THE POTENTIAL OF SPATIAL COMPUTING AND NATURAL LANGAUGE PROCESSING INCORPORATION IN HIGHER EDUCATION: A HUMAN RESOURCE-BOT CASE

[1]SANRI VAN RENSSEN, [2]BERNHARD A. VAN RENSSEN

[1,2]Stadio School of Administration and Management South Africa
E-mail: [1]sanrim@stadio.ac.za, [2]bernhard@b-v-r.co.za

Abstract - The higher education systems of today will not be applicable to the demands and requirements of tomorrow. This highlights the importance to keep on adapting and improving the higher education sector to meet the demands of consumers and the changing environment. One of the most prominent changes we currently face is the era of the fourth industrial revolution and the incorporation of new technologies in our higher education systems. This study aimed to contribute to this growing area of research by exploring the potential of combining Natural Language Processing (NLP) tasks through Large Language Models (LLM) via sentiment analysis with spatial computing in higher education through a review of literature. Additionally, this paper aimed to contribute novel information on the design and building of a 'smart-HR-bot' (NexAR) as one potential use-case for combining these technologies. This web-based HR-bot offers many unique characteristics such as being accessible via any mobile device and a customizable avatar of which its data can be tailored for a wide array of use cases. The HR-bot has been developed by the co-author and is showcased in this paper as one solution to incorporate these technologies in the higher education classroom to enhance learning and meet the challenges of the rapidly changing environment. As a case study, NexAR simulates a human resource scenario where the student can interact with the bot according to a predetermined data set within specific parameters. The bot aims to enhance the teaching and learning experience, increased inclusivity, efficient teaching and assessment, innovative pedagogical approaches and flexible learning environments. The bot is showcased in this paper, the next step will be testing it in the higher education setting.

Keywords - Spatial Computing, Augmented Reality, Artificial Intelligence, Higher Education, Natural Language Processing.

I. INTRODUCTION

The current higher education systems will not meet the needs and expectations of the future (Munir & Nudin, 2021, 137). This statement raises the importance of adapting higher education systems to the changes and challenges of tomorrow. Accordingly, one of the most prominent changes in society that is currently influencing higher education is the rise of the fourth industrial revolutions also known as Industry 4.0 (4IR) and the application of its related technologies (Zhukava, Mandragelia, Alieksieienko, Semeneko & Skibina, 2023). Recent research indicates that the traditional higher education model is ill-equipped to tackle the challenges presented by the 21st-century digital, global economy (Halabieh, Hawkins, Bernstein, Lewkowict, Unaldi Kamel, Feliming & Levitin, 2022). Accordingly, they further explain that research findings have identified existing shortcomings within our current education system, such as outdated pedagogical approaches and a lack of skills relevant to the world of work. Traditional educational systems have faced challenges adapting to the digital age's demands. To prepare students for the rapid advancements of technology, there is an urgent need to change the teaching methods and pedagogies in higher education and to continuously update their curricula (Alenzi, Wardat & Akour, 2023; Swartz & Patnaik 2023). 4IR technologies offer unique solutions to these challenges. It allows for immersive and interactive learning experiences, fostering student engagement and collaboration (Nahi, Ghaib & Ali, 2023). They further explain that 4IR incorporation is still in its nascent stages and that there is a need for further research to understand the full scope of the possibilities and challenges. Incorporating Industry 4.0 technologies holds great promise, but its successful implementation in higher education requires careful planning and research-driven insights (Nahi, Ghaib & Ali, 2023). Higher-education institutes hold the responsibility to guide the students to succeed in an era of 4IR by incorporating the related technologies (Khan, Sarwar, Chen & Khan, 2022).

With recent advancements in learning technologies, along with the ways information and communication technology (ICT) are implemented, many exciting possibilities have emerged to reshape students' learning behaviors and pedagogical approaches (Kinshuk, Nian-Shing Chen, Cheng & Sie Wai Chew, 2016). In order to prepare students for the advancements of technology, there is an urgent need to change how education is taught in higher education institutions. Despite this, many countries' higher education institutions are currently behind with the incorporation of digital education (Aleneziet al.,,2023). Zhukova, Mandragelia, Alieksieienko, Semenenko and Skibina (2023) argue that education processes must constantly adapt to new challenges and conditions, technology should be incorporated in order to improve the quality of education and the use of innovative teaching methods. Swartz and Patnaik

(2023) raise one reason why higher education institutions are behind namely that there is a lack of consensus on which emerging technologies should be included into the higher education curriculum.

