contexts [16].

- *Assessing effectiveness*: Conducting a systematic review enables the assessment of the efficacy of AR applications in augmenting learning outcomes. Through the analysis of empirical investigations, this review can discern the influence of AR on facets such as student engagement, motivation, knowledge acquisition, and retention. Such a rigorously evidence-based evaluation serves as a compass for educators, aiding them in making judicious choices regarding the integration of AR technologies into their instructional methodologies [21].

- *Examining implementation challenges*: AR implementation within educational environments may encounter diverse challenges. These obstacles encompass technical hurdles, educator training needs, financial constraints, and the seamless integration of pedagogical approaches. Through a systematic review, these challenges can be illuminated, offering valuable insights into both the impediments and the enablers crucial for the effective deployment of AR technologies in educational settings [6].

- *Informing design and development*: Understanding the attributes and obstacles associated with AR applications in education can guide the conception and crafting of innovative AR tools and instructional methodologies. This insight allows developers and instructional designers to tackle the identified challenges and craft AR applications that are not only more efficient but also more user-friendly, designed to meet the unique demands of educational settings [13].

Quirino State University (QSU) is a dynamic institution dedicated to provide high-quality education and fostering a supportive learning environment for its students. In an era of rapid technological advancement, universities worldwide are exploring innovative ways to augment the educational experience, enhance campus services, and engage students effectively. AR technology, which overlays digital elements onto the physical world, has emerged as a promising tool to achieve these objectives. The use of AR has awakened the interest of educators and opened up new potential for learning. Education academics may now use cutting-edge tools and strategies for tracking and evaluating the teaching and learning process in recognition to the development of artificial intelligence.

This study seeks to explore the possibilities and potential benefits of implementing an AR application at QSU. It envisions to design a framework for the envisioned AR application of QSU, outlining the intended impact on education, student engagement, and campus services. Specifically, it seeks to answer the following: to identify potential challenges in the adoption and implementation of AR technologies in the classroom, along with opportunities for improving educational outcomes; to assess the potential of AR in improving student engagement, motivation, and interaction within an academic environment; to design a comprehensive framework for integrating augmented reality into the classroom setup of Quirino State University; and to assess the usability of the architecture using SUS as perceived by the end users and IT experts. These objectives serve as the guiding principles for evaluating the feasibility and benefits of integrating AR technology into the fabric of QSU. Augmented Reality has demonstrated its capacity to transform traditional education, enriching it with interactive and immersive experiences.

AR emerges as a promising avenue for transforming education by enhancing learning outcomes in today's digital era. The study of Sharmila (2024), explores the role of AR within educational settings, aiming to examine its influence on learning effectiveness. Through an exhaustive review encompassing theoretical frameworks, empirical evidence, and practical implementations, this study illuminates the potential of AR as an innovative educational tool. The results indicate that AR facilitates immersive, interactive, and personalized learning experiences, effectively bridging the chasm between abstract concepts and real-world applications. By harnessing AR technology to cultivate dynamic and captivating learning environments, educators can adeptly prepare students for triumph in an ever-evolving, technology-infused landscape [12].

AR has the potential to revolutionize education by enhancing student engagement and improving learning outcomes. It creates immersive and interactive learning environments, bridges abstract concepts, fosters collaboration, and applies theoretical knowledge to practical contexts. Despite technical challenges, accessibility, and safety concerns, the benefits of AR outweigh these limitations. Collaboration between educators, policymakers, and technology innovators can create a future where AR is integrated into curricula [14].

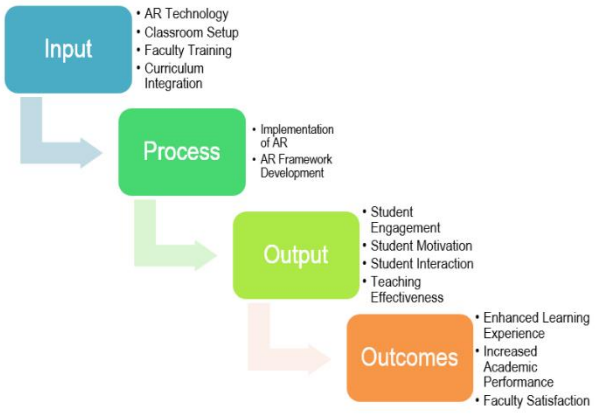

Figure 1. Conceptual Framework of the Study

Figure 1 is the conceptual framework of the study. The conceptual paradigm of implementing Augmented Reality (AR) in the classroom consists of several interconnected components that illustrate its potential impact on educational outcomes. At the foundation are the input variables, which encompass the essential resources and conditions necessary for the effective integration of AR into the learning environment. These inputs may include technological tools, teacher training, and curriculum alignment. Following this, the process refers to the specific

