future internet

Article

Envisioning Architecture of Metaverse Intensive Learning Experience (MiLEx): Career Readiness in the 21st Century and Collective Intelligence Development Scenario

Eman AbuKhousa [1], Mohamed Sami El-Tahawy [2] and Yacine Atif [3,*]

[1] Faculty of Computer Information System, Higher Colleges of Technology,
Abu Dhabi 25026, United Arab Emirates
[2] Customer Transformation, Microsoft Corporation, Microsoft Egypt, Smart Village, Cairo 12577, Egypt
[3] School of Informatics, University of Skövde, 541 28 Skövde, Sweden
* Correspondence: yacine.atif@his.se

Abstract: Th metaverse presents a new opportunity to construct personalized learning paths and to promote practices that scale the development of future skills and collective intelligence. The attitudes, knowledge and skills that are necessary to face the challenges of the 21st century should be developed through iterative cycles of continuous learning, where learners are enabled to experience, reflect, and produce new ideas while participating in a collective creativity process. In this paper, we propose an architecture to develop a metaverse-intensive learning experience (MiLEx) platform with an illustrative scenario that reinforces the development of 21st century career practices and collective intelligence. The learning ecosystem of MiLEx integrates four key elements: (1) key players that define the main actors and their roles in the learning process; (2) a learning context that defines the learning space and the networks of expected interactions among human and non-human objects; (3) experiential learning instances that deliver education via a real-life–virtual merge; and (4) technology support for building practice communities online, developing experiential cycles and transforming knowledge between human and non-human objects within the community. The proposed MiLEx architecture incorporates sets of technological and data components to (1) discover/profile learners and design learner-centric, theoretically grounded and immersive learning experiences; (2) create elements and experiential learning scenarios; (3) analyze learner's interactive and behavioral patterns; (4) support the emergence of collective intelligence; (5) assess learning outcomes and monitor the learner's maturity process; and (6) evaluate experienced learning and recommend future experiences. We also present the MiLEx continuum as a cyclic flow of information to promote immersive learning. Finally, we discuss some open issues to increase the learning value and propose some future work suggestions to further shape the transformative potential of metaverse-based learning environments.

Keywords: metaverse; metaverse for higher education; ecosystem; metaverse platform architecture; experiential learning cycle; career readiness; 21st century skills; immersive learning experience; community of practice; collective intelligence; instructional design; learning technology

check for updates

Citation: AbuKhousa, E.; El-Tahawy, M.S.; Atif, Y. Envisioning Architecture of Metaverse Intensive Learning Experience (MiLEx): Career Readiness in the 21st Century and Collective Intelligence Development Scenario. *Future Internet* **2023**, *15*, 53. https://doi.org/10.3390/fi15020053

Academic Editor: Davide Tosi

Received: 16 December 2022
Revised: 9 January 2023
Accepted: 11 January 2023
Published: 30 January 2023

Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

The internet has been empowering us to experience the world, and to express ourselves within a global audience. The metaverse promises to further immerse us into this digital experience as avatars who socialize, transact, create, play, work, and teleport across multiple spaces and try the untried [1]. The advent of 5G networking, blockchains, artificial intelligence (AI), the internet of things (IoT), edge computing, and augmented and extended reality (XR) contribute to metaverse developments [2]. Companies of all shapes and sizes across industries are increasingly investing into these technologies to fully realize the potential of the metaverse experience [3,4]. This booming interest has labeled the year 2022 to be "the Metaverse gold rush" [5].

The metaverse remains difficult to define due to different technological, experiential, and regulatory interpretations, but the consensual perspective is that it is a virtual space blending physical and digital elements [2], or where users are fully immersed into digital extensions to everything that is real [4]. Our understanding of the metaverse is based on the four meanings described by [6] that: (1) it is a virtual mirror world that simulates every element of the physical/real world (i.e., digital twins); (2) it is also a native virtual world with imaginary elements that do not necessarily correspond to elements in the physical world (i.e., pure digital creations such as the non-player character (NPC) [2]; (3) it is a virtual world that synchronously interacts with the physical world; and (4) it is a persistent self-sustained virtual world formed by the coexistence of virtual and physical world interactions. These two worlds influence each other in such a way that any change in one of them will be reflected in the other one (i.e., digital twins). Hence, the metaverse is fully realized when the interactions between the two worlds are of the highest level of independence. As such, the metaverse will eventually achieve experience-duality, where humans use their digital avatars to experience alternative situations in virtual spaces that are closely paired-up with their real-world counterparts. It will also provide interoperability across virtual worlds on different platforms, enabling users to concurrently experience different activities, while creating and distributing contents into these platforms [1,2,6].

Several research studies and industrial reports have discussed the opportunities of metaverse to create values for consumers and enterprises in different sectors, including education [7–11]. Educators and learners of higher education levels have experiences with the metaverse as digitally generated environments with a positive attitude to future improvement in learning performance and outcomes [12–14]. For example, the work in [15] explored the applicability of augmented reality (AR), virtual reality (VR), lifelogging, and mirrored worlds in practical classes of a physical education curriculum. AI and XR are used in [16] to develop an application for aircraft maintenance training, while the work in [17] provided an AR application for an educational "escape room" activity for improving learners' communications skills. Obviously, immersive education is the direct experience provided to learners in metaverse environments. To achieve this immersion, the learner and his development are emphasized, while his digital image (avatar) is performing tasks in virtual spaces. These tasks involve communicating, and working with others, using digital objects, while producing contents in, and editing the space. This self-reflection can influence and be influenced by the learner behaviors and prior experiences on and off the digital space. However, recent literature reviews of metaverse-related applications in higher education highlighted the focus of these applications on content creation and socialized communication, but lacked attention to user-centric factors [9]. In fact, it was argued that most VR immersive developments are not explicitly grounded in learning theories [18]. Furthermore, the gap analysis of metaverse applications in education could further narrow the integration between learning theories and practice-based strategies. The resulting outcome spurs metaverse-based educational models for higher order thinking competences while adjusting to individual cognitive attributes [7,11]. Capitalizing on the differences of individuals as they interact in communities of practice is a key enabler of collective intelligence [19,20]. For example, a recent study published by Stanford University's Virtual Human Interaction Lab on instrumenting avatars in immersive virtual environments demonstrates that people represented by lookalike avatars of themselves better "sync" with others, and they feel greater group cohesion, enjoyment and realism than in constrained environments [21]. A similar study that investigated how students interact and learn using a social VR platform indicated that the social dynamics of VR has a positive impact on students' ability to work together as a group and to focus on the presented instruction away from physical world distractions. The results also indicated the potential of social VR to promote creativity in educational settings [22].

In previous works, we employed social learning analytics, social network analytics, machine learning, and behavioral change support systems to construct virtual social spaces for learners to connect, practice, and share experiences, as well as to reflect, and develop their career-readiness. In these virtual communities, learners are engaged in a cognitive apprenticeship process designed to meet their individual dispositions, interests and needs [23,24]. In this present work, we extend our previous investigations into metaverse developments through a novel architecture of Metaverse Intensive Learning Experience (MiLEx) platform. The MiLEx platform aims to provide the experiential, technological and governance capabilities for designing and delivering a higher order of personalized immersive learning experiences that enhance career practices and competencies for the 21st Century. The design and creation of the learning experiences in the MiLEx platform follows some principles and strategies associated with effective teaching and learning in higher education to produce career-ready graduates. It also integrates the dynamics and themes underlying communities of practice and collective intelligence.

The remaining part of this paper is structured as follows. Section 2 introduces a background for the concepts and methods underlying our proposed platform, Metaverse Intensive Learning Experience (MiLEx). Section 3 presents the ecosystem and architecture of the MiLEx platform. Section 4 describes the experience journey in MiLEx. Section 5 discusses key challenges and open issues. Finally, Section 6 presents the concluding remarks.

2. Background

2.1. Learning for Career Readiness

Career readiness describes the practices necessary for individuals to act on the knowledge and skills acquired through education and experiences to compete in the workspace and to improve their local and global communities. The Asian Society Center for Global Education and Advance CTE identifies a set of career-ready practices that are required for global competence [25]; and proposes a rubric to guide learning strategies and to evaluate an individuals' progression toward becoming a global-ready practitioner [26]. Advanced global career ready individuals:

- Act as a responsible and contributing citizen to the betterment of teams, families, community, and workplace.
- Connect abstract concepts with real-world applications and apply academic and technical resources to communicate and collaborate effectively with diverse individuals and groups to attain desired outcomes.
- Reflect on how context and culture can influence diverse interpretations of situations, events, issues, and phenomena, and so, influence actions and decisions making.
- Plan future actions and decisions based on reflections and evaluations of the complexities of how actions impact the global context
- Engage in individual and collaborative experiences and translate ideas and findings to actions that improve local and/or global situations.
- Select, evaluate, and utilize a variety of resources, including technology applications, to make sense of situations and solve problems.
- Take ownership of their development and participate in ongoing educational and experiential processes.

On the other hand, 21st century skills refer to the competences that individuals need to be able to compete in the ever-changing technologically advanced world, such as collaboration, creativity, critical thinking, problem solving, and digital literacy [27,28]. Career-ready practices and 21st century competencies both call for transformative, practice-oriented learning models that promote independent lifelong learning and employability prospects [29,30]. These learning models should be based on social constructivism and experiential learning strategies, and should integrate trans-disciplinarily and inter-disciplinarily, formal and informal instructional approaches. Most importantly, they should create opportunities for practice, formative assessment, and feedback [28,31].