This highlights the need for further research on the incorporation of 4IR technologies in higher education. Three of those technologies specifically will be investigated in this paper namely, spatial computing, natural language processing (NLP) and sentiment analysis through Large Language Model (LLM) application. Spatial computing is a broader concept that encompasses both AR and VR, amongst other technologies. It refers to the use of technology to understand and interact with the physical world in a spatial context. Spatial computing combines the real and virtual worlds, allowing users to perceive and interact with digital content within their physical environment (Yenduri, Maddikunta, Gadekallu, Jhaveri, Bandi, ChenWang, Shirawalmath, Ravishankar & Wang, 2024). Natural language processing (NLP) is a field that involves the use of computational techniques to enable computers to understand, interpret, and generate human language combining semantics and grammar to help computers comprehend human speech and writing, allowing them to infer meaning from textual data (Eisenstein, 2019). Large Language Models (LLMs) are a type of Artificial Intelligence (AI) model designed to understand and generate human-like text. These models are trained on large amounts of text data, such as books, articles, and websites, to learn the patterns, structures, and nuances of human language. LLMs use deep learning techniques, particularly neural networks, to process and analyze text data, enabling them to perform tasks such as language translation, text summarization, question answering, and text generation (Kasneci, Sebler, Küchemann, Bannert, Dementieva, Fischer, Gasser, Groh, Günnemann, Hüllermeier & Krusche, 2023). The exponential growing adaptation and use of LLMs since the late 2010s have given increasingly more use to NLP tasks (Zubiaga, 2024), the power of which is demonstrated in the application in the case study presented in this paper: a web-based virtual bot (NexAR) that presents a pre-loaded case study to the user and intuitively responds to the answer via various NLP tasks given for the specific case study – through sentiment analysis by a LLM – in-line with a dataset and evaluation criteria structured by the educational entity.

The purpose of the study is twofold. Firstly, to contribute to the growing area of research through a review of literature by exploring the potential of combining NLP tasks with LLMs and spatial computing and employing these technologies in higher education. Secondly, to contribute novel information on the design and implementation of a 'smart-HR-bot' as one potential use-case for combining these technologies within the higher education space.

II. LITERATURE REVIEW

2.1. The Higher Education sector

Throughout the 20th century, the quality of teaching and learning faced significant criticism. However, by the end of the century, educational standards had enhanced due to the incorporation of technology (Jain & Jain, 2021). The 21st century has observed transformation of education from a traditional 'classroom' pedagogy to emerging 'internet' based pedagogy. The challenges with the current higher educational system discussed in this study are twofold. Firstly, research suggests that the future of work will require a skill-focused approach rather than a knowledge/degree focused (Kasriel, 2018). It is noted that an increase in technology-based skills in the world of work is becoming more important. Accordingly the second challenge is that studies are reporting on the outdated educational system and the irrelevance of universities for the future of education (Mouton, Louw & Strydom, 2012; Llopis, 2022). This highlights once again the need for updated higher education systems by incorporating 4IR technologies. Technology allows education to become more flexible and accessible, breaking down geographical and time-related barriers, and it can redefine the way educational institutions are structured, with a reduced emphasis on physical infrastructure in favor of digital and online learning platforms (Blessinger, Singh, Poobalan & Nauman, 2022).

It is noted that the current higher education system is undergoing a transformative shift towards Education 4.0, a paradigm that aligns with the 4IR's emphasis on digitalisation, interconnectivity, and smart automation (Jamaludin, McKay & Ledger, 2019). This evolution reflects a strategic response to the rapidly changing global economic landscape, known from the emergence of advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and mixed reality (MR). But the challenges lie in effectively incorporating the technologies, getting buy in from universities, student accessibility and technological skills in the higher education sector, amongst others. This will be discussed in more depth in the next section.

2.2. Education 4.0

Education 4.0 is defined as learning that can take place anywhere and anytime. It has wide-ranging characteristics that encourage personal and flexible learning, it encourages practical application, modular and project-based learning, student ownership and evaluated rather than examined instructional performance (Jamaludin et al., 2019). Students take a more active role in the learning process and teachers

function as facilitators, this enables students to learn at their own pace, on flexible schedules and according to their individual needs (Ghanem, 2023). It could also improve students' independent problem-solving and collaboration with fellow students.

Education 4.0 advocates for a learner-centered approach, promoting personalized learning experiences, flexibility in educational pathways, and the integration of digital technologies into the curriculum. It emphasizes the development of critical 21st-century skills, including creativity, problem-solving, and digital literacy, to prepare students for the complexities of the modern workforce. As such, the transition towards Education 4.0 represents a significant reimagining of traditional educational models, aiming to equip learners with the skills and knowledge necessary to navigate and thrive in an increasingly digital and interconnected world. As stated earlier, the global society has entered the era of 4IR known by the integration of artificial intelligence (AI), big data, robotics, the Internet of Things (IoT), augmented reality (AR), virtual reality (VR), amongst other technologies (Swartz & Patnaik 2023; Ghanem, 2023). These technologies have a big impact on the labor force requiring different skillsets in the workplace, this emphasizes the importance to update the higher education curricula to meet the requirements of the workplace and align with required world of work skillsets (Swartz & Patnaik 2023). Education 4.0 encourages a seamless integration between higher education institutions and industry, encouraging theoretical knowledge and practical application and problem-based learning, thereby enhancing employability and encouraging innovation. Accordingly, to identify the trends, emerging technologies in the education systems require planning for the future digital world (OECD, 2018). Additionally, according to Alenezi et al. (2023) digitalization is a prerequisite for higher education institutions that want to draw in more and stronger students while enhancing the quality of their courses, module materials and programs as a whole.