actions taken to incorporate AR into the classroom setting, which involves developing a structured framework that guides its use, ensuring that both educators and students can navigate this innovative technology effectively. The output variables represent the immediate results of AR implementation, such as various metrics related to student engagement, comprehension, and teaching performance, providing a snapshot of how AR is influencing classroom dynamics. Finally, the outcomes reflect the long-term impacts of AR on the educational landscape, including enhancements in learning experiences, improvements in academic performance, and increased faculty satisfaction. Together, these elements create a comprehensive view of how the integration of AR can transform the classroom environment and positively influence educational results, highlighting the interconnected nature of resources, processes, and outcomes in the study of AR in education.

II. METHODOLOGY

Research Design

The research employed a descriptive and evaluative research design to analyze the integration of AR technology in classroom environments. The descriptive phase focused on documenting the current status of AR implementation, including the setup of AR tools, their curriculum integration, and the experiences of students and faculty. This involved data collection through surveys, observations, and interviews. The evaluative phase assessed the effectiveness of AR by measuring its impact on student engagement, motivation, and interaction compared to traditional teaching methods. This included analyzing data collected before and after AR implementation, evaluating academic performance, and gathering qualitative feedback. By combining these two approaches, the study offers a comprehensive overview of the AR implementation process and its outcomes, providing valuable insights and recommendations for enhancing AR integration in educational settings.

Participants and Sampling Method

This study used purposive sampling to include all those who are directly involved with AR. The following will be the participants of the study:

Students. A sample of students from the various departments who will use AR in their classrooms.

Faculty. Instructors from departments that will integrate AR into their teaching.

IT Staff. Technical staff involved in setting up and maintaining AR systems.

Data Collection Methods

Surveys/Questionnaires. These are used to measure engagement, motivation, and interaction levels before and after AR framework implementation. Also, the questionnaires are used to evaluate perceptions of impact of AR on teaching effectiveness, ease of integration, and overall satisfaction.

Interviews and Observations. Semi-structured interviews were conducted to gain insights into the experiences, challenges, and perceived benefits of using AR in the classroom and to understand respondents' experiences with AR, including benefits, challenges, and suggestions for improvement.

Focus Groups. These are organized with students and faculty to discuss their collective experiences and gather detailed feedback on the AR implementation process.

Software Development Methodology

The Design Thinking methodology is being applied to the study as it involves a human-centered approach to problem-solving. Design thinking is a mindset and methodology focused on solving problems and fostering innovation with a human-centered approach. Unlike traditional innovation processes that focus on identifying and analyzing problems, design thinking emphasizes creating solutions with the end-user in mind.

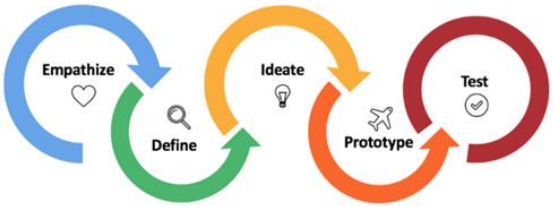

Figure 2. The Design Thinking Methodology Process

The design thinking approach emphasizes enhancing user engagement rather than just focusing on productivity challenges. At its core, design thinking is centered around the users, paying attention to those affected by both the problem and the solution. It includes posing essential questions like "Who will utilize this product?" and "What impact will this solution have on the user?" A crucial aspect of design thinking is cultivating empathy with users. Gaining insight into their experiences and needs leads to the creation of more effective solutions. Additionally, design thinking entails observing how users interact with products, extracting insights from research, and maintaining a user-centric perspective throughout the implementation process [20].

Empathize. The empathy stage aims to comprehend the experiences, emotions, and challenges faced by students, teachers, and technical staff in order to develop an AR framework that truly meets their needs. By thoroughly understanding each group, the study can create a more effective and user-focused AR framework that boosts student engagement, assists teachers, and aligns with the university's technical capabilities. This stage is vital for ensuring that the AR implementation is advantageous, inclusive, and meaningful for all stakeholders involved.