While there is still little evidence about the most effective methods to develop career-readiness practices and future skills, the use of contemporary ICT to further personalize learning pathways and experiences do contribute to the development of these practices and skills [31–34]. Personalized learning is assembled from a set of socially oriented, and self-reflective activities designed according to the learner's background to meet his learning needs and interests [35,36].

2.2. Experiential Learning Cycle and Immersive Learning

Experiential learning suggests that learning progresses through a four-stages cycle [37,38] illustrated in Figure 1. First, learners start with a concrete experience (seeing and doing). Second, they reflect on the experience and review their observations. This includes the assessment of their thoughts during the experience and the consequences of their behaviors and actions. Third, learners draw conclusions about the experience and transform their reflective observations into learnt concepts. Fourth, they use these concepts to solve problems. Learning resumes with an experience where learners interact with their environment by sensing, thinking, and acting in diverse ways. This process is accompanied by continuous feedback and generating new ideas that support learners' beliefs and assumptions.

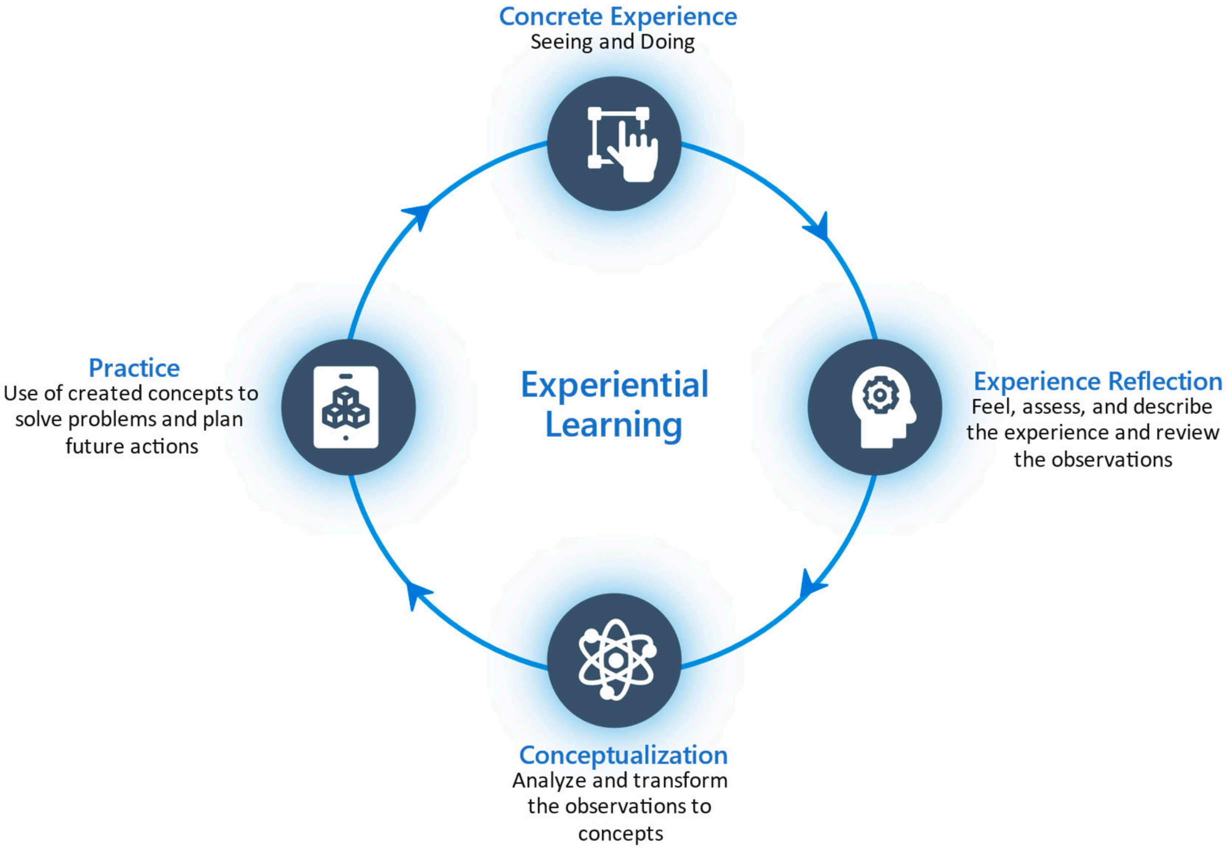

Figure 1. The Experiential Learning Cycle.

Today immersive technologies are replacing the–mostly hard to build—concrete experiences in the above experiential learning framework with virtual experiences, where learners are actually "immersed" into real-life situations to improve their engagement, learning performance, and ability to apply their know-how and skills [39–45]. Several studies in the literature have examined the application of immersive and experiential learning models in higher education and acknowledged their potential to deliver career-ready graduates [46–50].

To maximize learning from any experience, Boud and Walker [51] and Boud [52] highlighted the importance of building new learning on prior experiences, and of engaging learners actively in the experience which they are part of. They presented the experience-based learning as a process of three events:

(1) Prior to event: This event focuses on (a) profiling learners as the personal foundation of the experience (i.e., the learner′ previous experiences, expectations and intended outcomes, levels of engagement); (b) preparing the learning environment (milieu); and (c) designing the learning strategies while capturing all physical, social, emotional and intellectual elements needed to create and maximize opportunities for engagement and sustaining learning during the event.

(2) During event: The is the situated learning trigger that uses of the resources available in the environment to construct personalized learning paths and to raise awareness of the surroundings. Interventions in the form of actions that change the milieu and reflections that interpret events and their outcomes, occur during this event phase.

(3) Post event: The learner formulates reflections after experiences while considering three elements: (a) returning to the lived experience in order to fully capture its context; (b) analyzing the feelings and emotions presented during and after the experience to understand enhancements or seize the opportunities for further learning and reflections; and (c) re-evaluating the experience and using the outcomes to prepare for future events. The re-evaluation involves activities to associate and integrate the new knowledge to what is already known, to validate the authenticity of the resulting ideas and feeling, and to own and operate the new knowledge.

Kolb and Kolb [53] suggested a similar model to enhance experiential learning in higher education through creating and holding hospitable learning spaces that promote growth-production experiences for learners. The growth-production experience uses learners′ prior experiences, while building new ones and linking the experience to the learners′ interests. The learners, intrinsically motivated, live the experience where they feel, think, act, reflect, communicate, and take charge of their own learning. Kolb [54] provides a learning style inventory as a tool to increase awareness of how individuals learn from their own experiences, and to design effective experience-based learning systems.

Furthermore, Fromm [49] explored the provision of AR to realize the four learning modes in the experiential learning cycle by designing and evaluating three VR prototypes based on personas for students in business administration, media science, and education. Accordingly, the authors identified six elements to design an immersive, holistic experiential learning process in higher education: (1) evaluate how the immersive technology will serve the pedagogical requirements; (2) enable students to practice in realistic job scenarios; and (3) provide vivid experiences of high interactivity (4) provide different learning activities to support integration between practical modes of the cycle (i.e., experience and experiment); and the cognitive modes (i.e., reflect and conceptualize); (5) provide individual and group practice spaces; and (6) include the gaming element to increase learning motivation.

2.3. Collective Intelligence and Community of Practice

Collective Intelligence (CI) started appearing in cyberspace in the early nineties as a "form of universally distributed intelligence, constantly enhanced, coordinated in real time, and resulting in the effective mobilization of skills" [55]. CI platforms such as Climate CoLab and Interacting are designed to facilitate knowledge sharing, decision making and problem solving among individuals and groups. The underlying design models of existing CI platforms are presented in [20] where the authors investigated the characteristics of 12 CI models to propose a generic model for CI design. The proposed model as shown in Figure 2 presents CI as a system of four components: goals (what), staff (who), motivation (why), and processes (how); each is further described as types, interactions, and properties. It also provides the requisites for CI systems to work effectively and to change over the period of its existence, according to the needs of its collective. For example, the "who" focuses on promoting diversity, interdependency and fostering trust and respect among members (trust each other′s experiences) before they are engaged in a process to create well-defined and objective outcomes. In this process, individuals can independently carry certain activities and use information provided by others to make decisions, or they can collaborate, discuss, or even dispute with others to contribute to the group decision making, where results impact the whole community. The "why" focuses on understanding the individuals to decide the intrinsic motivation (i.e., social, passion, self-fulfillment, desire to learn) and/or the extrinsic motivation (i.e., rewards, trophies, glory, money) in order keep them participating actively in the process. This process is designed based on the SECI model [56]. The SECI model describes four process to create knowledge: (1) socialization: where learners share experiences and practices to create tacit knowledge; (2) externalization: whereby learners collectively reflect to create concepts and convert tacit knowledge to explicit knowledge; (3), combination: as learners integrate concepts to develop more complex and systematic explicit knowledge; and (4) internalization: embody explicit knowledge into tacit knowledge, i.e., use the past and present knowledge to assemble new knowledge and develop the future practices. In all the above, technology is the artifact which integrates knowledge and ensures that it is distributed between participants and objects in the experience environment.