We can see that Education 4.0 is already being incorporated and holds many benefits, but universities are still facing multiple challenges with the incorporation of Education 4.0 technologies namely: (1) students who are familiar to traditional learning settings might find it difficult to switch to the digital setting (Alenezi et al., 2023). (2) Another prominent challenge with digital learning is getting educators to modify their teaching methods to incorporate digital technologies. (3) lack in digital literacy, (4) lack of teacher-student direct interaction, (5) required self-discipline, (6) technological obstacles such as infrastructure and investment; and (7) digital education not suitable for certain lessons. Despite all the challenges there are multiple anticipated benefits. Alenezi et al. (2023) argue that digital learning is far superior to the conventional classrooms' paradigm. One big advantage of digital learning is increased flexibility and learning that extends beyond classroom 'walls' through engagement and learning material sharing in their own time. Other advantages include improved teaching and learning, growing return on investment in higher education, reduced inequality, improved access, meeting the skills requirements of the world of work, collaboration, amongst others (Sharma & Srivastava, 2020). In short, higher education institutions should be adapting to Education 4.0 strategies, whilst there are many challenges to still overcome. Education 4.0 shows many benefits, and more research and investment should be made into these efforts. This study aims to address this with one proposal of using two specific Industry 4.0 technologies, spatial computing and natural language processing (NLP) in order to move one step forward with incorporating Education 4.0 into higher education in an effective manner.

Fisk (2017); and Moraes, Kipper, Hackenhaar Kellermann, Austria, Leivas, Moraes and Witczak (2022), discuss nine principles that guide Education 4.0, the principles are listed in the table below. The table also summarizes how the proposed bot for the study aims to meet the Education 4.0 principles.

Principle	How the proposed bot meets the principles
Learning not limited to time and space	The web-based bot allows for use across platforms and devices. At minimum a computer or mobile device with internet connection is required to use the bot, which can be expanded to more immersive devices capable of AR/VR or Spatial Computing.
Personalized learning according to students' abilities and needs	The bot is set-up to work with any dataset in any field, thus it can base their feedback on the student's response - this offers personalized learning for the student
Flexibility for the student to choose the tools and resources to be used	The student can choose how long to interact with the bot and have flexibility to practice 'scenarios' in their own time on their own personal devices. It is recommended that higher education institutions also offer opportunities to work with the bot on-site if applicable.
Project-based learning	This simulation offers scenarios which supports the project-based learning approach.
Practical and experimental experiences, such as internships, mentoring and collaboration	For the case study, the bot will represent an employee in an HR simulation scenario, thus preparing the student for the practical application of their studies very much.

projects	
Interpretation of data to infer logics and trends	The program will offer the student feedback based on their responses offering instant data and feedback of their performance. It will also store the data of users for which future trends can be identified in how a curriculum should change/adapt to the students' requirements.
New ways of assessment, such as testing knowledge by applying it to field projects	The HR-bot is a novel way to test student knowledge by practical scenarios and application to world of work scenarios.
Student contribution to develop and review curricula	The student will provide valuable data to the educator by participating in the scenarios and will contribute to develop further scenarios and different simulations.
Increasingly independent learning	The student can complete the 'task' of interacting with the bot in their own time, this increases independent learning with real-time feedback.

Table 1: The nine principles of Education 4.0 and how the bot in the study aims to meet the nine principles (Moraes et al., 2022).

An advantage relevant to this study is that 4IR technologies enable us to tailor learning experience to specific requirements and offer flexible learning experiences, digital education is adaptive, blended, personalized and virtual (Alenezi et al., 2023;& Sharma, 2019). This approach is an adaptive learning strategy that uses AI to analyze the students' strengths and weaknesses and can adapt their learning specifically to the student needs. Education 4.0 can provide individualized learning experiences that take individual requirements into consideration and provide just-in-time feedback, pathways and resources. This greatly enhances the student experience within the higher education setting. A virtual learning environment (VLA) includes multiple tools that can facilitate online collaboration, student evaluation and feedback (Phungsuk, Viriyavejakul & Ratanaolarn, 2017) VLAs continue to be one of the most important tools for advancing pedagogical and instructional practices capable of adapting to the changing nature of education and teaching methods (Alenezi et al., 2023). The integration of virtual learning in higher education institutions have been slow, but anticipated advantages include improved communication, interactive elements, cooperative pedagogical methods integration, increased asynchronous communication, international intelligence gathering and knowledge advancement through continuous interaction. Digital technologies are being applied in the possibilities of improving the online platform for teaching professional skills, with improved interactivity especially in the virtual environment (Zhukova et al., 2023). According to Ghanem (2023) Education 4.0 relies heavily on VR, AR, AI, mobile and distance learning systems and project-based learning. The bot uses spatial computing, including AI and AR technologies with NLP and LLMs in order to create an effective virtual learning environment for the student in the higher education class.

2.3. Spatial computing

Spatial computing is a term that encompasses a variety of technologies and experiences that that facilitates the seamless integration of devices into the physical environment, resulting in a more natural and intuitive digital world user experience (Yenduri et al., 2024). It involves the use of computers to perceive, analyze, and interact with the three-dimensional space around us. This includes how devices understand and navigate our environment, how we interact with digital objects in real or virtual spaces, and how physical and virtual realities can be merged or augmented to create immersive experiences (Goldenberg, 2023). Spatial computing encompasses many enabling technologies including IoT, Augmented reality (AR), Virtual reality (VR), mixed reality (MR), Artificial intelligence (AI), 3D Scanning and modeling and gesture recognition and natural user interfaces (NUIs). The advancement of these modern technologies is blurring the distinction between real and virtual environments. This smooth and vastly efficient blending of the physical environment with the digital domain creates infinite possibilities for highly immersive, interactive experiences (Yenduri et al., 2024).