Define. During the define stage of the study, the emphasis is on precisely identifying the issues that AR technology can resolve in the classroom, including low student engagement, insufficient resources for teaching abstract concepts, and technological preparedness. The goals are centered on leveraging AR to boost engagement, enhance learning outcomes, assist faculty, and confirm technological viability. This stage is essential for establishing clear objectives and defining success metrics that the AR framework seeks to accomplish, ensuring that the solutions created in later stages effectively meet the needs of students, teachers, and technical staff.

Ideate. During the ideate stage of the study, diverse creative and practical ideas are generated to effectively incorporate AR into classroom settings at Quirino State University. The emphasis is on boosting student engagement through interactive, gamified, and collaborative AR experiences, while also equipping teachers with intuitive tools and training to effortlessly integrate AR into their teaching. Additionally, the ideate stage explores methods to address technical hurdles, such as guaranteeing scalability, affordability, and offline functionality. By involving stakeholders in the ideation process and utilizing real-time feedback mechanisms, the study aims to develop an innovative and sustainable AR framework that benefits both students and educators.

Prototype. The fourth phase is the development and testing the preliminary versions of the proposed solutions. The researcher created prototypes of the frameworks to visualize and test ideas. The prototypes were presented to the users for feedback, focusing on usability, functionality, and overall experience. Prototypes were iterated based on user feedback, making improvements and adjustments as needed.

Test. The fifth phase focuses on the evaluation of the effectiveness of the developed framework and refine them based on testing results. Data is being gathered on user satisfaction, and the impact of AR in the university as a whole using the SUS. Through this, the test results were being assessed to identify strengths, weaknesses, and areas for further improvement.

III. Results and Discussions

A. Potential challenges in the adoption and implementation of AR technologies in the classroom and opportunities for improving educational outcomes

To summarize and reflect the results of interviews and observations done by the researcher for the potential challenges in the adoption and implementation of AR technologies in the classroom, empathy maps were designed which focuses on understanding the experiences, emotions, and perspectives of the primary stakeholders—students, teachers, and IT staff. This helped in gaining deeper insight into their challenges and opportunities related

to AR adoption. The empathy maps provide a comprehensive understanding of the emotions, thoughts, and behaviors of the stakeholders—regarding the adoption and challenges of AR technology in the classroom. It underscores the pain points they may face and the potential benefits for each group if the implementation is successful.

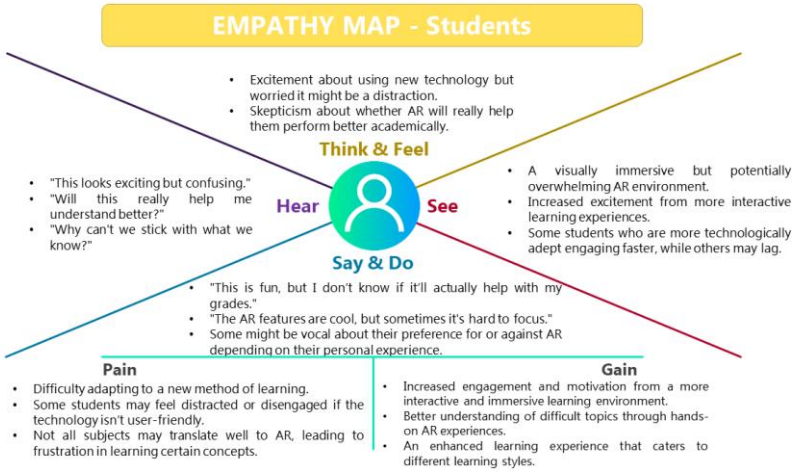

Figure 3. The Empathy Map of Students

Figure 3 is the empathy map of students which reveals that they have mixed feelings about AR. While many are excited by the novelty and interactive potential of AR technology, others may feel overwhelmed or skeptical about its benefits. The key challenge is ensuring AR is intuitive, engaging, and truly helpful in enhancing learning outcomes. By addressing students' pain points, such as difficulties in adapting to the new technology and ensuring AR is relevant to all subjects, the implementation can lead to increased engagement, motivation, and improved understanding of complex concepts.