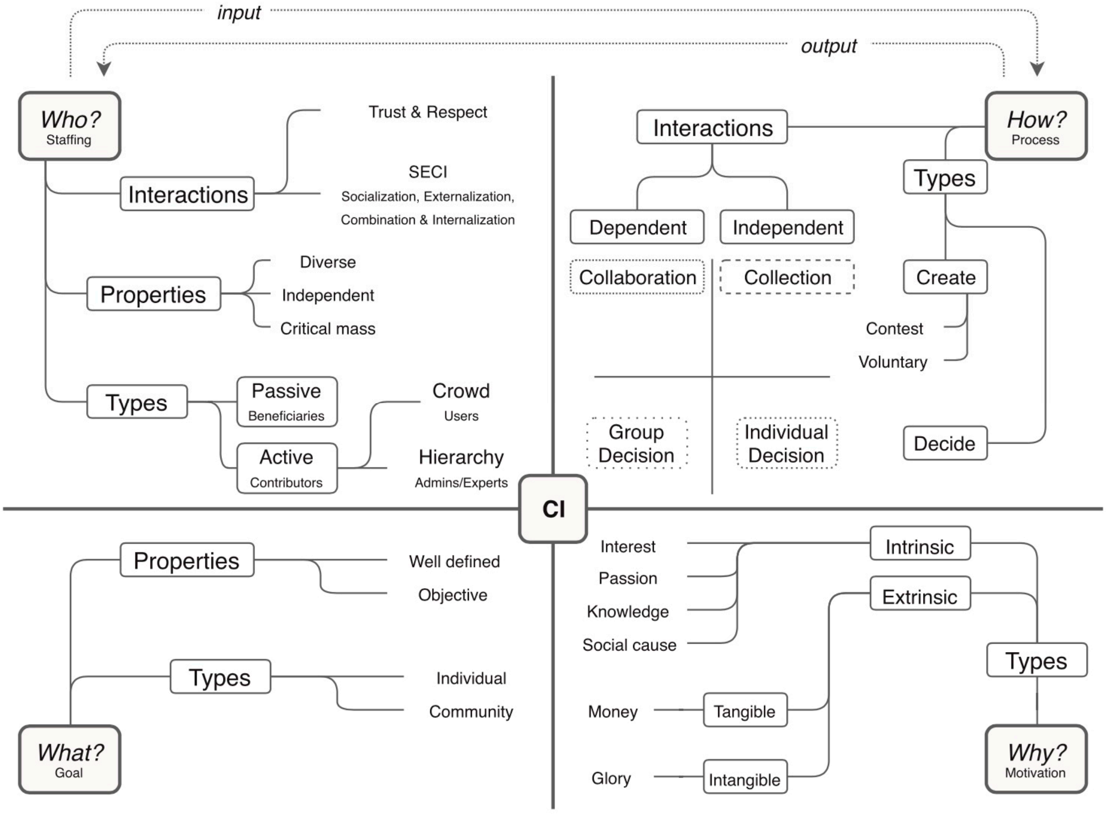

Figure 2. Generic Model for CI Systems Reprinted/adapted with permission from Ref. [20], 2023, Association for Computing Machinery.

The concept and application of CI and SECI as individuals build on each other's experiences to solve problems and construct new ideas is also exhibited to positively contribute to learning performance in higher education [56–60].

This dynamic to accomplish learning goals together while adapting to changing environments are also presented in the themes of approaching practice in communities as "agency of objects," "model of situated actions", "knowing-in-practice", and "collective knowledgeable doing" [19,61–63]. The agency of objects examines the relationships between individuals and objects in their world, and how the different styles of objects influence the ways in which individuals make and use them [19,64]. For example, the emerging technology forms have changed our ways of communicating and doing things in contemporary societies, where technological competence has become a precondition for the exercise of digital citizenship [65]. The situated action approach focuses on understating the situations in which the interests of participants and the opportunities in the environment meet and are reciprocally defined, while knowing-in-practice is the practical activities constructed by participants in the situations. Knowing as a situated activity is understood in the context of the activity (while practicing) or as the object of reflection after practicing. The collective knowledgeable doing-like experiential learning is when participants use objects in the environment (such as technology) to carry out their activities and then juxtapose these objects to condition future actions.

Furthermore, Gherardi [19] highlighted the theme of practice as "sensible knowing" (i.e., how individuals use their bodies to relate to the practice and how the practice shapes knowledgeable bodies) as a fundamental dimension to detect the "what next" in practice and to improve practice-based experiences. Practice is then defined as a situated seeing, saying, and doing activity that comprises sensible/sensory knowledge. Sensory knowledge is developed through learning how to use the five senses when interacting with others within the shared space and with practice-related objects [66]. While sensory knowledge is not a pure form of knowing and learning, it is still one basis for practice-based learning [67]; and this is where the features of the metaverse, such as a sense of immersion, real-time interactivity, and user agency can support the creation of effective practice-based learning experiences.

2.4. Experience Creation in the Metaverse

Yosuke Matsuda, president of the video gaming company Square Enix, noted that "we are trying to not define the metaverse so rigidly that it limits the imagination of creators" [4]. Instead, the metaverse is described by its design characteristics and blocks of technologies to realize these characteristics [3,4,6]. For example, the author in [68] ideated a metaverse construction that consists of experience, discovery, creator economy, spatial computing, decentralization, human–computer interaction, and infrastructure. The work in [2] described the following six user-centric factors as pillars for metaverse development: user identity, content creation, virtual economy, social acceptability, security and privacy, and trust and accountability. As such, the experiences in the metaverse are immersive real-time social activities where individuals with unique identities in the virtual world exchange, trade, and share contents within a context that is governed by rules and norms, as in real life communities.

These experiences are continuously updated according to new discoveries and economic gains. The convenient access to a realistic immersive experience is also described by [6] as a core feature of the metaverse that drives excitement by providing verisimilitude of the senses, objects, and environment. Other features include real-time operations, content production, identity and rules, and finally, large-scale networking capabilities. Figure 3 is adopted from [6] and depicts metaverse characteristics along with the enabling technologies that are mapped to their roles and categories. A comprehensive survey of these technologies and their developments is presented in [2].

For producing educational experiences, the work in [11] proposed an architecture of four layers (physical, network, data, and application) and VR and AI capabilities for interactivity, collaboration, and digital creation of spaces and resources. The work in [69] developed the design and architecture of VorTex as a metaverse system to support collaborative learning activities in virtual environments. VorTex consists of a database layer, collection layer, business logic layer, centralized identity layer and presentation layer. The work in [70] presented an architecture for a campus metaverse prototype consisting of three layers: infrastructure, interaction, and ecosystems. The immersive user experience is achieved by two components in the interaction layer: digital twins and real-time content creation. The ecosystem layer is for applications to enable user-generated content (UGC), virtual economy, and AI-driven NPCs. Another education metaverse ecosystem is presented in [71] which consists of four hubs: (1) instructional design and performance technology to deliver experiential learning outcomes; (2) knowledge hub to enable collaborative knowledge creation; (3) research and technology to drive innovation; and (4) talent and training hub to offer professional development and training solutions.

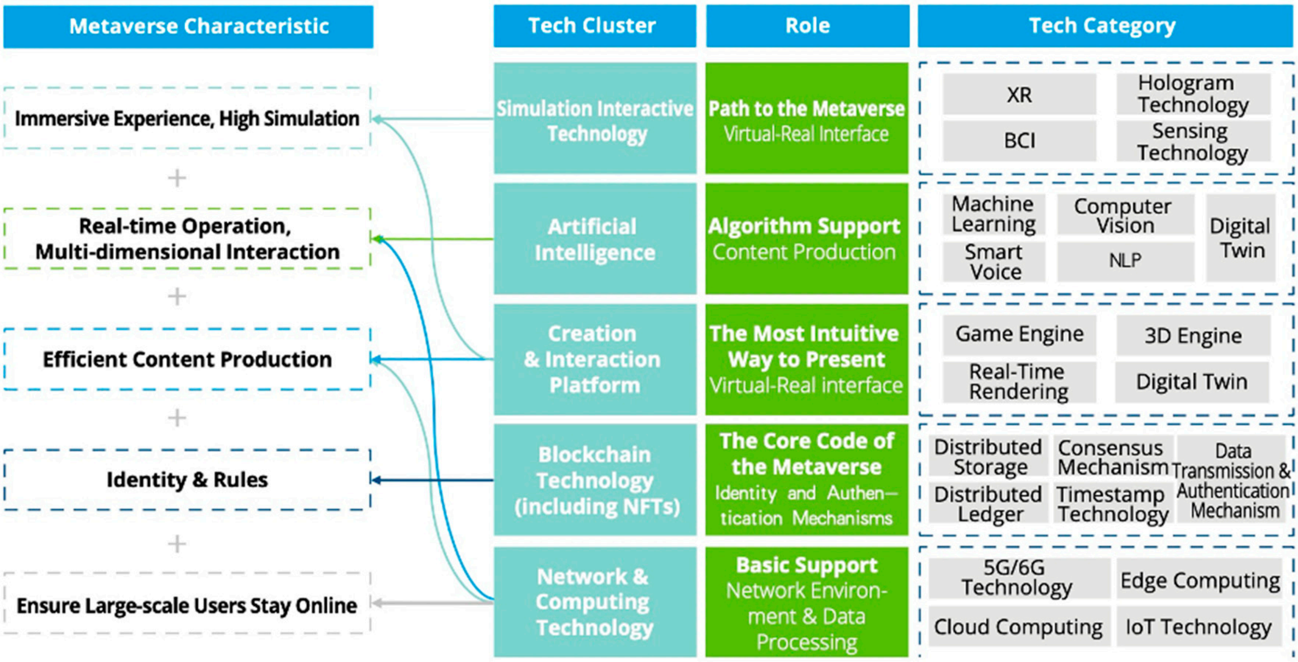

Figure 3. The Enabling Technologies for Metaverse Characteristics [6].

