Research on the Curriculum System of the Intelligent Interaction Design Major: A Case Study

Tianlun Yang[1*], Zuyao Wang[1], Georgios Kapogiannis[2], Byung-Gyoo Kang[3]

[1] Ningbo Tech University, Ningbo, China
[2] AFG with University of Aberdeen, Doha, Qatar
[3] University of Nottingham Ningbo China, Ningbo, China

tianlun.yang@nbt.edu.cn

Abstract. The onset of the intelligent era demands a multifaceted approach to talent development in education, focusing on enhancing students' cognitive skills. Existing educational models face challenges such as limited interdisciplinary courses, disjointed skill development, and a lack of practical application, hindering students' ability to integrate knowledge and apply it professionally. To address these issues, our educational research has thoroughly evaluated the needs of the intelligent interaction design major. We have conducted an in-depth review of the curriculum to align it with the era's talent demands, emphasizing critical thinking, technical skills, and tool development. The research culminates in a curriculum system that uses the metaverse as a case study, supported by pedagogical strategies aimed at the specific courses within the major.

Keywords: Intelligent Interaction Design; Pedagogic, Metaverse, Curriculum Design, Critical Thinking

1 Background and Introduction

Human progress has been tied to the evolution of written language and its recording methods, from oracle bones to digital media, enhancing information exchange. The 20th century brought computing, leading to the digital age, while the 1990s and 2010s saw the internet and mobile internet, respectively, revolutionizing communication. The 2020s marked a leap in AI, driven by computer technology. The integration of intelligent and information technology is set to boost productivity, requiring industry adaptations [1]. Educational institutions, particularly applied universities, must update their methods to meet the demands of the intelligent age. Current university education is challenged by a theoretical focus, outdated content, and fragmented curricula, disconnecting from industry needs [2]. Educational reform should align teaching with industry demands, fostering systematic cognition and critical thinking [3]. Educators must understand talent needs in the intelligent age and design interconnected courses to build students' knowledge and skills. The focus should be on cognitive abilities for problem-solving, technology application, and tool development. This study aims to research and address these educational imperatives.

M. F. A. Ghani et al. (eds.), *Proceedings of the 2024 4th International Conference on Education, Language and Art (ICELA 2024)*, Advances in Social Science, Education and Humanities Research 907,
https://doi.org/10.2991/978-2-38476-364-1_16

2 Literature Review

2.1 Critical Thinking Capability in the Age of Intelligent

Speculative design, a convergent approach that amalgamates design practice with critical thinking, rigorously examines pressing social, cultural, technological, and environmental challenges through the construction and deconstruction of hypothetical design objects or scenarios [4]. This methodology not only stimulates public discourse but also acts as a catalyst for social transformation, solidifying its role as an essential instrument in design research since the late 20th century.

Wallace's four-stage theory of creative thinking - encompassing preparation, incubation, illumination, and verification - provides a comprehensive framework for deciphering the cognitive processes that underpin creative endeavors [5]. This theory underscores the paramount importance of critical thinking skills, ethical reasoning, and decision-making capabilities, which are crucial for thriving in the intricate landscape of a globalized professional environment. In higher education, these competencies are nurtured through inquiry-based learning methodologies, which are designed to foster a deep understanding and application of knowledge [6].

Knowledge reserves serve as the cornerstone of creative thinking, supplying the indispensable raw materials necessary for innovation [7]. They extend beyond mere factual data to include conceptual frameworks and problem-solving strategies, which are vital for identifying problems, formulating hypotheses, and exploring solutions. A robust knowledge base is particularly instrumental in fostering interdisciplinary innovation, positioning creative thinking as a dynamic and adaptive process [8]. This process requires not only a broad and deep knowledge foundation but also the dexterity to apply this knowledge in a flexible manner [9]. It necessitates the ability to surpass existing paradigms and to boldly explore new frontiers of understanding.

2.2 The Definition and Demand of Metaverse

The metaverse, an emerging research domain, is garnering significant attention from industry stakeholders for its capacity to substantially elevate work quality and operational efficiency across diverse sectors. This virtual platform transcends the limitations of the physical world, offering unprecedented flexibility in design and application. Accessible through a variety of interfaces, including Virtual Reality (VR), Augmented Reality (AR), and traditional monitors, the metaverse enables immersive virtual interactions and activities, redefining the potential for digital engagement [10].