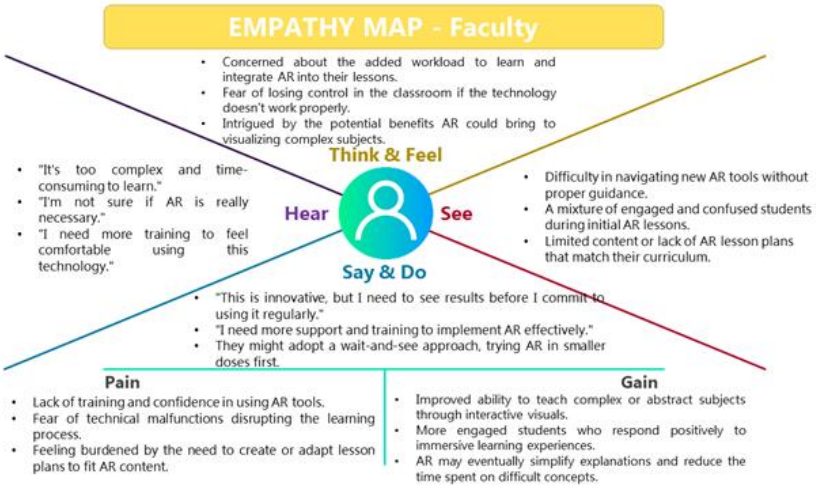

Figure 4. Empathy Map of Faculty

Figure 4 is the empathy map for faculty which reveals that they experience a combination of curiosity and anxiety about AR technology. While many see the potential for AR to enhance engagement and improve learning outcomes, they also worry about the added workload, lack of training, and possible technical failures. Teachers are cautious and seek more support, but they recognize the gains in terms of improving their effectiveness and providing a more dynamic classroom experience. By addressing their pain points, such as providing comprehensive training and ensuring AR is easy to use, they can become more open to adopting the technology, ultimately leading to a more engaging and effective learning environment.

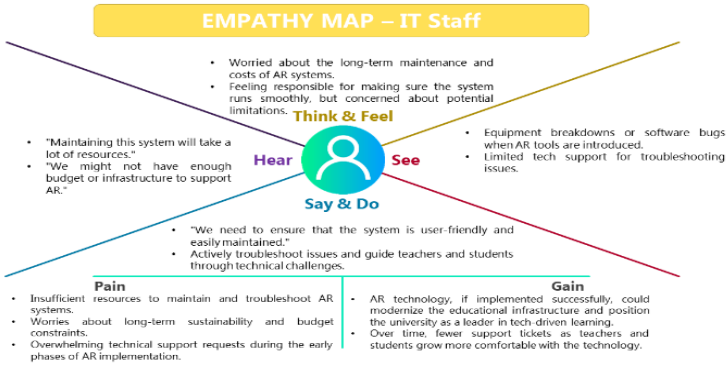

Figure 5. Empathy Map of IT Staff

Figure 5 is the empathy map of IT/support staff which reveals that they are critical players in ensuring the successful implementation of AR technology in classrooms. They face significant challenges, including limited resources, technical malfunctions, and the high demand for support. While these challenges may cause frustration, the potential gains—such as professional growth, recognition for innovation, and a more efficient learning environment—motivate them to push through these difficulties. By addressing their pain points with adequate training, funding, and streamlined support systems, IT staff can focus on maintaining and enhancing the AR experience, leading to a more sustainable and effective educational tool.

B. Potential of AR in improving student engagement, motivation, and interaction within an academic environment

The modern educational landscape requires innovative approaches to engage students and encourage active participation in their learning. Traditional teaching methods often struggle to maintain student motivation and interaction, creating a need for solutions like augmented reality (AR) technology. As this study aims to examine how AR can be effectively integrated into academic settings to enhance student engagement, motivation, and interaction. It seeks to provide insights into its benefits and applications, ultimately contributing to the creation of a more dynamic learning environment that improves academic performance and prepares students for a technology-driven future.