3. The Metaverse Intensive Learning Experience (MiLEx)

3.1. Ecosystem and Layering Architecture

From the perspective of common elements theory [72], education is the process of orchestrating experiences to stimulus representations for learners to select knowledge and skills that produce adaptive responses to encountered problems in their environment. The critical elements for the current problem are selected by comparing the representation of the current situations to stored representations of past situations, i.e., use the same mental models from previous experiences to solve the current problem. When mental models fail to provide solutions, learners are engaged in inferential reasoning and metacognitive activities to allow them to solve the new problem or to cope with unseen situations. The guiding principles of the cognitive approach state that: (1) personal mental frameworks influence perception and interpretation; (2) learning is an intellectual, active process of continuous construction of meaning; (3) learning is maximized when situated in real-life settings; (4) humans reach a threshold for learning complex skills independently; and (5) reflection is a key component in learning [73]. Thus, MiLEx is envisioned to deliver practice-based learning as a situated performance within equipped environments for learners to practice, reflect and learn in collective and socially regulated spaces. In practice-based learning:

- Learner needs or problem are the immediate purpose of learning
- Learning is a self-directed process
- Learning occurs through authentic experiences within the practice environment.
- Learning is a social act that involves interactions over a lengthy period.

Accordingly, we introduce the MiLEx platform to build a practice-oriented learning ecosystem that integrates four key elements:

- **Key Players:** to define the main actors and their roles in the learning process. This also involves understanding the personal needs, interests and expectations that drive access to MiLEx. This understanding is exploited to motivate learners to explore MiLEx environments and communities; and to engage in learning experiences.
- **Practice Context:** to present the working environment (i.e., learning space) and the networks of action–interactions among human and non-human objects.

- **Experience Cycles:** to prepare the environment (context) and design the events/activities/simulated real-life problems to deliver the learning outcomes. During these events learners are empowered to rely on their awareness of the environment, their prior experiences, and their community connections to make actions (i.e., produce content and edit the environment), reflect on their actions and evaluate their impacts, develop new understandings, and put them into practice in the next situations.
- **Technology:** to define the technologies that support virtual communities of practice, ensuring rules enforcement, experience cycles development, and knowledge transformation and distribution between human and non-human objects within the community.

Figure 4 illustrates a layering architecture for MiLEx platform and its related modules and building blocks to realize our proposed metaverse-based practice-oriented learning experiences model.

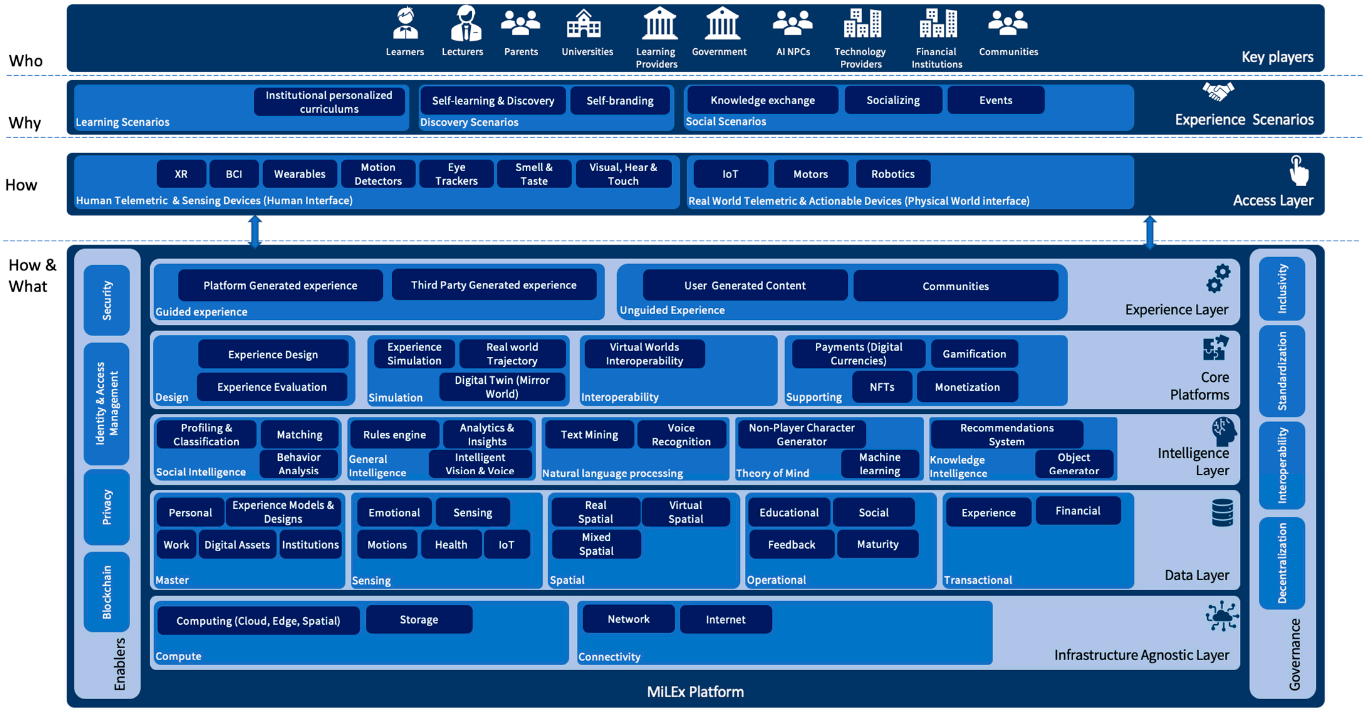

Figure 4. MiLEx Ecosystem and Layering Architecture.

3.2. MiLEx Key Players

The key players' layer corresponds to different stakeholders who can influence, impact, use, or govern the experiences offered in MiLEx. As MiLEx is designed to be inclusive, different stakeholders have an interest in being part of that experience. For example, universities, governments, and industrial bodies will be able to design and provide different learning experiences based on specific objectives for learning curriculums and training programs. However, MiLEx provides a learner-centric culture where the "learner agent" leads autonomous learning experiences with minimal structural influence [74]. Thus, the creation and modeling of learners as avatars in MiLEx maximizes the personal identity representation of the learners to include and exhibit relevant individual features such as social conditions, emotions, and cognitive dispositions. Most importantly, it incorporates prior experiences and develops the character according to the growth-production experience. This is also applied to the development of the AI_NPCs who play different roles inside MiLEx (i.e., tutor, peer, tutee) and who display intelligent behaviors not only to meet the needs and expectations of the learner (i.e., provide advice, share experiences, response to instructions, or be a role model) but also to create conflicts and challenge learner's beliefs and assumptions. In fact, NPC peers will serve a significant role in the cognitive and social learning context as they may guide and participate in the experience and even learn and mature with the main human character.

3.3. Practice Context in MiLEx

MiLEx enables the creation of visible and implicit elements of the workplace environment. A work environment consists not only of the physical objects that are required for practice (e.g., furniture, machines, document, etc.) but also includes a common orientation (i.e., a shared understanding of what needs to be accomplished), a network of social relationships, communication mechanisms, and normative controls. The recognition of reciprocal intentions in the practice context, understanding of the actions of other players and the ability to interpret surrounding signals are what drive learners' actions to manage unforeseen events as they arise from the context. Besides using the non-fungible token (NFT) objects to produce the virtual practice context, MiLEx simulates the contextual events for learners to experience and act on. It also simulates the interactions dynamic to develop and sustain practices while adapting to updates resulting from new rules, learning from experiences, conflicts among players or groups, competitions, and changes in players and/or players' beliefs.

3.4. MiLEx Experience Cycles

MiLEx offers three categories of events or scenarios that are critical for a holistic practice-based experience: institutional learning scenarios, discovery scenarios, and social scenarios. The institutional learning scenarios are offered by higher education institutions which are enabled to design and build personalized curriculums and learning paths on the platform. The discovery scenarios motivate self-learning objectives for individuals to learn new topics, explore new science or worlds, or as a step to change career or self-rebranding. In the social scenarios, MiLEx provides means for "knowing across communities" where learners may start at a single practice of community until becoming familiar with its situated working practices, and gradually moving to focus on the interacting communities (i.e., industries) and society at large. The three categories incorporate the career-ready practices that are required for global competence.

3.5. MiLEx Platform

The MiLEx platform presents the fourth building block in the ecosystem, and which describes the architecture and components to support the development of metaverse immersive practice-based learning. MiLEx consists of five horizontal layers and two vertical layers. The access gateway is a critical construct to enable the key players to join the metaverse and live the experience scenarios. The horizontal layers represent the foundational infrastructure and capabilities to achieve experience-duality such as user identity, content production, immersive simulation, multidimensional interaction interfaces, virtual economy, and real-time operations. The vertical layers depict the enablers and governance as the pillars to actualize and sustain the practice communities in MiLEx. The access to MiLEx platform is through the access gateway.

3.5.1. The Access Gateway

The access gateway enables users/learners to interact with the digital entities and to immerse themselves in the learning experience. As the metaverse combines the virtual and physical worlds, MiLEx incorporates two important sub-building blocks inside the access gateway:

1. The first enables users to enter that intensive immersive experience through multiple forms of access equipment technologies including continuum of extended reality (VR/AR/MR), brain–computer interaction (BCI), and sensing technologies to capture human vital measures, from vision, eye, or motion tracking as well the ability to reproduce some sensing information, such as smell, touch, or taste.

2. The second enables the physical world connections with MiLEx to collect different telemetric data about physical objects as well as to embed actions to trigger the physical world to react to different changes. This includes digital twin technology, internet-of-things (IoT) and robotics.

3.5.2. Horizontal Layers

Infrastructure Agnostic Layer

The infrastructure agnostic layer contains all computing capabilities (e.g., the cloud, edge, spatial computing); and connectivity capabilities (e.g., internet, mobile networking, and even satellite connectivity if needed). These resources are essential to timely execution of heavy computation tasks, large data processing and communication between systems.