The metaverse's application spectrum is expansive, with the potential to significantly enhance manufacturing processes through the integration of digital twin technology and to transform online retail by transitioning from static 2D images to dynamic 3D models within virtual environments [11]. This shift provides consumers with a more authentic and interactive product experience. Additionally, the metaverse serves as a platform for conducting business meetings, effectively surmounting geographical constraints and fostering more efficient and interactive communication [12]. Consequently, there is an escalating imperative for industries to devise strategic metaverse presences, which in turn is driving a surge in demand for professionals with specialized metaverse expertise.

The development of the metaverse is intricately connected with advancements in intelligent interaction technologies, presenting formidable challenges in user engagement and the realization of immersive visualization [13]. The construction of the metaverse necessitates sophisticated scene modeling, with Artificial Intelligence Generated Content (AIGC) technology playing a supportive role in content generation. However, the process remains heavily dependent on manual modeling efforts. The essential demands of the metaverse can be categorized into two primary areas: the fabrication of virtual scenes and objects, and the innovation of a variety of interaction techniques to facilitate visual and immersive engagement with digital entities.

2.3 Tools and Technologies to Develop Metaverse

As the metaverse evolves, it poses unprecedented challenges that underscore the urgency for students to cultivate robust problem-solving skills, pivotal for their future professional endeavors. Central to these challenges are the development of advanced visualization capabilities for metaverse navigation and the seamless integration of immersive technologies to enrich user interactions [14]. The realism of the metaverse is further enhanced by the ability to interact with virtual objects, necessitating a deep understanding of modeling techniques and cutting-edge computer technology.

The construction of scenes and objects within the metaverse hinges on sophisticated information modeling techniques and a suite of tools, encompassing data collection devices and an array of modeling software. The complexity of information models demands that students become proficient in a multitude of software applications to achieve effective synergy [15]. Proficiency in both software and hardware is essential for visualization and interaction technologies, particularly in the realms of Virtual Reality (VR) and Mixed Reality (MR), where software-hardware integration is crucial.

Educationally, it is imperative to dissect the multifaceted requirements and challenges inherent in the metaverse and to integrate the teaching of complementary tool combinations to bolster students' intuitive problem-solving acumen [16]. Informed by situated cognition theories, this study employs metaverse development as a case study, systematically imparting relevant theoretical frameworks, cognitive processes, and tool utilization methods. This pedagogical strategy is designed to instill in students a transferable problem-solving mindset, thereby augmenting their overall competencies. Armed with a mastery of current technologies and sharpened problem-solving skills, students are poised to drive innovation, enhance work quality and efficiency, and nurture essential critical thinking capabilities [17].

3 Research Design

The question of this research investigates the impact of enhancing students' critical thinking skills in the intelligent era on their practical and problem-solving abilities. The aim of this research is to strengthen students' overall competencies by devising specialized courses in intelligent interaction. These courses will leverage metaverse-based teaching to construct curricula that integrate theoretical knowledge with practical tool skills. This study is categorized into three objectives based on the research aim: a) Identifying the competencies essential for students in the intelligent era; b) Assessing the role of the metaverse in the intelligent era, along with the technological and skill requirements for metaverse development; c) Exploring strategies for implementing metaverse teaching to enhance students' comprehensive abilities in the intelligent era.

This study employs a literature review to delineate the talent requirements of the intelligent era and to identify pivotal metaverse technologies. The insights gleaned from this review are utilized to formulate a curriculum focused on intelligent interaction, designed to bolster students' skills in metaverse development and enhance their problem-solving capabilities. The scope of this research is confined to curriculum design, with the implementation and preliminary assessment of the curriculum in actual educational settings. A comprehensive analysis of the curriculum's effectiveness will be conducted in subsequent studies.

4 Strategy of Teaching to Enhance Students' Capability in Critical Thinking

4.1 Process and Strategy to Integrate Problem Solving and Creativity Capability

This study employs a metaverse-based teaching model to bolster students' critical thinking skills in the intelligent era, with a focus on the intelligent interaction design major. The metaverse is constructed around three fundamental components: virtual environments, virtual objects, and digital characters (see Table 1). Development of these components is based on key information, differentiated into graphical and non-graphical categories. Graphical information encompasses environmental textures and the material properties of objects, whereas non-graphical information pertains to physical laws, the physical properties of objects, and the dynamics of characters.