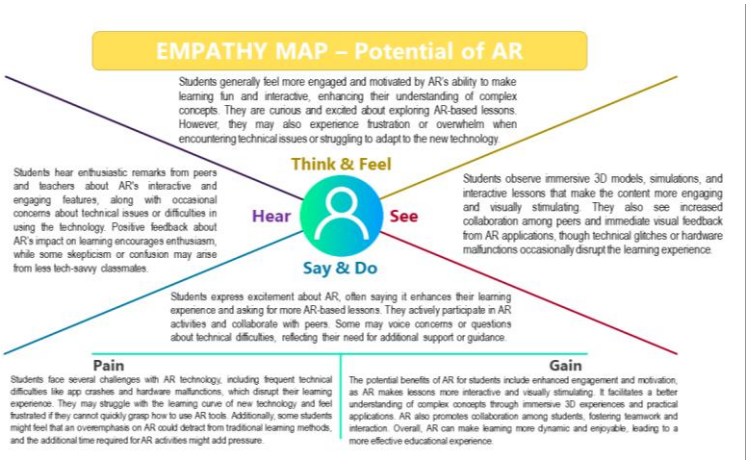

Figure 6. Empathy Map – Potential of AR

The empathy map for the potential of AR in student activities is presented in Figure 6. It reveals that AR has strong potential to improve student engagement, motivation, and interaction. While students are generally excited and curious about AR, technical difficulties and the learning curve pose challenges that could hinder its effectiveness. By addressing these pain points, such as providing better support and smoother technology experiences, AR can significantly enhance the academic environment, making learning more dynamic, interactive, and enjoyable for students.

Formulating a clear and concise problem statement is an essential part of the Define stage in the Design Thinking process. This statement serves as the focal point for all participants involved in the design thinking journey. The Define stage is vital for understanding the problem and developing effective, valuable solutions. During this phase, the raw information and findings gathered from research, interviews, surveys, and problem analysis in the empathize stage are processed and interpreted. The objective is to derive meaningful insights from the data collected.

Point of View (POV) statements were designed according to the data gathered during the empathy phase of the study. These POV was crafted carefully which enabled the researcher to brainstorm and address the challenge in a targeted way, maintaining a focus on the users, their needs, and the insights gained about them. These POV helps in the customer story, plus increasing the alignment and understanding across the organization as a whole

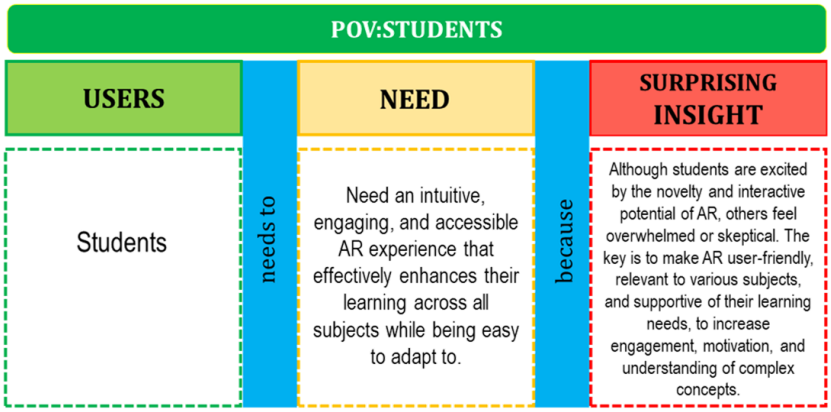

Figure 7. POV of Students

The POV of students as presented in Figure 7 highlights that students have mixed feelings about AR technology. While some are excited by its novelty and interactive potential, others feel overwhelmed or skeptical. To meet their needs, AR must be intuitive, engaging, and relevant across all subjects. The key insight is that AR must not only be easy to use but also provide tangible benefits that enhance learning. Addressing these concerns will increase student engagement, motivation, and improve understanding of complex concepts.

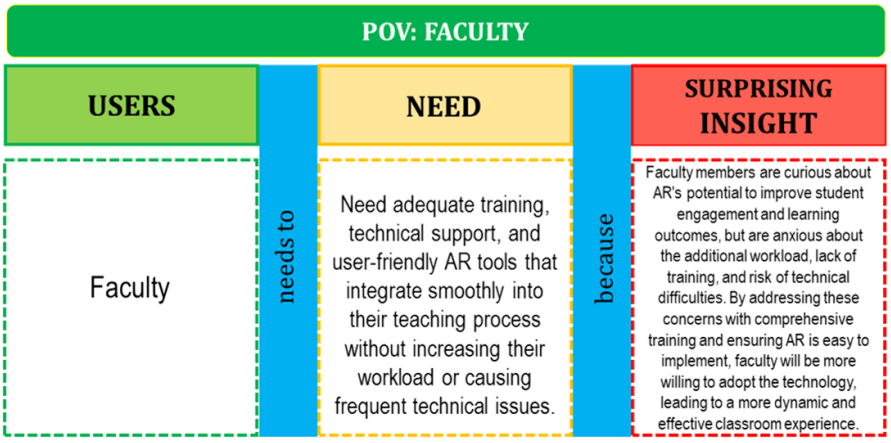

Figure 8. POV of Faculty

The POV statement for faculty as presented in Figure 8 highlights their mixed reactions to adopting Augmented Reality (AR) technology in the classroom. Faculty members recognize the potential benefits of AR, particularly in enhancing student engagement and improving learning outcomes. However, they also express concerns about the additional workload that AR might bring, as well as their lack of training and the possibility of technical failures disrupting lessons. These anxieties make them cautious about fully embracing the technology. To help faculty overcome these concerns, they need comprehensive training programs, technical support, and AR tools that are user-friendly and easy to integrate into their existing teaching methods. By addressing these pain points,

faculty can become more open to adopting AR, ultimately creating a more engaging and effective learning environment for their students.