Data Layer

MiLEx manages several types of data, including master, sensing, spatial, operational, and transactional data. Master data consists of "golden records" which encompasses all information we need to know about the learner profile and practice context, and which will be used to design and create learning experiences. Sensing data contains all the data that the MiLEx senses from human and physical world interfaces, from emotions, motions, health activities, heart rate, hearing, respiration, and others.

Spatial data is important to enable mixed spatial correlation when the user moves or interacts with the virtual object using physical-world objects or even by simulations using the BCI.

The operational data is the data used for operating the platform collected during the learner's interactions with the platform such as the access technical data, data generated while living the experience, and other types of data that are important to improve the overall operation and scalability of the platform.

The transactional data is generated on each interaction during the experience to define that experience and control its flow according to the human and physical interactions, from moving objects, tapping on things, designing space activities, as well as financial transactions (e.g., buying digital assets or getting rewards).

Intelligence Layer

The intelligence layer augments and enriches the data layer using AI-intensive models and algorithms to support building the personalized experience. AI capabilities serve different purposes such as the automatic integration between the virtual and physical world (digital twining), development of computer agents (NPCs), and the personalized representation of learners in the metaverse (avatar creation and modeling). The AI techniques in MiLEx are of five goals:

1. Social Intelligence: targets profiling and analyzing behaviors of individuals and groups as they socially interact; and track the changes on these behavioral patterns during situations and experience contexts.
2. General Intelligence: employs rules engine and decision-making models to generate insights and inform the NPCs development process.
3. Natural language processing recognizes and interprets voices and texts either handwritten texts or by converting voice to text during the experience.
4. Theory of Mind develops the ability of NPCs to collaborate with human players. In our practice context, it is used to develop socially intelligent NPCs who are able to perform the same cognitive mechanisms (i.e., reasoning process) involved in making decisions from the human learners' perspectives and engage with them in an effective learning interaction in response to critical situations. This is perceived to improve the trust in NPCs, so that learners may use their support to better understand their surroundings and plan their future actions [75].
5. Collective Intelligence: uses collectively generated data and experience histories to build new spaces, environments, and objects for future experiences.

Core Platforms

The core platforms layer provides design, simulation, interoperability, and supporting capabilities. The design process uses insights generated from understanding, profiling, and modeling the individuals and surrounding environments to deliver personalized immersive metaverse experiences to serve the unique individual needs and interests. The simulation capabilities focus on enabling high interactions between players and objects in the metaverse.

Furthermore, the interoperability between MiLEx and other similar platforms or metaverses is critical to exchange data with user consent to share or get other behavior data that can support the intensive experience or move between different worlds smoothly.

The payment, NFTs, and monetizing of the digital assets are part of the supporting capabilities to enable exchange of digital assets (virtual economy) as one of the main metaverse components. A virtual economy is used inside the experience for rewarding learners in tangible and intangible ways (corresponding to our understanding of individual motivations). The tangible one can be considered intangible as well, as it will be a form of digital assets, like premium avatar customization, private space tools, cloth, trophies, and others. This is supported by a gamification platform to inject the gaming elements into the experience so it can be a fun learning experience that can also help in learning recognition and branding.

Experience Layer

Once the learner is interfaced and connected to the MiLEx with the surrounding physical world according to the experience needs and designs, MiLEx offers diverse types of experiences: guided experience and unguided experience.

The guided experiences are generated from the system according to the learner's identity, profile, indented outcomes, and the history of prior experiences. This type of experience can be designed according to institutional curriculum or a third party that uses the platform to host their curriculum and learning paths. Unguided experiences belong to discovery and social scenarios, and which are generated by the users or their communities to freely decide what spaces, objects, connections, and events they need to experience and toward what objectives.

3.5.3. Vertical Layers

Enablers

The enablers layer includes important technologies that are critical to the different and mostly architectural horizontal layers, for example, the blockchain technologies, identity and access management, security, and privacy.

Blockchain enables trading activities inside MiLEx, especially in the user-generated content that can be shared in a marketplace and other participants can buy it and benefit from that content.

Identity and access management is an integral part of any digital interaction, especially in MiLEx where the learner's identity leads the experience development. This also includes the identity of NPCs who learn over time using the AI-intensive models and as such providing a better experience for participants.

Privacy and security are important foundations of the MiLEx platform. User privacy is important to enable the participants to select and deselect what part of data they need to share to design their experience, and also, give them the ability to see how their data is used inside the platform. Security protects all layers from any potential threats or harmful behaviors that can impact MiLEx functionalities, from secured infrastructure and connectivity to data security in motion, rest, or during access.

Governance

The governance is influenced by important aspects such as decentralization, user-generated content (UGC) telepresence through the virtual world and standardization to ensure interoperability between internal capabilities and external worlds or experiences that may exist. Users are allowed to create anything and to move in the virtual world unrestricted by real-world operating, spatial or physical rules. These aspects support the notion of "joint regulation" by Gherardi in [19] noting that "working practices are not regulated through a prescriptive process which exercises organizational control from above; but nor are they regulated by control exerted from below and which expresses both the autonomy of the work collective and social space".

One more critical governance aspect to consider for MiLEx as designing practice-based learning experiences is the inclusiveness to include and value the variety of unique individuals, empower them to be part of the Metaverse and allow them to work together as equal contributors regardless of their ability, culture, gender, age, and other natural human differences.

Governance is a challenging subject in the real world and moving that to the MiLEx is even more challenging as it will require a deep understanding of how to model interactions, conflicts, negotiation, and cooperation to regulate and sustain the situated social practices while shaping situations/experiences.

4. Experiential Journey in MiLEx

The experiential journey in MiLEx is visualized as a connected, continuous, and proactive series of cycles of gathering information in an experience, while reflecting on the design to update the context, and updating the learner's profile and personalization attributes. The MiLEx immersive experience journey contains three streams: (1) living the experience (2) insights and analytics, and (3) continuous engagement, support and feedback. These streams are important to shape the full potential of MiLEx that is realized from the architecture.

Figure 5 shows how the three streams flow and cycle information to ensure continuous platform self-learning.

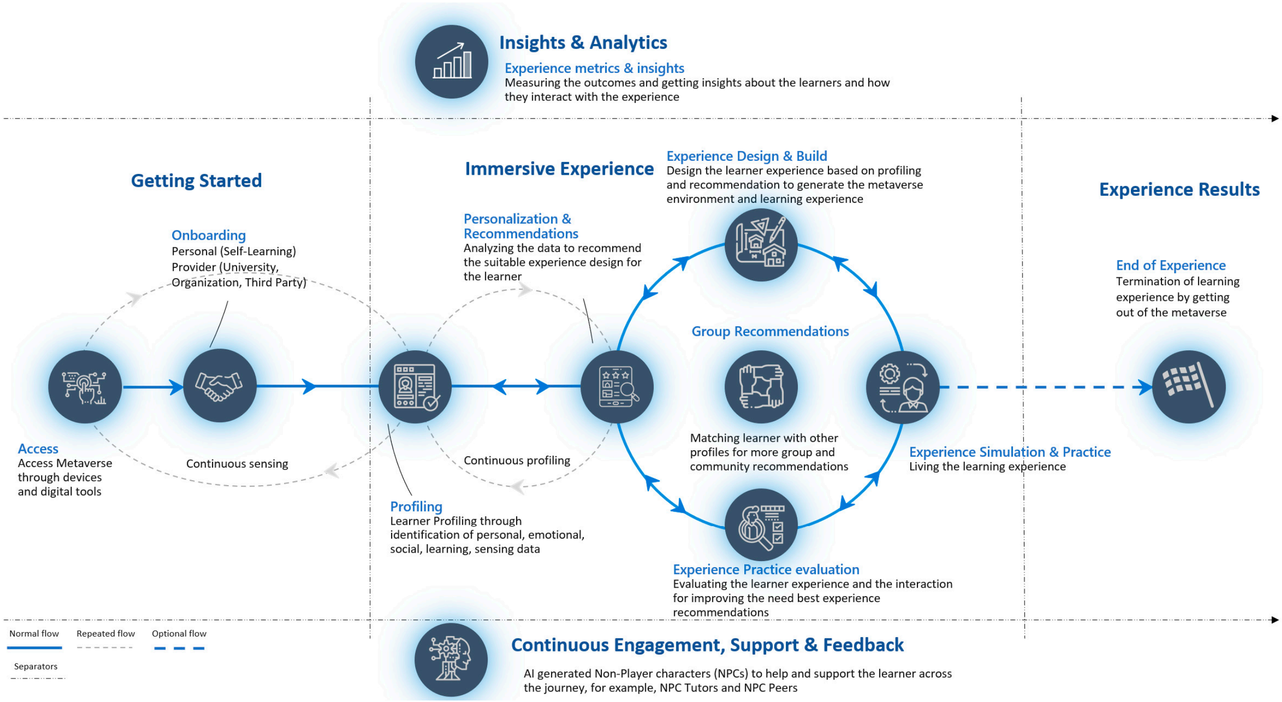

Figure 5. Cycles of Experience Journey in MiLEx.

4.1. Living the Experience

This activity evolves along the three following stages: (1) getting started, (2) immersive experience, and (3) experience results.

4.1.1. Getting Started

This is the first step which is considered mandatory to start using the MiLEx platform. The learner starts to perform the registration by accessing the platform through the access gateway using any of the human interfaces. The platform onboards the learner through understanding the initial foundation of the experience, i.e., expectations and intended outcomes. This is executed in parallel with profiling the user, i.e., learner discovery. The learner discovery uses the data components mentioned in the data layer, for example, the personal master data, social data, historical learning activities, and sensing data to extract insights and personalize the best fit learning experience that match the learner profile.