Table 1. Key Elements in Metaverse Development

	Graphical Information	Non-Graphical Information
Virtual Objects	Shape, Size, Material	Physics Data
Virtual Environment	Weather, Sky Box	Physics Law
Digital Characters	Appearance	Weights, Movements, Manipulation

In metaverse education, fostering critical thinking in students requires an understanding of three core elements as shown in (Fig. 1). The virtual environment, essential to the metaverse, necessitates meticulous design to accommodate a variety of activities and challenges in virtual scene design and development. Students must analyze the impact of virtual objects, such as architectural structures and vegetation, on immersive experiences and their interaction with the broader virtual environment. As part of digital humans, digital characters bridge the real and virtual realms, and it is imperative for students to grasp their role in enhancing metaverse interactions, vital for optimizing user experience and ensuring the smooth operation of the virtual environment.

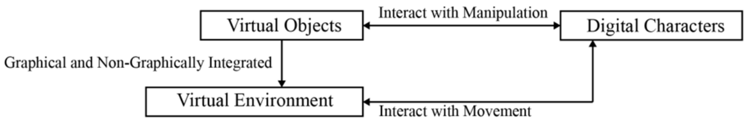

Fig. 1. Interrelations Between These Three Elements

After mastering the basics of the metaverse, students must refine their skills for deeper exploration and innovation. Building on the framework presented in (Fig. 1), this study identified key learning modules (as depicted in Fig. 2) that are essential for constructing the metaverse: computer literacy, information modeling, and programming. Students must become proficient in information modeling to create virtual environments, objects, and digital humans, which necessitates the integration of both graphical and non-graphical information. Recognizing the diverse information demands within the metaverse is crucial for selecting appropriate software and is key to effective metaverse development and innovation.

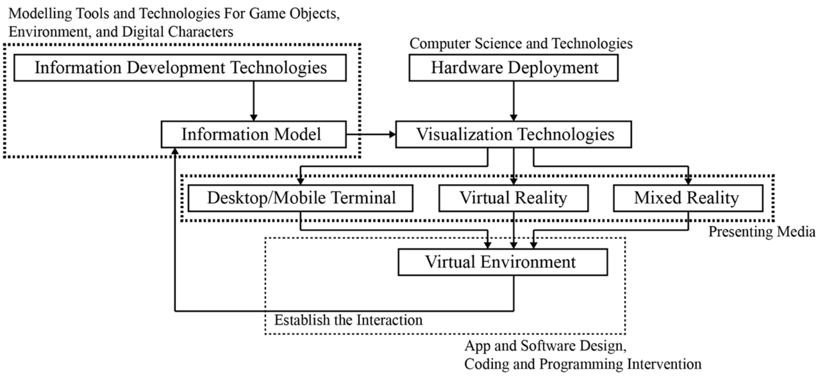

Fig. 2. Interrelations Among Different Knowledge and Skills

Information modeling for the metaverse necessitates a unified platform that emphasizes real-world interaction. Students require systematic computer science education, spanning both hardware and software, to effectively grasp and utilize tools of the information age. Visualization and interaction technologies, including desktop displays, Virtual Reality (VR), and Mixed Reality (MR), are pivotal in bridging the real and virtual realms within the metaverse. The efficacy of these technologies in enhancing activity performance hinges on the synergy between hardware and software, mandating that students achieve proficiency in programming and a comprehensive understanding of computer systems.

4.2 Strategy to Teach Tools and Skills

This study aims to strengthen students' problem-solving skills in the intelligent era by integrating an interdisciplinary approach that focuses on information modeling, programming, and computer literacy. (Fig. 3) illustrates the synergy among these areas, emphasizing the importance of computer application skills for programming expertise. A structured curriculum that covers both hardware and software is essential for establishing a solid foundation in computing. This foundation is further developed through exposure to various programming languages and coursework in data structures and algorithms, which are critical for enhancing analytical and problem-solving abilities.

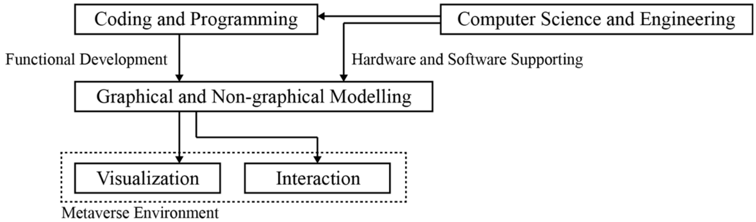

Fig. 3. Interrelations Among Computer Skills, Programming and Information Modelling

The cultivation of information modeling skills not only enhances the ability to create content within the metaverse but also, due to the need to coordinate various software applications, improves students' capacity to integrate different tools for problem-solving. Integrating computer technology and programming functionalities into information models enables their visualization and interactivity, significantly enriching the user experience in the metaverse. Moreover, combining information modeling with computer hardware and software is cognitively challenging, which makes such instructional approaches particularly effective in developing students' comprehensive problem-solving skills.