Enabling technologies for Spatial computing and relevant to the bot featured in this paper includes AI by analyzing human sentiment through several NLP tasks then gets processed through a LLM to generate intuitive human-like intelligent questions and evaluation of the user's answers thereof. Furthermore, it is utilizing AR device sensors to project a 3D scanned realistic representation of any human, anchored in the real world through computer vision techniques to further immerse the user in their experience – adding realism to the scenario. All these technologies are built in a web-based technology stack to allow cross-device application.

2.4. Natural Language Processing and Large Language Processing

The second technology used for the bot is Natural language processing (NPL) which is a very novel field. Its history can be tracked back to the late 1940s, when during World War II mathematicians, linguists and engineers spent years contributing towards the war efforts of code breaking and early computers. According to Nadkarni, Ohno-Machodo and

Chapman (2011) NLP began in the 1950s as the intersection of AI and linguistics. An important shift happened in the early 2010s with a few key incursions of deep learning into the field. It was in the 2010s that mobile phones moved from being devices used to call and text humans to smartphones, devices with which users could connect to the internet, towards the end of the decade, even begin to use as smart personal assistants. This has reignited hopes that natural language, whether through voice or text, could again be used to interface with complex systems. As a result, study into dialogue systems experienced increased interest. From 2018, the strongest neural machine translations systems function very close to humans (Zukov-Gregoriˇc, 2019). Simply stated, NPL is a field that involves the use of computational techniques to enable computers to understand, interpret, and generate human language (Nadkarni et al., 2011).

NLP enables rapid analysis of huge volumes of text, which is where most of the data driving innovation lives. "When utilized effectively, machine learning can quickly mine data to produce actionable insights, significantly decreasing the time it takes for a comprehensive analysis to be performed. An analysis that would have previously taken weeks can now be reduced to days," said Kevin See, Ph.D., VP of Digital Products for Lux Research. The speed conferred through NLP is enabled by the comprehensiveness of topic modeling, which extracts important concepts from text while eliminating the human assumption and bias associated with it. In its current status, NLP techniques like Text-to-speech (TTS) and its inverse – Speech-to-text (STT) can happen nearly instantaneously, making it an ideal technology to be used the bot showcased in this study. It translates user input to text for sentiment analysis through Large Language Models (LLMs), where the question, answer and evaluation criteria of a selected topic gets assessed together, and presents the answer back to the bot, where it gets translated through a STT process and presented back to the user in a natural voice.

In recent years, NLP tasks have been seamlessly integrated with Large Language Models, which represent a form of AI designed to mimic the way humans structure language, enabling them to comprehend, anticipate, and produce text (Zubiaga, 2024). This capacity facilitates a nuanced grasp of natural human language, empowering LLMs to comprehend conversational input and deliver responses that feel authentic. Recent instances of this technology, like the Generative Pre-Trained Transformer (GPT) model, which gained prominence through OpenAI's online platform, exemplify these capabilities (Bonner, Lege and Frazier, 2023). The bot in this case study leans on this technology as an engine for comparison between user sentiment and predetermined evaluation criterium to generate follow-up questions on answers given as well as grade the final interaction against fields of evaluation.

III. THE WEB-BASED SMART BOT

3.1. Overview

Introducing NexAR – the bot developed and showcased in this paper. A culmination of modern-day 4IR technologies including spatial computing, NLP, LMM, AI and AR as a method for our next generation of education fully accessible through your web browser.

Conceptually, NexAR represents a vanilla shell that can be fed a variety of predetermined datasets that include case-studies as well as detailed evaluation criteria for each study. It serves then as the point of interaction between the user (in this case the student) and the data loaded by the facilitator or educator. Through natural and intuitive dialogue, NexAR will present the user (student) with a case study in its respective discipline, await a user response, and through NLP and AI driven technologies, respond back with possible follow-up questions on the topic. This loop can either be intuitively repeated until a benchmark answer has been determined, or (and for simplicity of this case study) be predetermined. After this iteration of natural conversation, NexAR will grade the response to the original case study, as well as the follow-up conversation it had against the pre-set evaluation criteria and present a report on each of the fields it evaluated. The figure below illustrates the user interaction flow between the user and NexAR's frontend interface.

