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From Metastudies to Metaverse: Disrupting the University

Ray Gallon, Dr. Neus Lorenzo (The Transformation Society)

Abstract: The authors believe that the metaverse is a paradigm shift infrastructure technology that may make 60% of universities irrelevant in the next 20 years if they do not move away from the metastudies model. The metastudies model is an archival, largely paper-based process of "teaching" what other people have written about. The metastudies model is focused on the past and supported by the publish-or-perish imperative. Although the COVID-19 pandemic has forced universities to adopt technologies that form a part of the metaverse, universities have mostly used these technologies to perpetuate the status quo. Universities need to change their practices and become more agile, adopting design thinking, inquiring minds, and critical thinking both for students and for themselves as institutions. If they do not, commercial entities such as Meta and Microsoft will decide what education takes place in the metaverse. If that happens, students will go to those commercial entities to learn, whether universities are present or not. It is therefore important that universities change their paradigms and engage with this technology. By doing so, they will discover how metaverse can be used effectively in education to foster principles and values for building knowledge and cementing practices that are ethical and sustainable.

Keywords: university, metaverse, virtual reality, augmented reality, learning, teaching, education, Covid, ethics, sustainability

Des méta-études aux métavers : le grand bouleversement de l'université

Résumé : Les auteurs pensent que le métavers est une technologie d'infrastructure de changement de paradigme qui pourrait rendre 60% des universités non pertinentes dans les 20 prochaines années si elles ne s'éloignent pas du modèle des méta-études. Le modèle des méta-études est un processus d'archivage, largement basé sur le papier, qui consiste à "enseigner" ce qui a été écrit par d'autres personnes. Ce modèle est orienté vers le passé et soutenu par l'impératif "publier ou périr". Bien que la pandémie de COVID-19 ait forcé les universités à adopter des technologies qui font partie du Métavers, les universités ont surtout utilisé ces technologies pour perpétuer le statu quo. Les universités doivent changer leurs pratiques et devenir plus flexibles, en développant le design thinking, le questionnement et l'esprit critique, tant pour les étudiants que pour elles-mêmes en tant qu'institutions. Si elles ne le font pas, des entités commerciales telles que Meta et Microsoft décideront de l'enseignement dispensé dans le métavers. Si cela se produit, les étudiants iront vers ces entités commerciales pour apprendre, que les universités soient présentes ou non. Il est donc important que les universités changent leurs paradigmes et adoptent cette technologie. Ce faisant, elles découvriront comment le métavers peut être utilisé efficacement dans l'éducation pour favoriser les principes et les valeurs permettant de construire des connaissances et de cimenter des pratiques éthiques et pérennes.

Mots-clés : université, métavers, réalité virtuelle, réalité augmentée, apprentissage, enseignement, éducation, Covid, éthique, pérennité

Introduction

This paper is based on the premise that the metaverse represents a sharp paradigm shift that may make 60% of universities irrelevant in the next 20 years. Professional learning outside of regulated professions (such as medicine, law, and accounting) will become mostly non-formal or informal and will happen inside the metaverse. Universities are not prepared for this.

Metastudies

The authors use the term *metastudies* to refer to common university teaching practices and processes based on someone "teaching" what others have written about. The orientation of this approach remains archival despite some modernizations. In other words, metastudies are built around what was important in the past (Lorenzo & Gallon, 2014). The well-known "publish or perish" model for academic success remains essentially a paper-based paradigm, despite the advent of electronic publishing, online indexing, and the like. It is a system that generates multiple academic and economic inequities, for example:

- The peer-review system is time-consuming and does not always guarantee quality. But journals and publishers offering fast publication are often criticized for lack of rigour and low standards.
- Academic publishing functions on a model in which creators of intellectual property cede rights to their original work without payment, and sometimes even must pay to be published, especially for open access. The only other area of publishing in which this exists is so-called "vanity" publishing. This situation is accepted because of the "publish or perish" imperative. Reviewers also work without compensation, while "Scientific publishers routinely report profit

margins approaching 40% on their operations, at a time when the rest of the publishing industry is in an existential crisis" (The Guardian, 2019). Schemes such as Diamond Open Access solve some of these problems but fail to address the concept of remuneration for intellectual work by authors and reviewers.