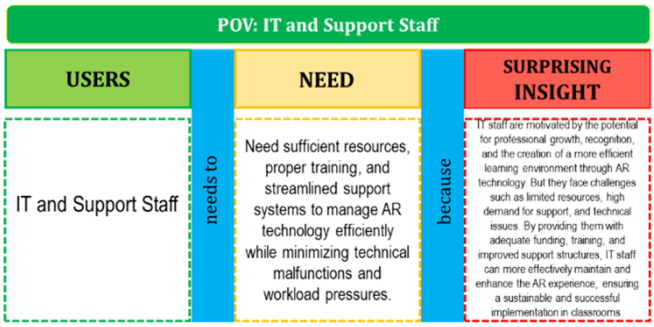

Figure 9. POV of IT and Support Staff

The POV statement for IT and support staff as highlighted in Figure 9 emphasizes their crucial role in the successful implementation of AR technology in classrooms. These staff members face significant challenges, such as limited resources, technical malfunctions, and the high demand for support, all of which can lead to frustration. Despite these obstacles, they are motivated by the potential gains, including opportunities for professional growth, recognition for their innovative efforts, and the creation of a more efficient educational environment. To help IT staff overcome these difficulties, they need adequate training, funding, and streamlined support systems. By addressing their pain points, they can focus on maintaining and improving the AR infrastructure, ensuring its sustainability and effectiveness in enhancing the overall learning experience for students and faculty alike.

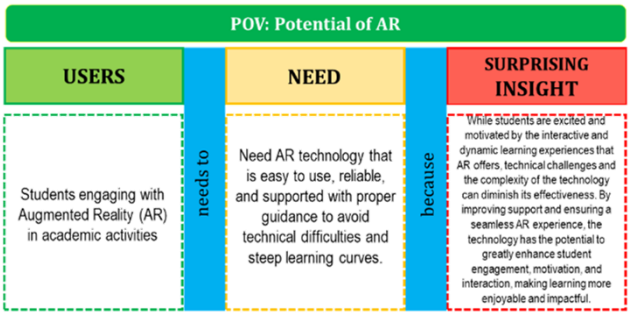

Figure 10. POV of Students in the Potential of AR

The POV statement for students engaging with Augmented Reality (AR) in academic activities presented in Figure 10 highlights the technology's strong potential to enhance learning. Students are generally enthusiastic about the dynamic and interactive experiences that AR can bring to the classroom, which boosts their engagement, motivation, and interaction with the material. However, technical challenges, such as malfunctions and the steep learning curve, can hinder its effectiveness and cause frustration. To fully realize AR's potential, these pain points need to be addressed by providing better technical support, making the technology more user-friendly, and ensuring a smooth experience. When these issues are resolved, AR can transform the academic environment, making learning more engaging, enjoyable, and effective for students.

C. Framework for integrating augmented reality into the classroom setup of Quirino State University

Visual Diagram

The ideate process is rooted in a commitment to innovative exploration. It is based on the idea that augmented reality technology has the power to fundamentally alter the environment of Quirino State University's academic and administrative operations. It promotes original thought and the investigation of cutting-edge concepts and AR applications in a university context.

This study pursues to move beyond the existing quo and envision fresh ways that AR technology might increase administrative effectiveness, enrich the learning experience, and ultimately support the purpose and goals of the

institution. It aims to produce useful, scalable, and sustainable AR solutions while taking into account how these novel ideas may affect society over the long run.

It aims to harness the creative power of all stakeholders in order to imagine and build ground-breaking solutions, and is distinguished by a dedication to inventive exploration, collaborative thinking, and the long-term influence of AR technology inside the institution.