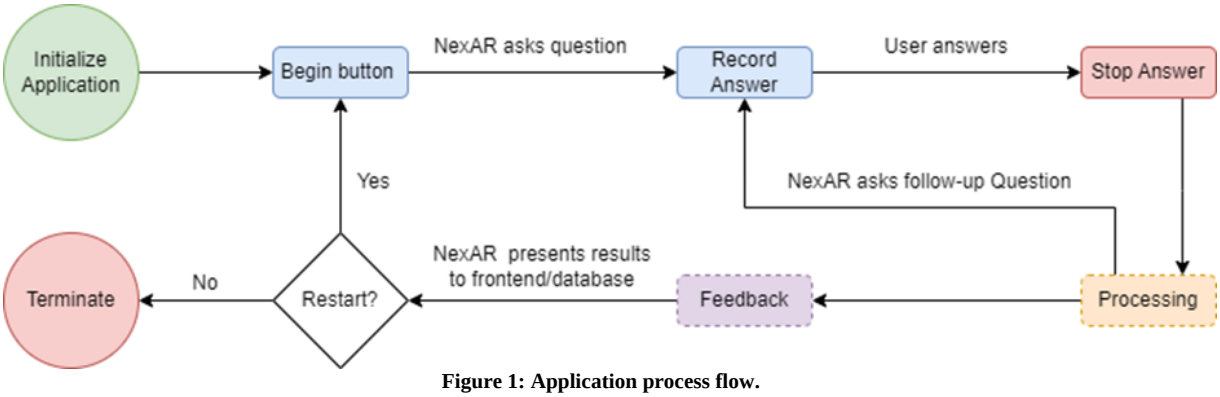


Figure 1: Application process flow.

Specific to this paper, the field of Human Resource (HR) Management was chosen as the topic for our application. NexAR occupies the role of an employee and has been pre-loaded with one of five common workplace scenarios that HR managers must respond to. The user, in turn, will fulfil the role of the HR manager, and must respond to the (one of five) randomly generated scenarios.

The bot will evaluate the answer based on the question given and respond to the answer with one follow up question by passing the question and answer as a prompt to the GPT model. It then identifies a possible unclear or unanswered element of the question and raises a follow-up question to adress this, after which the user can respond one more time. Both responses along with the questions and evaluation criteria will then be processed, and the evaluation will be presented to the frontend for the user to see how he/she has performed.

For this specific scenario, the user will be evaluated against 5 different subjects relevant to HR, each with a point rating scale of 1 to 5, with 1 representing a poor effort and 5 representing an excellent effort. Each of the 5 subjects has its own set of criteria in its pre-set dataset. Below the 5 evaluation subjects with a brief explanation:

1. Empathy: Does the user relate to the situation and present a safe space for sharing concerns.
2. Communication Skills: Clarity and sensitivity towards the subject, specifically towards the process presented.
3. Confidentiality: How is trust maintained and a safe space presented towards the subject
4. Action Plan: Is there a clear and detailed plan of resolution and proactive leadership.
5. Support Provision: How well are viable support plans or options presented towards the subject.

As an added layer of immersion and realism, this interaction is presented in AR, with a fully scanned replica of a person (in this case one of the authors) that can be further developed to immerse the user into the scenario.

The individual scan is achieved through 3D modeling and existing facial-scanning software to construct a close representation of an individual. Due to the nature of a web-based platform, this layer can already be viewed on any mobile device, smart AR-glass with web connectivity. For future application, it can be adapted to be viewed in a fully immersive VR or MR experience on popular devices such as the Meta Quest or the Apple VisionPro.

The NexAR bot will be illustrated below in two images. The first image showcases the web interface of NexAR upon initialization.

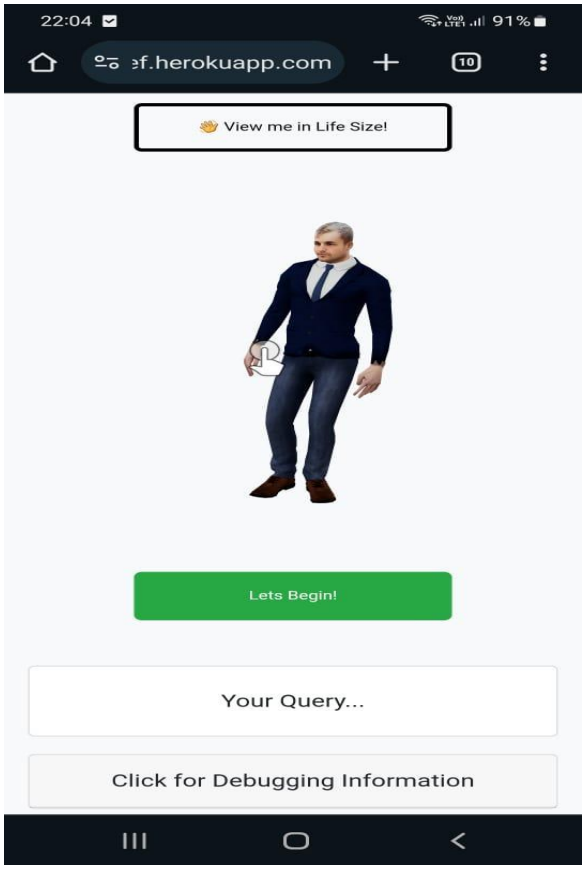


Image 1: NexAR web interface

The secondimage showcases NexAR's web interface, where the bot can be observed inits AR environment anchored in the real world.