- Professors are vetted for subject-matter expertise, but not for their pedagogical skills, knowledge, or ability.
- Many universities are plagued by internecine conflicts such as often happen between "professionalized" disciplines (such as media, performing arts, journalism, and communication), as compared to "noble" disciplines (such as literature, social sciences, philosophy, and mathematics).
- The advent of systems like ORCID, Web of Science, and others fosters the gamification of reputation and academic status based on citation indexes. As a result, works may be cited but rarely read, and content may be treated as less important than publicity. One French teachers' union has called this bibliométrie (Syndicat national de l'enseignement supérieur, 2022). Because these systems are put in place and controlled by academic publishers, they rarely include true open-access journals.

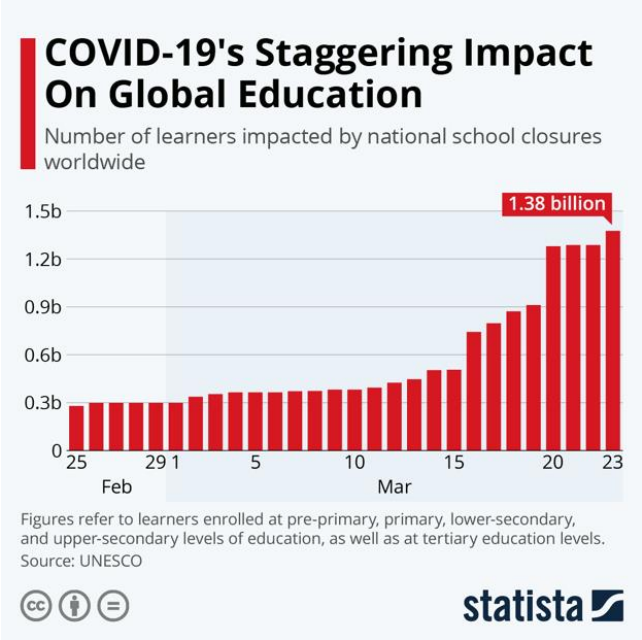
The COVID-19 Wake-Up Call

The COVID-19 pandemic that began in 2019 and continued as this article was being written represents a global event. The COVID-19 virus will target everyone equally. However, differences in economics, culture, language, and access to technology have created vastly unequal access to learning at all levels during the pandemic. Clearly, educators were not prepared for the pandemic, and the scramble to create distance learning alternatives almost overnight often meant a direct transference of lecture courses from the amphitheatre to screens of various shapes and sizes in people's homes. But this

assumes that homes are equipped with screens. UNESCO data for 2020 show an exploding impact of the virus on education throughout the world (see Figure 1). In many places, children have simply stopped their education.

Figure 1

Impact of School Closures Due to COVID-19 on Global Education in 2020



Note. Covid-19's Staggering Impact on Global Education by McCarthy (2020). [Long description]

UNESCO also anticipates that 30% of girls affected by school closures, which is about 11 million girls, will not return to school (UNESCO, 2020, as cited in McCarthy, 2020).

If children are not being educated, who will populate the student benches of our universities in the next decades? What jobs will the people who are not being educated be able to hold? Where will leadership come from?

Even where equipment and bandwidth are available, the impact of the pandemic on collectives is only now being understood. Competition for limited screen access

between remote-working parents and remote-schooled children has readjusted family dynamics. We must ask ourselves what happens to community relationships and solidarity when the strongest connections we have are online, rather than face-to-face?

We are confronted with a demographic crisis in higher education and a crisis in the world at large over knowledge and leadership because of the situation caused by the pandemic. How will new leaders be trained? Who will step in to fill the gaps?

From Internet to Metaverse

The internet began as a U.S. multi-university network for defence research, became generalized to the public in the late 1980s, and developed into the World Wide Web. Since its origins, the story of the internet has been one of infrastructure development. In the same way that the Web was built on top of existing protocols, metaverse technologies are now being built on top of today's structures. The resulting infrastructure development will become part of the daily activity of millions of people. The technological impact, once metaverse technologies are widespread, promises to be at least as great as that caused by the advent of the Web. The social impact of metaverse could be of an even greater magnitude.