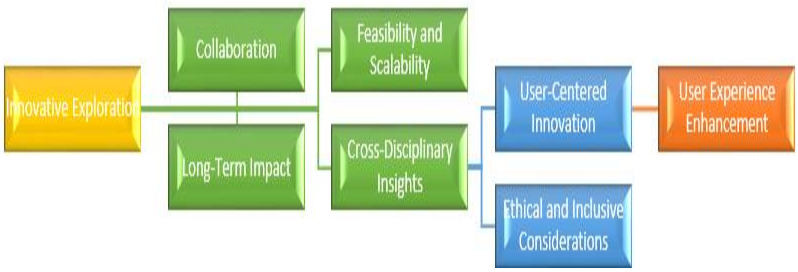

Figure 11. The Visual Diagram of the Innovative Exploration on the Implementation of AR in QSU

In this diagram, "Innovative Exploration" is at the top priority, surrounded by key perspectives and elements of the ideate process. Each of these factors contributes to the creative investigation of AR possibilities at Quirino State University, including "Collaboration," "Long-Term Impact," "Feasibility and Scalability," "Cross-Disciplinary Insights," "User-Centered Innovation," "Ethical and Inclusive Considerations," and "User Experience Enhancement."

In a time when technology constantly transforms education, incorporating AR into classroom environments marks a significant leap forward in enhancing learning experiences. At Quirino State University, the goal of creating a comprehensive framework for AR integration in classrooms stems from the necessity to innovate teaching approaches and engage students in more interactive and immersive ways. This framework is derived from the empathy maps and POV of the end users and are designed to seamlessly integrate AR technology with current educational practices, fostering a dynamic learning atmosphere that boosts student engagement and enriches the educational journey. By addressing the specific needs of students, faculty, and IT support staff, the framework aims to ensure that the implementation of AR is both effective and sustainable, ultimately revolutionizing the academic experience at the university.

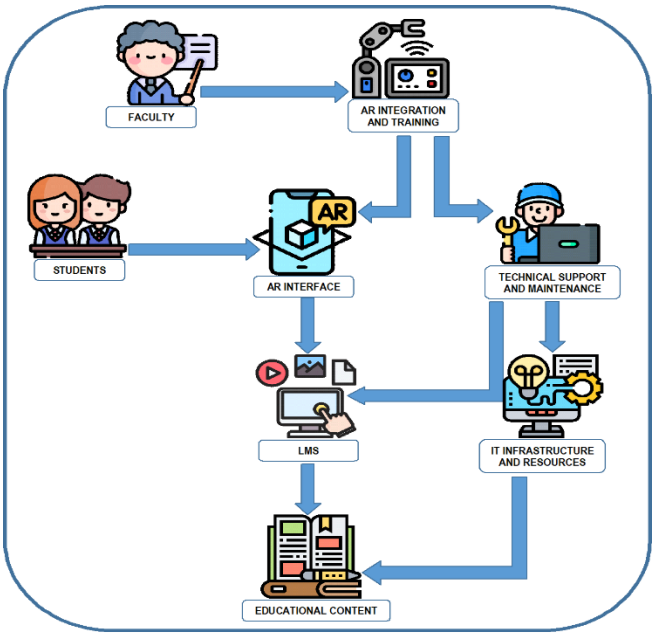

Figure 12. AR Integration Framework

The framework for integrating AR into the classroom at Quirino State University is designed to address the diverse needs and concerns of students, faculty, and IT/support staff. At the core of the system is the AR Interface, which provides students with an engaging and interactive learning experience. This interface is essential for making learning more dynamic and effective, leveraging AR's potential to enhance student engagement and understanding. The Learning Management System (LMS) integrates AR content with existing educational resources, ensuring that the technology supports and enriches the curriculum while tracking student progress.

For faculty, the framework includes a dedicated AR Integration and Training component. This provides comprehensive training and resources to help educators incorporate AR technology seamlessly into their teaching practices. Addressing concerns about additional workload and technical disruptions is crucial; hence, Technical Support and Maintenance is a key aspect, ensuring that faculty receive the necessary assistance and that any technical issues are promptly resolved.

The IT Infrastructure and Resources component is designed to support the deployment and maintenance of AR technology. This includes providing adequate hardware, software, and funding to ensure the AR systems operate effectively. IT and support staff are crucial for troubleshooting and managing the technology, so Technical Support and Maintenance is tailored to address their challenges and ensure a smooth operational experience.

Overall, this system framework aims to create a balanced and effective AR-based learning environment by addressing the concerns of all stakeholders. It ensures that students have an engaging and intuitive learning tool, faculty have the support and training they need, and IT staff have the resources and support to maintain the technology. By integrating these components, Quirino State University can leverage AR to enhance educational outcomes and create a more interactive and effective learning environment.