Image 2: NexAR in an AR environment

3.2. Development of the bot explained

Developed to avoid any device-related hardware restrictions, NexAR is developed as a web-based solution, hosted in the cloud and solely reliant on cloud-based third-party integrations. The below figure represents a high-level architecture on the services within the lifecycle of a user case evaluation:

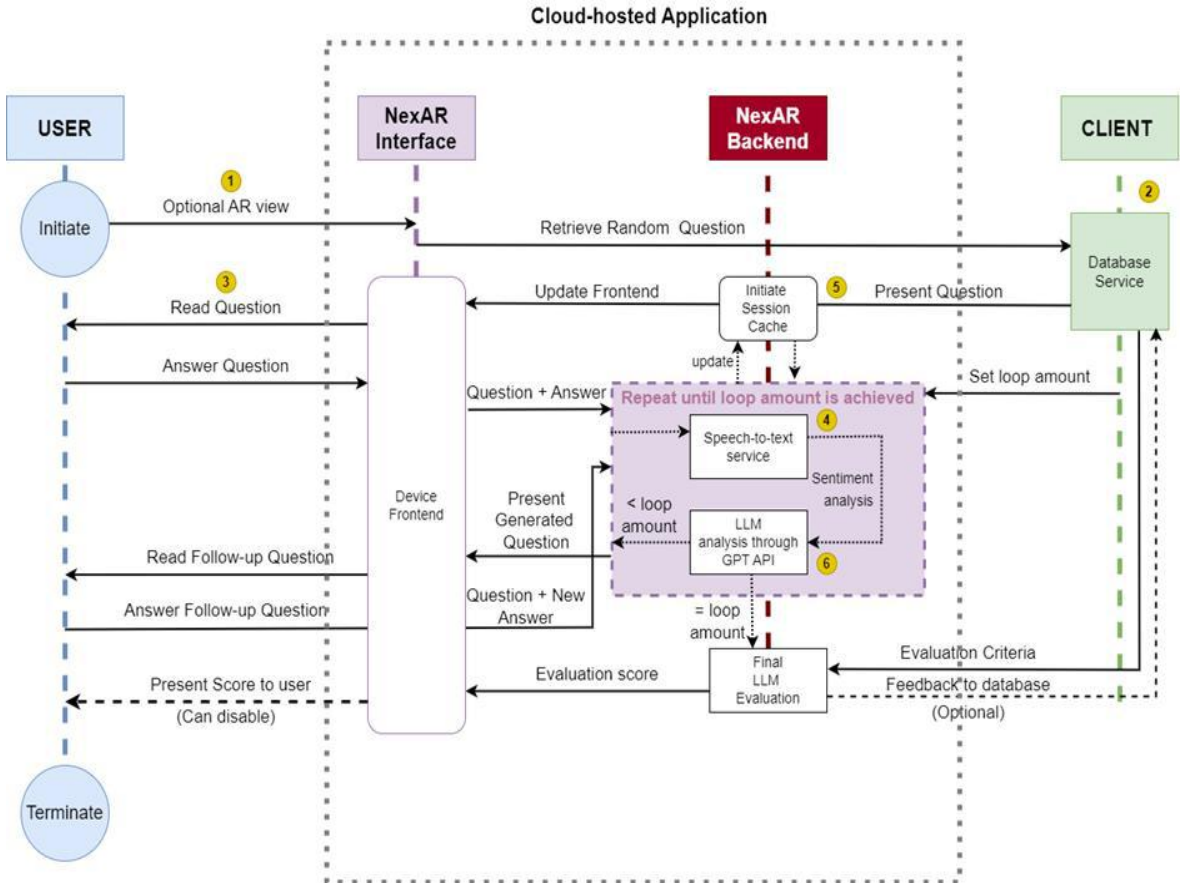


Figure 2: High-level Architecture flow diagram of a NexAR lifecycle.

For this specific case study, the services used in the NexAR case study are listed with their respective functions as per the above diagram:

1. Model-Viewer: an open-source web-based AR solution that casts the loaded 3D model into reality for a full AR or MR experience to enhance immersion and simulate a higher degree of reality for the user.
2. Database service: both for dynamic loading and editing of scenarios and evaluation criteria, as well as possibly storing user answers and ratings that can be used to improve the trained NexAR bot, as well as provide useful insights for the client or industry hosting the training. This database can be client-hosted to avoid any 3rd party privacy issues or leaking of training data and evaluation criteria. For the purposes of this case study, a simple JSON file was populated covering questions and evaluation criteria, but for industrial application, quicker and real-time access to this data will require a hosted Database Service for higher traffic and dynamic updating of data.
3. Text-to-speech (TTS) API: adding to the intuitive flow of conversation, NexAR will present the question by speaking directly through the hardware device to the user. With the current availability of web-based services, some even offer real-time translations, which will make it easy to convert the conversation into any available language, depending on availability without having to change the original dataset language.
4. Speech-to-text (STT) API: converting spoken language into text to enable NLP by recording the user's voice prompt and converting it to text as a requirement for processing by an LLM.
5. Web Cache: keeping track of questions asked and answers given by the user, this cached data can be stored for a single lifecycle and stored in-browser, only committed to the client-side database once the session is closed.
6. GPT API – Sentiment analysis used to quantify the subjective information provided by the user, to both develop follow-up questions as well as evaluate answers against input evaluation criteria.