What Is the Metaverse?

The term metaverse was first used by author Neal Stephenson in his 1992 novel, *Snow Crash* (Stephenson, 2008). The metaverse is defined as "A collective virtual open space, created by the convergence of virtually enhanced physical and digital reality" (Gupta, 2022). Some of the most important characteristics of the metaverse are:

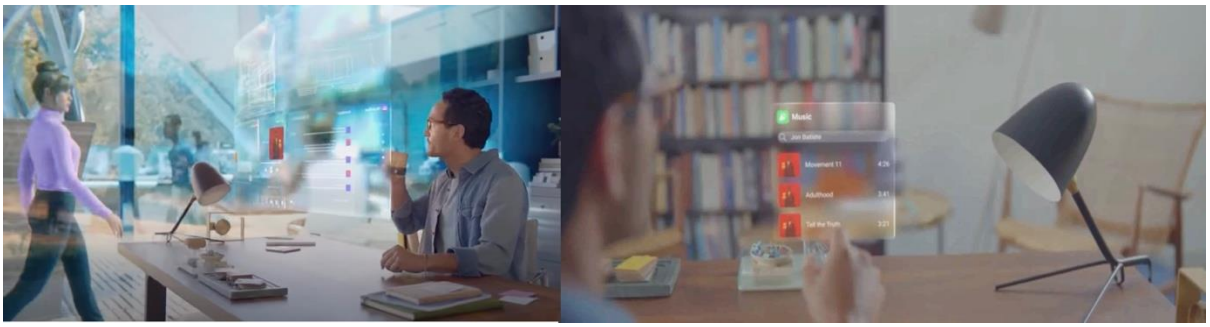
- It is physically persistent; it is an infrastructure technology.
- It is always active; it exists in real-time, all the time.
- It is immersive, but participants have individual agency.

- It represents and fosters an independent, virtual economy.
- It crosses multiple technological platforms, even crosses into physical reality.
- It allows and encourages user-generated content (Gupta, 2022; Sinelnikov, 2022).

Perhaps the most important characteristic of the metaverse is its ability to seamlessly integrate physical and digital realities. For example, the CEO of Meta (formerly named Facebook), Mark Zuckerberg, suggests that in the future we will be working from home often, but our home work environment will be totally integrated with a distant office (Zuckerberg, 2021). We will routinely work through our digital twin, an exact replica of ourself in virtual space. The home-office worker will gain access to their digital twin in a distant office space by donning a pair of glasses. Real people in the office will presumably be able to see the remote worker's digital twin in their home (or as much of their home as they want to share), and wave as they walk by. This seems like a nice gadget, and Mr. Zuckerberg does not predict how many people will actually be in the distant office. But the social implications of having that kind of free interaction with distant colleagues could change our ideas about remote working in significant ways. In the metaverse, workers also have access to dematerialized data, which they can grab with their fingers and manipulate or display in different ways on their heads-up displays. This is currently available via glasses and may soon be available using contact lenses (Mojo Vision, 2022). The two frames in Figure 2 show how the shared digital/physical environment might look, and provide a glimpse at direct data manipulation.

Figure 2

Two Frames from Mark Zuckerberg's 2021 Presentation About the Metaverse



Note. Work in the Metaverse — Still-Frame Image from Meta (2021)

Metaverse Infrastructure Versus Metaverse Technologies

It is important to clearly separate the metaverse infrastructure from the technologies it includes. The metaverse as an infrastructure does not exist today, but the technologies it needs certainly do, and some of these technologies have existed for a while. But none of these technologies, or even combinations of them, are enough to constitute a metaverse (Amy Webb, as cited in Brown, 2022).