Through the registration, the learner owns his/her digital identity on MiLEx which is used to identify the learner when accessing the platform each time. This getting started process is circular as well, to keep getting sensing data during the experience itself and learn more about emotional activities, motions, or other sensory data that can be used to enhance the learning experience.

4.1.2. Immersive Experience

This is the core stream where the learner starts living the experience as a personalized context generated by the platform after simultaneously using and analyzing all available information. In the experience context, the learner begins to interact with virtual and/or physical objects according to an experience scenario where certain problems need to be solved, certain products need to be created, or certain decisions need to be made. We like here to use “the wrong prosthesis in the operating theater” [19] as an example of this experience context and scenario within which the learner will step into an operating room where there are two other surgeons, an instrumental nurse, an anesthesiologist, and a nursing assistant surrounding an operating table on which there is a woman whose breast tumor must be removed. When the learner arrives to the room, he asks the nursing assistant to bring the prosthesis to be implemented indicated by a number. The nurse goes to a shelf that holds twenty boxes, takes one and gives it to one of the surgeons who approves it. The three surgeons then proceed with the operation to insert the prosthesis and just before closing the operating field, the instrumental nurse declares that the inserted prosthesis is the wrong one. The anesthesiologist then confirms the mistake. While the learner is a practitioner in that room at that time who needs to decide on how to proceed, the most important learning outcome will be re-presenting the practice to the learner to first be aware of the errors in medicine, and second, to reflect on how the prevention of such errors is conducted in an ordinary way as part of the normal practice. This scenario is a good illustration of “knowing in practice” and how a potential error like this could be avoided by means of communication and collective consultation among the operators present in the room without distinction of role.

4.1.3. Experience Results

While the metaverse is a continuum, the learner has the control to end or pause the experience. This can happen by simply removing the human interfaces or consciously ending the learning experience itself to start another one. Every time the learner completes or ends the practice, the platform evaluates the qualities of the experience from platform inner measurements, for example, how quickly the learner interacts with the experience context, how easily he/she understands and reflects on the new learning, the facial reactions, the motion, and behavioral reactions. Furthermore, the learner’s evaluation about what was good or what went badly during the experience. The feedback is used to optimize the next cycles of experiences.

The experience is not paused until the learner decides to exit or move to another new learning scenario. In the middle of this continuous loop, the group recommendations are important to guide the learner to which communities to join or with which learners he/she can connect to in accordance with his/her learning profile.

4.2. Insights and Analytics

Insights and analytics are important for two primary areas: operational intelligence and key players decision making. The operational intelligence aims to understand how the key players interact with the platform, getting insights from collective experiences on an individual and group level to understand the norms in the behavior of individuals as they act alone and/or when they act within groups, and if there are outliers in that behavior. For example, when existing in the experience, the insights unlock why things happen and if there is a fault in the platform, a flaw in the experience design, or other reasons. The operational insights also contribute to scaling the platform through understanding the users' demographics and their usage patterns.

Operational insights and analytics help in planning future improvements and what other capabilities need enhancements, or areas that the platform needs to explore more.

The other dimension provides insights for individuals, communities owners, and other participants from universities' and learning providers' insights about the learning results and the progress, interactions, and metrics that help them better engage and have insightful information about their participations. This dimension enables each key player to make decisions according to what they experience or own inside the platform.

4.3. Continuous Engagement, Support and Feedback

It is expected that during the journey the key players need support to use the platform effectively and achieve their goals. It is envisioned that the platform uses the NPC especially for that reason, for example, when the learner is in the getting started stage, the AI-generated character starts to have a conversation with the learner to collect some information and guide the learner on how to set up his/her profile and connect various human or physical interfaces. Through the immersive experience, the AI-generated character can lead the learner into a training mode where the character shows how to live the learning experience and how the platform works as the first skill.

The platform provides this support character for the user to call at anytime through voice command or hand gesture to get support. So, it acts as a help center for the users during the interaction with platform. Moreover, when finishing a step, it asks for feedback and whether the experience delivered the intended outcomes.

5. Challenges and Open Issues

5.1. Technology Demands

A big challenge is whether the metaverse in its ideal form will be built, at least as we envision it. The demand to develop a fully realized metaverse requires technological developments and solutions to solve several issues such as:

5.1.1. Access to the Metaverse

At present, the metaverse is mostly accessed through display applications while the current AR/VR/XR sets are immature and heavy. Entering and interacting in the metaverse will require immersive equipment that is flexible and convenient. In addition, the existing interactivity technologies are still limited to reflect minimum body movements while the need is for more accurate on- and off-body interface peripherals (i.e., sensors and haptics) to capture user input and output feedback cues.

5.1.2. Computing and Networking Infrastructure

In the metaverse, many users will need to be online at once and to interact simultaneously and ubiquitously, generating unfathomably massive amounts of data. Thus, a smooth metaverse experience will require to build and operate sophisticated storage and computing capabilities over a stable, low-latency and high-bandwidth connection.

5.1.3. Data Security and Privacy

In the metaverse, as a digital social community, the users can experience multiple privacy and security risks. The amount of data will be increasing exponentially in the metaverse with more frequent data collection, retrieval and use. This data includes sensitive personal information (e.g., user's demographics, physical culture, and economics); and personal communications and behaviors (i.e., user's interactions, habits, and choices in the metaverse). The designers and developers of the metaverse will be required to provide solutions to control data use and to protect users from privacy and security threats according to established polices.

5.1.4. Digital Inclusion and Accessibility

Digital accessibility for inclusive higher education emphasizes equality, so that all learners are to be able to independently acquire the same knowledge, engage with the same spaces, interactions, and technologies, and to enjoy the same services within the same timeframe regardless of any diversity factors (e.g., ability, language, socioeconomic status, culture, religion) [76,77]. Equitable access to learning experiences in the metaverse goes beyond providing affordable wearable devices, to adopting proactive designs and inclusive strategies for constructing the learning experiences; and to enforcing relevant legislation and regulations to ensure equity and to prevent the emergence of a metaverse divide [71,78].

5.1.5. Learning Experience Design

The instructional design and technology (IDT) field has focused so far on creation and delivery of learning materials with little attention on the concepts and practice of learning experience design [79]. On the other hand, a recent survey on how global universities approach digital learning and what learners seek in their individual learner experience revealed that universities are indeed investing more on technology, but are not succeeding yet in providing more personalized, data-driven experiences [80].

The emerging learning experience phenomenon can be characterized as learner-centric, theoretically grounded, with related methods and processes from HCD and UGC, and a socioculturally sensitive approach to learning design that is informed by user experience (UX) methods (e.g., engagement, likability, and usability) [81]. While shifting to the digital learning experience, there is a need for a collaborative work between educators, instructional designers, and technology developers to define, design and operationalize learning experiences in a useful way from learning and practice perspectives. The work in [82] provides an example of a learning experience designed to effectively engage learners in IDT classes which presents a great case of how IDT graduate-level students can firsthand practice the design and implementation of learning experiences.

5.2. Governance Structure

This presents one of the greatest challenges for metaverse development, as if governance rules are set to be too conservative, the metaverse will not meet expectations, while if they are set to be too radical, then the economic operations and social systems of the metaverse will intensify, contradict and even threaten the real world [6]. Ideally, the metaverse should weaken the central privileges and offer a community that is inclusive and outside of local restrictions that diminish personal identity and freedom. The regulations and rules in the metaverse are developed by the creators through decentralized autonomous organizations (DAOs) which record the relationship between a creator and their creations, establish e-commerce system and voting system for all users to participate in decision making process in regard any changes in the platform. However, the questions out there are: Who are the rule makers in metaverse? Who will manage it? What are the ownership and control mechanisms? How to ensure that UGC does not violate rules and norms while maintaining freedom of speech? How to enforce ethical standards and protect human rights and economic dividends?

The work in [83] proposes an ethical design of a metaverse in alignment with an "ethical hierarchy of needs". The proposed design is a federated approach based on a modular-based framework for governance, where every necessary party (e.g., developers, regulators, users, content creators) can take independent decisions, but are still connected to other decision modules, resources, and policies. Still, more research work and experimentation remain in order in this area.

When it comes to metaverse applications in education, there are even more governance aspects to consider, such as inclusion and accessibility, the organization, integration, analysis and use of lifelong learning data and achievements [84], the control of interactions between social, technical, and economic factors [85], and the production of learning content [86].

6. Concluding Remarks

Higher education provides learning experiences that meet learner needs and improve learners' disposition to compete and succeed globally. To best prepare learners for the future, universities should develop responsive digital instructional systems leveraged by data to create a holistic view of individual learners in order to enable early identification of specific needs and expectations; and to accordingly design learning experiences that build upon prior knowledge, and engage and motivate while learners acquire new knowledge through an iterative practice and learning transformation process. In this paper, we presented our vision for a metaverse-based intensive learning experience (MiLEx) as a situated performance within an equipped environment for learners to practice, reflect and learn in collective, social, and regulated spaces. The new and emerging technologies for metaverse development as an immersive learning environment will provide the opportunity for learners to experience the practical value of their learning in real-life settings. Learning within practice-based experiences will also help learners to find their career path and take ownership of their development while working with others.

The metaverse development is still at preliminary stages and we are witnessing an increasing number of research studies on the potentials of metaverse on higher education. We believe that MiLEx can serve as a reference framework for future works on designing metaverse learning environments. We also hope this paper will contribute to ongoing research work on best practices for instructional design and technology.