Programming Skills Development. Studying programming within a metaverse-based educational framework enhances students' problem-solving and critical thinking abilities. This research incorporates three programming languages into the curriculum to cultivate cognitive and analytical skills and to boost metaverse interactivity (see Fig. 4). Beginning with C, a fundamental language in computer science education for understanding data structures and algorithms, students are then equipped to quickly learn web development technologies such as HTML, CSS, and SQL. This enables the efficient creation and development of web pages and sites.

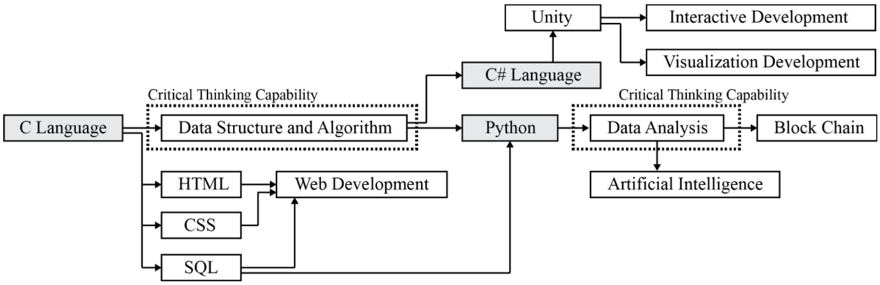

Fig. 4. Strategy to Teach Programming

The curriculum commences with C, foundational for operating systems, and proceeds to C# and Python, both object-oriented languages. C# is crucial for Unity-based metaverse development, and Python, being predominant in AI, is essential for data analysis within the metaverse. This curriculum, encompassing C, C#, and Python, enhances critical thinking and equips students with the necessary skills for metaverse visualization and interactivity.

Model Build Skill Training. In metaverse development, information is categorized into graphical and non-graphical types. The creation of graphical information, reliant on modeling tools such as SketchUp, Rhino, and Blender, necessitates the inclusion of modeling software training in the curriculum (see Fig. 5). Photogrammetry, using software like RealityCapture, further enhances the realism of virtual environments. These outputs, integrated with non-graphical data in Revit, are subsequently developed in Unity. For digital character development, the curriculum employs Character Creator for modeling and iClone for animating characters, which are then integrated into Unity scenes.

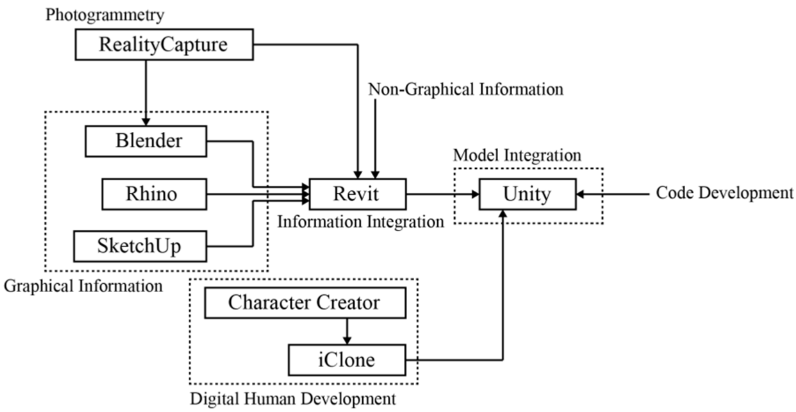

Fig. 5. Strategy to Teach Information Modelling

This course is designed to enhance students' problem-solving and critical thinking skills via modeling software education. It equips students with an understanding of modeling processes, the ability to evaluate software capabilities, and the skill to select suitable tools for diverse modeling tasks. This method not only strengthens cognitive abilities but also prepares students to integrate models with Unity programming, addressing the interactive demands of metaverse activities and promoting both problem-solving and innovative thinking.

Computer Operation Skill Education. The development of the metaverse necessitates that students gain a foundational understanding of both software and hardware, beginning with computer architecture, notably the von Neumann model (see Fig. 6). Students must grasp the operations of CPUs and GPUs, the interaction between CPUs and memory, and the GPU's role in aiding CPU computations. Following this hardware foundation, students should be introduced to the principles of operating systems, emphasizing the kernel and system variations. Given Linux's ubiquity in server deployment, an in-depth understanding of Linux is crucial, including its kernel, various distributions, and command-line interface (CLI) operations, equipping students for server management and maintenance.