3.3. Potential application and use

NexAR exhibits potential across various sectors. In healthcare, it could serve as a virtual medical tutor, guiding aspiring practitioners (users) through case studies and medical scenarios to induce critical thinking as well as diagnostic skills. In the legal field, NexAR could function as an interactive legal assistant, guiding law students in understanding intricate legal examples and case laws, thereby enhancing their analytical abilities. In engineering and architecture, the bot could provide immersive learning experiences, allowing students to visualize and interact with complex design concepts in AR, facilitating hands-on learning. In customer service and sales training, NexAR could simulate real-world scenarios, enabling employees to practice handling diverse customer queries and objections, ultimately enhancing their communication and problem-solving skills.

Specifically, to the higher education sector, within humanities and social sciences, the bot could facilitate debates and simulations of historical events, providing students with a deeper appreciation of complex socio-political issues. In a research domain, the bot could assist students in exploring vast datasets and conducting literature reviews, streamlining the research process and fostering interdisciplinary collaboration. By harnessing the power of spatial computing, AI, and AR, NexAR holds immense potential to redefine pedagogical approaches and enrich learning outcomes in higher education.

IV. THE EFFECTS ON HIGHER EDUCATION

Incorporating a bot such as NexAR into the higher education sector can have great effects on various aspects of teaching and learning. The effects include: (1) Enhanced Learning Experience: By leveraging NLP and LLMs, NexAR can provide personalized and immersive learning experiences for students. It can tailor content to individual student needs, preferences, and learning styles, thereby increasing engagement and understanding (Yenduri et al., 2024). Through interactive case studies, simulations, and real-time feedback, students can develop critical thinking, problem-solving, and communication skills essential for their academic and professional success. (2) Accessibility and Inclusivity: NexAR has the potential to make education more accessible and inclusive. It can accommodate diverse learning abilities and preferences by providing various learning styles and individual needs (Yenduri et al., 2024). Through its intuitive interface and adaptive features, it can cater to a broader range of learners, ensuring that all students have equal opportunities to succeed. (3) Efficient Teaching and Assessment: For educators, NexAR can streamline teaching processes and assessment tasks. It can automate routine tasks such as grading assignments, providing feedback, and tracking student progress. Assessment and feedback systems can be enhanced using interactive assessments and real-time evaluation (Yenduri et al., 2024). (4) Innovative Pedagogical Approaches: NexAR encourages the adoption of innovative pedagogical approaches that blend technology with traditional teaching methods. It promotes active learning, collaborative problem-solving, and experiential learning through its interactive features and immersive simulations. Educators can experiment with flipped classrooms, project-based learning, and other student-centered approaches, leveraging NexAR to enrich the educational experience. In summary, incorporating a bot like NexAR into the higher education sector holds the potential to transform teaching and learning, empowering students and educators to adapt and succeed in digital age.

V. CONCLUSION

The higher education sector has always faced pressure to adapt their strategies and policies to the current times. This is due to multiple reasons including, ensuring efficient and effective teaching and learning pedagogies and methods, meeting the needs of customers and ensuring students are equipped with world of work relevant skills. The current prominent advancement in society that has gained traction in business and societies at large is the Fourth Industrial revolution (4IR). Consequintly, the education sector needs to adapt their strategies in order to meet the challenges and opportunities 4IR is introducing, also referred to as Education 4.0. Higher education institutions have lacked behind in incorporation of 4IR technologies into their teaching and learning methods and strategies for multiple reasons discussed in this study. But, the incorporation of 4IR technologies including AI, AR, VR, MR (also referred to as spatial computing) and NLP and LLMs, amongst others can hold multiple benefits for higher education institutions and their students. The benefits include enhanced learning experience, increased inclusivity, efficient teaching and assessment, innovative pedagogical approaches and flexible learning environments. This paper showcases a web-based bot (NexAR) which incorporates all the abovementioned technologies that can be used by higher education institutions as one solution to adapt effectively to Education 4.0. This is a novel bot built by the co-author and holds multiple unique benefits such as its web-based architecture allowing it to be always-available on mobile devices, improving student accessibility. Facilitators and teachers will be able to upload specific data sets from their curriculum for the students to effectively apply knowledge from the classroom to a practical simulation. The bot has been developed for this paper, but the authors intent to test the bot in a higher education setting to gather valuable data on the actual perception and effects of the bot in a higher education classroom setting.

REFERENCES

[1] Alenezi, M., Wardat, S. and Akour, M., 2023. The need of integrating digital education in higher education: Challenges and opportunities. Sustainability, 15(6), p.4782.Anna Gilbert,

[2] Blessinger, P., Sigh, A., Poobalan, A. & Nauman, S. 2022. Our future demands critical and creative thinking skills. [Online] Available from: https://www.universityworldnews.com/post.php?story=20221019140828579 [Accessed: 14/02/2024].

[3] Bonner, E., Lege, R. and Frazier, E., 2023. Large Language Model-Based Artificial Intelligence in the Language Classroom: Practical Ideas for Teaching. Teaching English with Technology, 23(1), pp.23-41.

[4] Eisenstein, J., 2019. Introduction to natural language processing. MIT press.

[5] Fisk, P. (2017), "Education 4.0 [...] the future of learning will be dramatically different, in school and throughout life [article]", available at: www.peterfisk.com/2017/01/future-education-youngeveryone-taught-together/ [Accessed: 01/03/2024].