D. Usability of the architecture using SUS as perceived by the end users and IT experts.

In the assessment and testing of the usability of the proposed online systems, System Usability Scale was used. The System Usability Scale (SUS) is a widely used questionnaire method that evaluates the usability of a system or product through a series of standardized questions. It has become an essential tool in the field of User Experience (UX), providing valuable insights into the user-friendliness and overall quality of digital platforms [24].

Table 1. SUS Questionnaire

		Strongly Disagree 1	2	3	4	**Strongly Agree** 5
1	I think that I would like to use this system frequently.					
2	I found the system unnecessarily complex.					
3	I thought the system was easy to use.					
4	I think that I would need the support of a technical person to be able to use this					
5	I found the various functions in this system were well integrated.					
6	I thought there was too much inconsistency in this system.					
7	I would imagine that most people would learn to use this system very quickly.					
8	I found the system very cumbersome to use.					

9	I felt very confident using the system.					
10	I needed to learn a lot of things before I could get going with this system.					

Table 1 presents the SUS questionnaire which was handed to the respondents to answer with regards to the usability of the system. Responses were gathered from the faculty, students and IT experts.

Table 2. Distribution of Respondents

Respondents	Number
Faculty	15
Students	15
IT experts	5
Total	**35**

Table 2 presents the distribution of the respondents by purposive sampling.

The System Usability Scale (SUS) is a reliable tool used to assess the usability of products, services, or systems. It provides a quantitative measure of usability based on users' subjective assessments, making it a valuable resource in user experience research. [24]

Formula:

$SUS = (x+y) * 2.5$

The SUS survey's 10 statements are divided into odd-numbered and even-numbered questions for calculation purposes.

x = Subtract the sum of all points of odd-numbered questions by 5.

y= Subtract 25 from the sum of points from all even numbered questions.

In this analysis, the average SUS score is 90.65, reflecting exceptional usability. SUS scores can range from 0 to 100, with scores above 85 generally considered excellent. Thus, a score of 90.65 indicates that users view the architecture as highly intuitive, user-friendly, and well-constructed. This high score suggests that the system either meets or exceeds user expectations in terms of functionality, ease of navigation, and overall user experience.

IV. CONCLUSIONS

Augmented reality (AR) and virtual reality (VR) technologies are significantly transforming modern education by enhancing learning experiences through immersive and interactive environments that connect theoretical knowledge with practical application. As AR gains traction, its ability to promote engagement, collaboration, and personalized learning is becoming more apparent. Although there are technical challenges, such as accessibility and infrastructure issues, the advantages of AR—especially in education—are substantial. With ongoing collaboration among educators, policymakers, and technology developers, the integration of AR into classrooms has the potential to revolutionize learning outcomes and equip students for success in an increasingly technology-driven world.

This research utilized a descriptive and evaluative design to deliver a thorough analysis of AR integration in classroom settings. By documenting the current status of AR implementation and evaluating its effects on student engagement and teaching effectiveness, the study provides valuable insights into AR's potential to transform education. The application of the Design Thinking methodology ensured a human-centered approach, focusing on empathy and collaboration throughout the process. The findings from surveys, interviews, and focus groups, along with iterative prototyping and testing, establish a strong basis for refining AR frameworks and improving their integration in educational environments. The results underscore the advantages of AR in enhancing engagement, motivation, and learning outcomes, while also addressing challenges such as technical obstacles and user

adaptation. Ultimately, this study acts as a roadmap for future AR implementations, ensuring that technology effectively enriches both teaching and learning experiences.

The integration of AR technologies in classrooms presents both challenges and opportunities for enhancing educational outcomes. Through empathy mapping and point-of-view analysis, the study identified significant pain points for students, faculty, and IT staff, including the learning curve, workload concerns, and technical issues. However, the potential advantages of AR—such as increased student engagement, motivation, and interaction—underscore its value as a transformative educational tool. By addressing these challenges with targeted solutions like comprehensive training, improved technical support, and user-friendly AR designs, the adoption process can be significantly enhanced.

The research also highlights AR's ability to transform academic environments, making learning more dynamic and interactive. The integration framework developed for Quirino State University provides a structured method for utilizing AR to enhance education. Furthermore, the impressive System Usability Scale (SUS) score of 90.65 indicates that students, faculty, and IT experts perceive the AR system as highly intuitive and user-friendly, reinforcing its potential to revolutionize classroom learning.

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