Author Contributions: Conceptualization, E.A.; Methodology, E.A. and M.S.E.-T.; Validation, Y.A.; Writing—original draft, E.A. and M.S.E.-T.; Writing—review & editing, Y.A.; Visualization, M.S.E.-T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Conflicts of Interest: The statements [or testimony] I offer today represent my own personal views. I am speaking for myself and not on behalf of my employer, Microsoft Corporation.—Mohamed Sami El-Tahawy.

References

1. Meta Connect. The Metaverse and How We'll Build It Together. Available online: https://www.facebook.com/RealityLabs/videos (accessed on 31 January 2022).
2. Lee, L.H.; Braud, T.; Zhou, P.; Wang, L.; Xu, D.; Lin, Z.; Kumar, A.; Bermejo, C.; Hui, P. All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda. *arXiv* **2021**, arXiv:2110.05352.
3. JPMorgan. Opportunities in the Metaverse: How Businesses Can Explore the Metaverse and Navigate the Hype vs. Reality. Available online: https://www.jpmorgan.com/content/dam/jpm/treasury-services/documents/opportunities-in-the-metaverse.pdf (accessed on 31 January 2022).
4. McKinsey. Value Creation in the Metaverse. Available online: https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/value-creation-in-the-metaverse (accessed on 15 June 2022).
5. Tyilo, M. 2022: The Year of the Metaverse Gold Rush. Daily Maverick. Available online: https://www.dailymaverick.co.za/article/2022-01-12-2022-or-the-year-of-the-metaverse-gold-rush/ (accessed on 31 January 2022).

6. Deloitte. The Metaverse Overview Vision, Technology, and Tactics. Available online: https://www2.deloitte.com/cn/en/pages/technology-media-and-telecommunications/articles/metaverse-report.html (accessed on 15 June 2022).
7. Hwang, G.J.; Chien, S.Y. Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective. *Comput. Educ. Artif. Intell.* **2022**, *3*, 100082. [CrossRef]
8. Kye, B.; Han, N.; Kim, E.; Park, Y.; Jo, S. Educational applications of metaverse: Possibilities and limitations. *J. Educ. Eval. Health Prof.* **2021**, *18*, 32. [CrossRef] [PubMed]
9. Tlili, A.; Huang, R.; Shehata, B.; Liu, D.; Zhao, J.; Metwally, A.H.S.; Wang, H.; Denden, M.; Bozkurt, A.; Lee, L.-H.; et al. Is Metaverse in education a blessing or a curse: A combined content and bibliometric analysis. *Smart Learn. Environ.* **2022**, *9*, 1–31. [CrossRef]
10. Park, S.M.; Kim, Y.G. A Metaverse: Taxonomy, components, applications, and open challenges. *IEEE Access* **2022**, *10*, 4209–4251. [CrossRef]
11. Zhou, B. Building a Smart Education Ecosystem from a Metaverse Perspective. *Mob. Inf. Syst.* **2022**, *2022*, 1–10. [CrossRef]
12. Akour, I.A.; Al-Maroof, R.S.; Alfaisal, R.; Salloum, S.A. A conceptual framework for determining metaverse adoption in higher institutions of gulf area: An empirical study using hybrid SEM-ANN approach. *Comput. Educ. Artif. Intell.* **2022**, *3*, 100052. [CrossRef]
13. Burnett, G.E.; Harvey, C.; Kay, R. Bringing the Metaverse to Higher Education: Engaging University Students in Virtual Worlds. In *Methodologies and Use Cases on Extended Reality for Training and Education*; IGI Global: Hershey, PA, USA, 2022; pp. 48–72.
14. Talan, T.; Kalınkara, Y. Students' opinions about the educational use of the metaverse. *Int. J. Technol. Educ. Sci. (IJTES)* **2022**, *6*, 333–346. [CrossRef]
15. Yu, J.E. Exploration of Educational Possibilities by Four Metaverse Types in Physical Education. *Technologies* **2022**, *10*, 104. [CrossRef]
16. Siyaev, A.; Jo, G.S. Towards aircraft maintenance metaverse using speech interactions with virtual objects in mixed reality. *Sensors* **2021**, *21*, 2066. [CrossRef]
17. Estudante, A.; Dietrich, N. Using augmented reality to stimulate students and diffuse escape game activities to larger audiences. *J. Chem. Educ.* **2020**, *97*, 1368–1374. [CrossRef]
18. Radianti, J.; Majchrzak, T.A.; Fromm, J.; Wohlgenannt, I. A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Comput. Educ.* **2020**, *147*, 103778. [CrossRef]
19. Gherardi, S. *How to Conduct a Practice-Based Study: Problems and Methods*; Edward Elgar Publishing: Northampton, NA, USA, 2019.
20. Suran, S.; Pattanaik, V.; Draheim, D. Frameworks for collective intelligence: A systematic literature review. *ACM Comput. Surv. (CSUR)* **2020**, *53*, 1–36. [CrossRef]
21. Han, E.; Miller, M.R.; DeVeaux, C.; Jun, H.; Nowak, K.L.; Hancock, J.T.; Ram, N.; Bailenson, J.N. People, places, and time: A large-scale, longitudinal study of transformed avatars and environmental context in group interaction in the metaverse. *J. Comput. Mediat. Commun.* **2022**, *28*, 1–27. [CrossRef]
22. Han, E.; Nowak, K.L.; Bailenson, J.N. Prerequisites for Learning in Networked Immersive Virtual Reality. *Technol. Mind Behav.* **2022**, *3*. [CrossRef]
23. AbuKhousa, E.; Atif, Y. Virtual social spaces for practice and experience sharing. In *State-of-the-Art and Future Directions of Smart Learning*; Springer: Singapore, 2016; pp. 409–414.
24. Khousa, E.A.; Atif, Y. Social network analysis to influence career development. *J. Ambient. Intell. Humaniz. Comput.* **2018**, *9*, 601–616. [CrossRef]
25. Asian Society Center for Global Education and Advance CTE. Career Ready Practices: Reflecting Global Readiness. Available online: https://asiasociety.org/files/uploads/26files/Global%20Career%20Ready%20Practices%20Final.pdf (accessed on 15 June 2022).
26. Asian Society Center for Global Education and Advance CTE. Global Career Ready Practice Rubrics. Available online: https://asiasociety.org/sites/default/files/inline-files/Global%20Career%20Readiness%20Rubrics_FINAL.pdf (accessed on 15 June 2022).
27. Geisinger, K.F. 21st century skills: What are they and how do we assess them? *Appl. Meas. Educ.* **2016**, *29*, 245–249. [CrossRef]
28. Lavi, R.; Tal, M.; Dori, Y.J. Perceptions of STEM alumni and students on developing 21st century skills through methods of teaching and learning. *Stud. Educ. Eval.* **2021**, *70*, 101002. [CrossRef]
29. DiBenedetto, C.A. Twenty-First Century Skills. In *Handbook of Vocational Education and Training*; McGrath, S., Mulder, M., Papier, J., Suart, R., Eds.; Springer: Cham, Switzerland, 2018. [CrossRef]
30. Luna Scott, C. *The Futures of Learning 2: What Kind of Learning for the 21st Century? (ERF Working Paper No. 14)*; UNESCO Education Research and Foresight: Paris, France, 2015; Available online: https://unesdoc.unesco.org/ark:/48223/pf0000242996 (accessed on 20 December 2012).
31. González-Salamanca, J.C.; Agudelo, O.L.; Salinas, J. Key competences, education for sustainable development and strategies for the development of 21st century skills. A systematic literature review. *Sustainability* **2020**, *12*, 10366. [CrossRef]
32. Kucirkova, N.; Littleton, K. Developing personalised education for personal mobile technologies with the pluralisation agenda. *Oxf. Rev. Educ.* **2017**, *43*, 276–288. [CrossRef]
33. Longmore, A.L.; Grant, G.; Golnaraghi, G. Closing the 21st-century knowledge gap: Reconceptualizing teaching and learning to transform business education. *J. Transform. Educ.* **2018**, *16*, 197–219. [CrossRef]