Technologies metaverse draws on include:

- Virtual reality (VR)
- Augmented reality (AR)
- Internet of things (IoT)
- Artificial intelligence (AR)
- Computer-assisted meetings such as Zoom and Teams
- Wearable technology
- Implantable technology
- Telecommunications of different types and technologies

It is the ubiquity and persistence of the meta-infrastructure supporting these technologies that provide the distinct, immersive experience that we are calling the metaverse. No matter how immersive an isolated experience of a particular technology might be (such as the VR available today), the experience is only a component of the metaverse. People often point to Second Life, one of the oldest VR worlds in existence, as a paradigm for the metaverse (Brown, 2022), but it is not. Second Life is a site, or a virtual place people log onto so they can initiate interactions. The same distinction applies to immersive gaming environments such as Roblox or Fortnight. The metaverse will never be a distinct virtual or physical place; it will be a larger environment. The metaverse will be ubiquitous, immersive, and pervasive. The security of the metaverse will be provided by another infrastructure technology such as blockchain or some other technology that eventually replaces it. The universal deployment of the technological infrastructures underpinning this meta-infrastructure will take many years. However, corners of the metaverse will start to appear much sooner than many of us imagine, and this will inevitably raise questions of equity of access.

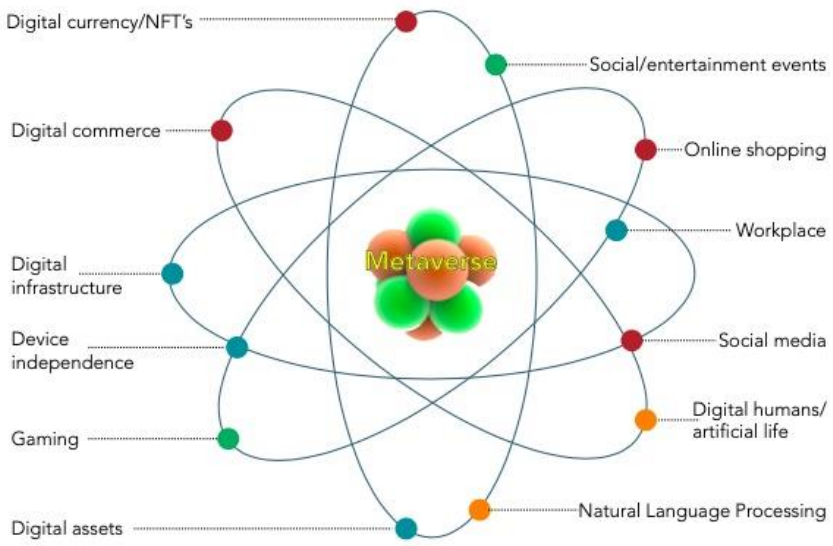
Nicol Turner Lee et al. (2022) point to the lack of equipment due to underfunding in Minority Serving Institutions (MSIs) in the U.S. The student populations served by these underfunded institutions also often lack the means to obtain equipment at home. There is widespread concern that the digital divide will be exacerbated as the metaverse develops, because of the high-entry cost of technological infrastructure. This is true despite some innovative projects developed at MSIs.

The Metaverse in Society

The metaverse creates new synergies and actively builds new socioeconomic contexts. Figure 3 shows one view of economic, social, and technological elements that will interwork in this new space.

Figure 3

Technologies, Concepts, Activities, and Interactions in the Metaverse



Note. Adapted from Gupta (2022). [Long description]

As an infrastructure, the metaverse also generates concern in some circles. James Muldoon (2021), working at the University of Exeter, states, "The end goal for Meta is that it is no longer a service you use, but instead, the infrastructure upon which you live." He is concerned that Meta would own not only users' data, but the servers where that data is housed, giving Meta a monopoly and opening opportunities for major abuse of confidence and violation of privacy. Still more disturbing is the Chinese military's interest in creating "cognitive warfare" inside the metaverse (Baughman, 2022). Chinese military researchers have described the metaverse as a "physical internet where you don't just watch content; you're a whole person in it" (Dai & Xiong, 2021, as cited in Baughman, 2022). On a psychological level, we might well question, if everyone has their personal version of the metaverse, will we have any shared common reality? There is some indication, as well, of a link between using immersive environments and developing psychoses and delusional tendencies (Reed, 2021).

In summary, we can view the metaverse as an internet of virtual worlds, in which simultaneous layers of objects and relations intermingle seamlessly without regard to their origins as physical or digital objects. This infrastructure offers opportunities to enhance our lives, but risks widening the digital divide. It also opens us to new risks, many of which are still unknown.