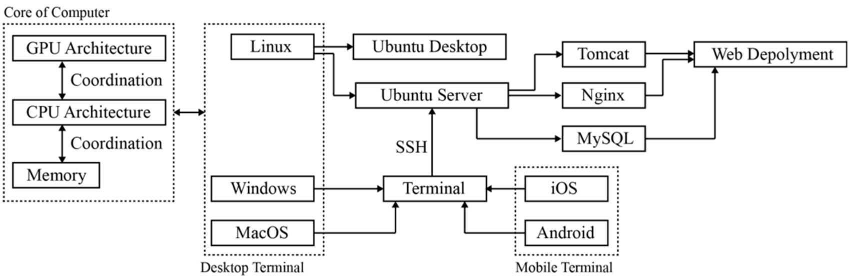

Fig. 6. Strategy to Teach Computer Skills

Incorporating computer-related knowledge into the curriculum enhances students' engineering thinking, bridging theoretical learning with practical computer hardware assembly. This approach allows students to understand hardware functions, models, and compatibility, fostering a comprehensive grasp of computer systems crucial for operational integrity and rigorously assessing their engineering proficiency. A thorough curriculum is vital, equipping students with insights into both hardware and software, and enabling them to apply engineering thinking to real-world industrial contexts.

5 Findings and Discussion

This pedagogical research aims to enhance students' problem-solving skills for the intelligent era with a curriculum focused on the metaverse. It integrates information modeling, interactive programming, and computer science, designed to foster visualization and interactivity within the virtual domain (see Fig. 7). The teaching system, divided into information model creation and functionality programming, aims to achieve visual and interactive capabilities through the synthesis of these elements.

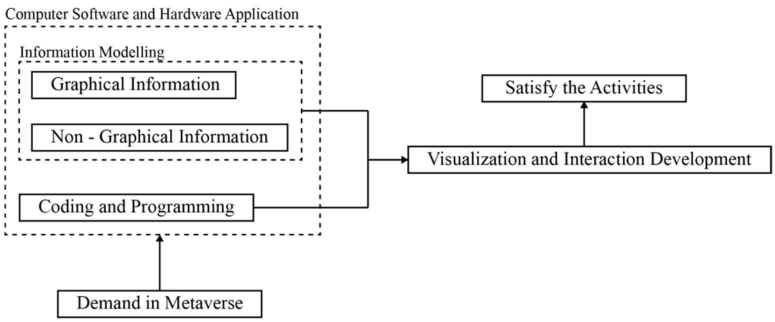

Fig. 7. Integration Between Information Model and Programming

The aim of this pedagogical research is to strengthen students' critical thinking skills by developing their proficiencies in operating and integrating a variety of software applications, as depicted in (Fig. 8). The process commences with identifying challenges and requirements within metaverse development to pinpoint suitable solutions. It then proceeds to evaluate appropriate tools within existing technologies and methodologies to address these specific issues and needs. If current technologies and methodologies are insufficient for resolving the issues at hand, the exploration of innovative approaches becomes imperative. This iterative process is pivotal in markedly enhancing students' problem-solving skills.

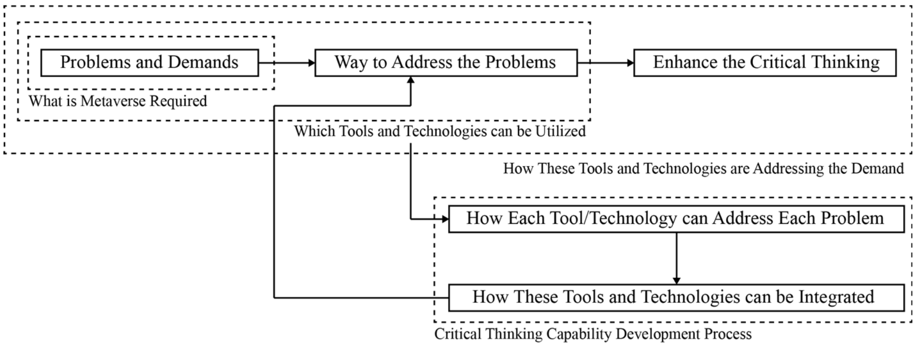

Fig. 8. Strategy to Enhance Critical Thinking Capability

6 Conclusion

In conclusion, this study presents a metaverse-centric teaching framework aimed at nurturing students' comprehensive competencies in the era of intelligence. Teaching software serves dual purposes: it is a cognitive exercise and a vehicle for knowledge acquisition. By providing instruction on an array of technologies and tools, students' understanding of the intelligent era is significantly deepened. Armed with a solid foundation of pertinent professional knowledge, students are better equipped to integrate and apply these technologies and methodologies, thus improving their critical thinking abilities. Therefore, the teaching framework proposed in this study is effectively aligned with the research objectives.