34. Joynes, C.; Rossignoli, S.; Amonoo-Kuofi, E.F. *21st Century Skills: Evidence of Issues in Definition, Demand, and Delivery for Development Contexts*; Institute of Development Studies: Brighton, UK, 2019.
35. du Toit-Brits, C.; Blignaut, H. Positioning self-directed continuing learning skills in twenty-first century education. *Tydskr. Vir Geesteswet.* **2019**, *59*, 512–529. [CrossRef]
36. Salinas, J.; De-Benito, B. Construction of Personalized Learning Pathways through Mixed Methods. *Comun. Media Educ. Res. J.* **2020**, *28*, 31–41. [CrossRef]
37. Kolb, D.A. *Experiential Learning: Experience as the Source of Learning and Development*; Prentice Hall: Englewood Cliffs, NJ, USA, 1984.
38. Greenaway, R. *Dynamic debriefing. The Handbook of Experiential Learning*; Pfeiffer University: Misenheimer, NC, USA, 2007; pp. 59–80.
39. Appelman, R. Designing experiential modes: A key focus for immersive learning environments. *TechTrends* **2005**, *49*, 64–74. [CrossRef]
40. De Freitas, S.; Rebolledo-Mendez, G.; Liarokapis, F.; Magoulas, G.; Poulovassilis, A. Learning as immersive experiences: Using the four-dimensional framework for designing and evaluating immersive learning experiences in a virtual world. *Br. J. Educ. Technol.* **2010**, *41*, 69–85. [CrossRef]
41. Beckem, J.M.; Watkins, M. Bringing life to learning: Immersive experiential learning simulations for online and blended courses. *J. Asynchronous Learn. Netw.* **2012**, *16*, 61–70.
42. Ahmed, A.; Sutton, M.J. Gamification, serious games, simulations, and immersive learning environments in knowledge management initiatives. *World J. Sci. Technol. Sustain. Dev.* **2017**, *14*, 78–83. [CrossRef]
43. Kwon, C. Verification of the possibility and effectiveness of experiential learning using HMD-based immersive VR technologies. *Virtual Real.* **2019**, *23*, 101–118. [CrossRef]
44. Wu, C.H.; Tang, Y.M.; Tsang, Y.P.; Chau, K.Y. Immersive learning design for technology education: A soft systems methodology. *Front. Psychol.* **2021**, *12*, 6061. [CrossRef]
45. Alfaro, S.M.A. Linking Experiential Learning and Real Life: A Design Case Featuring Immersive Learning. *J. Learn. Spaces* **2022**, *11*, 132–142.
46. Clark, R.W.; Threeton, M.D.; Ewing, J.C. The Potential of Experiential Learning Models and Practices in Career and Technical Education and Career and Technical Teacher Education. *J. Career Tech. Educ.* **2010**, *25*, 46–62. [CrossRef]
47. Atif, Y. Conversational learning integration in technology enhanced classrooms. *Comput. Hum. Behav.* **2013**, *29*, 416–423. [CrossRef]
48. Spanjaard, D.; Hall, T.; Stegemann, N. Experiential learning: Helping students to become 'career-ready'. *Australas. Mark. J. (AMJ)* **2018**, *26*, 163–171. [CrossRef]
49. Fromm, J.; Radianti, J.; Wehking, C.; Stieglitz, S.; Majchrzak, T.A.; vom Brocke, J. More than experience? On the unique opportunities of virtual reality to afford a holistic experiential learning cycle. *Internet High. Educ.* **2021**, *50*, 100804. [CrossRef]
50. Ummihusna, A.; Zairul, M. Exploring immersive learning technology as learning tools in experiential learning for architecture design education. *Open House Int.* **2022**, *47*. [CrossRef]
51. Boud, D.; Walker, D. Making the most of experience. *Stud. Contin. Educ.* **1990**, *12*, 61–80. [CrossRef]
52. Boud, D. Locating Immersive Experience in Experiential Learning. In *Conference Programme*; University of Surrey: Guildford, UK, 2008; p. 9.
53. Kolb, A.Y.; Kolb, D.A. Learning styles and learning spaces: Enhancing experiential learning in higher education. *Acad. Manag. Learn. Educ.* **2005**, *4*, 193–212. [CrossRef]
54. Kolb, D.A. *The Kolb Learning Style Inventory*; Hay Resources Direct: Boston, MA, USA, 2007.
55. Levy, P. *Collective Intelligence: Mankind's Emerging World in Cyberspace*; Perseus Books: Cambridge, MA, USA, 1997.
56. Thongkoo, K.; Panjaburee, P.; Daungcharone, K. An inquiry blended SECI model-based learning support approach for promoting perceptions and learning achievement of university students. In Proceedings of the 2017 6th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI), Hamamatsu, Japan, 9–13 July 2017; pp. 527–532.
57. Chootongchai, S.; Songkram, N. Design and development of SECI and Moodle online learning systems to enhance thinking and innovation skills for Higher Education Learners. *Int. J. Emerg. Technol. Learn.* **2018**, *13*, 154–172. [CrossRef]
58. Jeng, Y.L.; Huang, Y.M. Dynamic learning paths framework based on collective intelligence from learners. *Comput. Hum. Behav.* **2019**, *100*, 242–251. [CrossRef]
59. Gema, S.Ã.; Albaladejo, G.P. The use of a wiki to boost open and collaborative learning in a Spanish university. *Knowl. Manag. E-Learn. Int. J.* **2020**, *12*, 1–17.
60. Wong, P.P.Y.; Wong, G.W.C.; Techanamurthy, U.; Mohamad, W.S.B.; Febriana, A.; Chong, J.C.M. Using social mobile learning to stimulate idea generation for collective intelligence among higher education students. *Knowl. Manag. E-Learn. Int. J.* **2022**, *14*, 150–169.
61. Amin, A.; Roberts, J. Knowing in action: Beyond communities of practice. *Res. Policy* **2008**, *37*, 353–369. [CrossRef]
62. Argote, L.; Miron-Spektor, E. Organizational learning: From experience to knowledge. *Organ. Sci.* **2011**, *22*, 1123–1137. [CrossRef]
63. Feldman, M.S.; Orlikowski, W.J. Theorizing practice and practicing theory. *Organ. Sci.* **2011**, *22*, 1240–1253. [CrossRef]
64. Gosden, C. What do objects want? *J. Archaeol. Method Theory* **2005**, *12*, 193–211. [CrossRef]

65. Bøhler, K.K.; Giannoumis, G.A. Technologies for active citizenship and the agency of objects. In *Understanding the Lived Experiences of Persons with Disabilities in Nine Countries*; Routledge: London, UK, 2017; pp. 192–207.
66. Yanow, D.; Garud, R.; Simpson, B.; Langley, A.; Tsoukas, H. *After mastery. The Emergence of Novelty in Organizations*; OUP Oxford: Oxford, UK, 2015; pp. 272–317.
67. Strati, A. Sensible knowledge and practice-based learning. *Manag. Learn.* **2007**, *38*, 61–77. [CrossRef]
68. Radoff, J. The Metaverse Value-Chain. Available online: https://medium.com/building-the-metaverse/the-metaverse-value-chain-afcf9e09e3a7 (accessed on 31 January 2022).
69. Jovanović, A.; Milosavljević, A. VoRtex Metaverse platform for gamified collaborative learning. *Electronics* **2022**, *11*, 317. [CrossRef]
70. Duan, H.; Li, J.; Fan, S.; Lin, Z.; Wu, X.; Cai, W. Metaverse for social good: A university campus prototype. In Proceedings of the 29th ACM International Conference on Multimedia, Chengdu, China, 20 October 2021; pp. 153–161.
71. Wang, M.; Yu, H.; Bell, Z.; Chu, X. Constructing an Edu-Metaverse Ecosystem: A New and Innovative Framework. *IEEE Trans. Learn. Technol.* **2022**, *15*, 685–696. [CrossRef]
72. Butterfield, E.C.; Nelson, G.D. Theory and practice of teaching for transfer. *Educ. Technol. Res. Dev.* **1989**, *37*, 5–38. [CrossRef]
73. Brandt, B.L. Cognitive learning theory and continuing health professions education. *J. Contin. Educ. Health Prof.* **1996**, *16*, 197–202. [CrossRef]
74. Akella, D. A learner-centric model of learning organizations. *Learn. Organ.* **2020**, *28*, 71–83. [CrossRef]
75. Cuzzolin, F.; Morelli, A.; Cirstea, B.; Sahakian, B.J. Knowing me, knowing you: Theory of mind in AI. *Psychol. Med.* **2020**, *50*, 1057–1061. [CrossRef] [PubMed]
76. University of Montana. EITA Policies and Procedures. Available online: https://www.umt.edu/accessibility/implementation/policy/default.php (accessed on 15 June 2022).
77. Gargiulo, R.M.; Metcalf, D. *Teaching in Today's Inclusive Classrooms: A Universal Design for Learning Approach*; Cengage Learning: Boston, MA, USA, 2022.
78. Bong, W.K.; Chen, W. Increasing faculty's competence in digital accessibility for inclusive education: A systematic literature review. *Int. J. Incl. Educ.* **2021**, 1–17. [CrossRef]
79. Bodily, R.; Leary, H.; West, R.E. Research trends in instructional design and technology journals. *Br. J. Educ. Technol.* **2019**, *50*, 64–79. [CrossRef]
80. Anthology. Comparing Global University Mindsets and Student Expectations: Closing the Gap to Create the Ideal Learner Experience. Available online: https://www.anthology.com/sites/default/files/2022-06/UNESCO-Anthology-Whitepaper-v1.5.pdf (accessed on 2 December 2022).
81. Schmidt, M.; Huang, R. Defining learning experience design: Voices from the field of learning design & technology. *TechTrends* **2022**, *66*, 141–158.
82. Ensmann, S.Y.; Eggers, P.; Bing, B.; Li, L. Design of learning experience to engage learning in instructional design and technology graduate-level classes: Digital game-based learning (DGBL) cases. In *Learning: Design, Engagement and Definition*; Springer: Cham, Switzerland, 2021; pp. 147–166.
83. Fernandez, C.B.; Hui, P. Life, the Metaverse and Everything: An Overview of Privacy, Ethics, and Governance in Metaverse. *arXiv* **2022**, arXiv:2204.01480.
84. Ma, L.; Yang, Z.; Yang, W.; Yang, H.; Lao, Q. Study on the Organization and Governance of Bigdata for Lifelong Education. In Proceedings of the International Conference on Smart Computing and Communication, New York, NY, USA, 29–31 December 2021; Springer: Cham, Switzerland, 2021; pp. 493–500.
85. Williamson, B.; Gulson, K.N.; Perrotta, C.; Witzenberger, K. Amazon and the new global connective architectures of education governance. *Harv. Educ. Rev.* **2022**, *92*, 231–256. [CrossRef]
86. Decuypere, M.; Grimaldi, E.; Landri, P. Introduction: Critical studies of digital education platforms. *Crit. Stud. Educ.* **2021**, *62*, 1–16. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.