[6] Ghanem, B.M., 2023. Assessing Educational Management Strategies in the Era of Education 4.0 and TOPSIS Analysis: A Comprehensive Literature Review. i-Manager's Journal of Educational Technology, 20(1), p.1.

[7] Goldenberg, B., 2023. Spatial Computing: The Power to Transform CRM [article], available at: https://www.destinationcrm.com/Articles/Columns-Departments/Customer-Experience/Spatial-Computing-The-Power-to-Transform-CRM-160145.aspx [Accessed: 01/03/2024].

[8] Halabieh, H., Hawkins, S., Bernstein, A.E., Lewkowict, S., Unaldi Kamel, B., Fleming, L. and Levitin, D., 2022. The future of higher education: Identifying current educational problems and proposed solutions. Education Sciences, 12(12), p.888.

[9] Jain, V. and Jain, P., 2022. From Industry 4.0 to Education 4.0: acceptance and use of videoconferencing applications in higher education of Oman. Journal of Applied Research in Higher Education, 14(3), pp.1079-1098.

[10] Jamaludin, R., McKAY, E. and Ledger, S., 2020. Are we ready for Education 4.0 within ASEAN higher education institutions? Thriving for knowledge, industry and humanity in a dynamic higher education ecosystem?. Journal of Applied Research in Higher Education, 12(5), pp.1161-1173.

[11] Kasneci, E., Sebler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E. and Krusche, S., 2023. ChatGPT for good? On opportunities and challenges of large language models for education. Learning and individual differences, 103, p.102274.

[12] Kasriel, S., 2018. The future of work won't be about college degrees, it will be about job skills. CNBC. Retrieved, 8.

[13] Khan, N., Sarwar, A., Chen, T.B. and Khan, S., 2022. Connecting Digital Literacy in Higher Education to the 21st Century Workforce. Knowledge Management & E-Learning, 14(1), pp.46-61.

[14] Kinshuk, Chen, N.S., Cheng, I.L. and Chew, S.W., 2016. Evolution is not enough: Revolutionizing current learning environments to smart learning environments. International Journal of Artificial Intelligence in Education, 26, pp.561-581.

[15] Llopis, G. (2022) The future of higher education: What it means for students and educators, Forbes. Available at: https://www.forbes.com/sites/glennllopis/2022/09/14/the-future-of-higher-education-what-it-means-for-students-and-educators/?sh=6c651050502a [Accessed: 01/03/2024].

[16] Moraes, E.B., Kipper, L.M., Hackenhaar Kellermann, A.C., Austria, L., Leivas, P., Moraes, J.A.R. and Witczak, M., 2023. Integration of Industry 4.0 technologies with Education 4.0: advantages for improvements in learning. Interactive Technology and Smart Education, 20(2), pp.271-287.

[17] Mouton, N., Louw, G.P. and Strydom, G.L., 2012. A historical analysis of the post-apartheid dispensation education in South Africa (1994-2011).

[18] Munir, M.A. & Nudin, B. 2021. Educational Design for Alpha Generation in the Industrial Age 4.0.137-145.

[19] Nadkarni, P.M., Ohno-Machado, L. and Chapman, W.W., 2011. Natural language processing: an introduction. Journal of the American Medical Informatics Association, 18(5), pp.544-551.

[20] Nahi, A.A., Ghaib, A.A. and Ali, A.A.A.A., 2023, December. Metaverse Applications and Its Use in Education. In International Multi-Disciplinary Conference-Integrated Sciences and Technologies (pp. 61-80). Cham: Springer Nature Switzerland.

[21] OECD. (2018). The future of education and skills Available at: https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf [Accessed: 14/02/ 2024].

[22] Phungsuk, R., Viriyavejakul, C. and Ratanaolarn, T., 2017. Development of a problem-based learning model via a virtual learning environment. Kasetsart Journal of Social Sciences, 38(3), pp.297-306.

[23] Sharma, L. and Srivastava, M., 2020. Teachers' motivation to adopt technology in higher education. Journal of Applied Research in Higher Education, 12(4), pp.673-692.

[24] Swartz, B. and Patnaik, S., 2023, October. Meeting the Demands of Industry: A Study on Identifying and Teaching Emerging Technologies in Engineering Education. In 22nd European Conference on e-Learning: ECEL 2023. Academic Conferences and publishing limited.

[25] Yenduri, G., Maddikunta, P.K.R., Gadekallu, T.R., Jhaveri, R.H., Bandi, A., Chen, J., Wang, W., Shirawalmath, A.A., Ravishankar, R. and Wang, W., 2024. Spatial Computing: Concept, Applications, Challenges and Future Directions. arXiv preprint arXiv:2402.07912.).

[26] Zubiaga, A., 2024. Natural language processing in the era of large language models. Frontiers in Artificial Intelligence, 6, p.1350306.

[27] Zhukova, O., Mandragelia, V., Alieksieienko, T., Semenenko, A. and Skibina, E., 2023. Digital Technologies for Introducing Gamification into the Education System in the Context of the Development of Industry 4.0. Ingénierie des Systèmes d'Information, 28(1).

[28] Žukov Gregorič , A., 2019. Towards a question answering view of natural language processing (Doctoral dissertation, Royal Holloway, University of London).

★★★