7 Limitation and Future Research

The study's limitations stem from the fact that the curriculum system remains in an exploratory phase. While it has been initiated and is undergoing testing in practical teaching scenarios, the long-term nature of educational effectiveness means that its impact cannot be assessed in the short term. Future research endeavors will aim to identify the talent cultivation needs in the era of intelligence and systematically organize these insights to enhance curriculum development for the smart interaction design major. The ultimate goal is to equip students with the critical thinking skills necessary to become leading talents in the new era of intelligent construction.

Acknowledgments

This study was funded by 2024 General Project of Ministry of Education Foundation on Humanities and Social Sciences: "Ethic Research of Generative AI Design" (Project Number: 24YJA760103)

References

1. Czarnitzki, D., Fernández, G. P. & Rammer, C.: Artificial intelligence and firm-level productivity. Journal of Economic Behavior & Organization, 211, 188-205 (2023)
2. Zhang, K., Aslan, A.B.: AI technologies for education: Recent research & future directions. Computers and Education: Artificial Intelligence. 2: p. 100025 (2021)
3. Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T. & Du, Z.: Artificial intelligence in education: A systematic literature review. Expert Systems with Applications, 252, 124167 (2024)
4. Ericson, J. D.: Mapping the Relationship Between Critical Thinking and Design Thinking. Journal of the Knowledge Economy, 13, 406-429 (2022)
5. Sadler-Smith, E.: Wallas' Four-Stage Model of the Creative Process: More Than Meets the Eye? Creativity Research Journal, 27, 342 - 352 (2015)
6. Colomer, J., Pallisera, M., Fullana, J., Burriel, M. P. & Fernández, R.: Reflective Learning in Higher Education: A Comparative Analysis. Procedia - Social and Behavioral Sciences, 93, 364-370 (2013)
7. Chan, C. K. Y. & Lee, K. K. W.: Reflection literacy: A multilevel perspective on the challenges of using reflections in higher education through a comprehensive literature review. Educational Research Review, 32, 100376 (2021)
8. Ramdass, K. & Mokgohloa, K.: Curriculum design in higher education: A reflection. European Conference on e-Learning (2023)
9. Lee, D., Arnold, M., Srivastava, A., Plastow, K., Strelan, P., Ploeckl, F., Lekkas, D. & Palmer, E.: The impact of generative AI on higher education learning and teaching: A study of educators' perspectives. Computers and Education: Artificial Intelligence, 6, 100221 (2024)

10. Gao, H., Chong, A. Y. L. & Bao, H.: Metaverse: Literature Review, Synthesis and Future Research Agenda. Journal of Computer Information Systems, 64, 533-553 (2024)
11. Trunfio, M., Rossi, S.: Advances in Metaverse Investigation: Streams of Research and Future Agenda. Virtual Worlds. 1(2):103-129 (2022)
12. Hussain, S., Meehan, K. & Qadir, J.: Editorial: Metaverse in education: opportunities and challenges. Frontiers in Education, 9 (2024)
13. Mutlu Avinç, G. & Yıldız, A.: A bibliometric and systematic review of scientific publications on metaverse research in architecture: web of science (WoS). International Journal of Technology and Design Education (2024)
14. Villalonga-Gómez, C., Ortega-Fernández, E. & Borau-Boira, E.: Fifteen Years of Metaverse in Higher Education: A Systematic Literature Review. IEEE Transactions on Learning Technologies, 16, 1057-1070 (2023)
15. Farooq, M. S., Ishaq, K., Shoaib, M., Khelifi, A. & Atal, Z.: The Potential of Metaverse Fundamentals, Technologies, and Applications: A Systematic Literature Review. IEEE Access, 11, 138472-138487 (2023)
16. Rogers, R. R.: Reflection in Higher Education: A Concept Analysis. Innovative Higher Education, 26, 37-57 (2001)
17. Lousberg, L., Rooij, R., Jansen, S., Van Dooren, E., Heintz, J. & Van Der Zaag, E.: Reflection in design education. International Journal of Technology and Design Education, 30, 885-897 (2020)