The Metaverse and the University

Almost since the beginning of universities, the typical metastudies model has been presentation-practice-production (Lorenzo Galés & Gallon, 2019). Presentation can happen with a professor's lecture, students reading texts, or a combination of both. After the presentation, students practise until they can produce evaluable results, and the professor evaluates their performance. Although methodology has evolved somewhat to include more student agency, this basic linear throughput model continues to dominate most universities and is reaching the limits of its usefulness as our daily lives become more and more fragmented. When the metaverse is installed as an infrastructure, it will not be a place that we go. It will be all around us all the time. We will see people interacting with virtual agents and objects that we may never be able to actually observe in the real world. Conversely, people will see us as virtual agents doing things they may never be able to observe in the world. The perceptual and cognitive challenges of this kind of environment are difficult to imagine at this moment. However, the authors believe traditional linear structures will no longer be adapted to any level of education, including what we now think of as university studies. A lot of learning will take place through informal or non-formal processes, simply because these processes will present themselves at the moment information or skills are needed. Formal training will still be required for regulated professions such as physicians, lawyers, accountants, and airline pilots. A lot of the formal training will also take place in the metaverse.

Imagine, for example, an exact digital replica in virtual space (known as a "digital twin") of a patient being made available for direct manipulation by medical students. Add to this the potential to bring virtual avatars of distant experts and specialists into the same mixed (digital and physical) learning environment. Professors, students, experts and assistants all collaborate with equal ease, regardless of whether their presence is physical or virtual. Identities, authenticity, and integrity of data used during such sessions could be ensured using blockchain technology. This could make useful learning information more widely available, so that more medical students could benefit from the experience (Marr, 2022). We can extend this paradigm to actual medical procedures. For example, surgeons could observe and act on a digital model of the exact organ of the exact patient they are treating, before physically operating on the real patient. Similar digital twinning operations can be envisioned for mechanical or chemical engineering fields (Kang et al., 2021), or for working with radioactive materials (Hatch & Kemp Spangler, 2022).

Are Universities Ready?

The real question is: Will universities be prepared to engage with this new infrastructure in a timely and agile fashion? A policy brief by the Brookings Institution (Hirsh-Pasek et al., 2022) reminds us that when mobile apps first started flooding the market around 2007, apps labelled educational had no input from real educators, and evaluations of these apps showed them to be poorly adapted to learning. Hirsh-Pasek et al. claim that despite best efforts, input from educational experts has never been able to catch up, with disastrous results:

> *When education lags the digital leaps, the technology rather than educators defines what counts as educational opportunity… Today, as the metaverse infrastructure is still under construction, researchers, educators, policymakers, and digital designers have a chance to lead the way rather than get caught in the undertow* (Hirsh-Pasek et al., 2022, p. 1).

Being prepared for the metaverse will require universities to accept a major change in their mindset toward what the authors have previously identified as *educational agility* (Lorenzo Galés & Gallon, 2019). Steve Newhall, executive director of Korn Ferry consultancy, identified five characteristics of educational agility:

- *Mental Agility – How comfortable are they [learners] in dealing with complexity?*
- *People Agility – Are they skilled communicators who can work with diverse people?*
- *Change Agility – Do they like to experiment? Are they not afraid to be at the forefront of change?*
- *Results Agility – Can they deliver results in first-time situations?*
- *Self-Awareness – Do they recognise their own strengths and weaknesses?* (Cited in IEDP, 2014)

These characteristics need to be applied to educational institutions, especially universities, and not just students. Indeed, if we believe in the propagation of learning organizations, should we not consider our universities to also be learners?

Hirsch-Pasek et al. (2022) developed a list of principles for educational app development that applies equally in the metaverse. The principles were aimed at apps for children, but they apply equally well to adult learners:

- *Learning should be active, not passive, and… [learners] learn best in environments that are "minds-on..." A simple swipe [does] not count as an "active" move.*
- *The app should be engaging rather than distracting and only include bells and whistles that are integrated into the narrative of the game, lesson, or storyline. Many of the apps on the market interrupt the storyline with a chance to probe [something else] and/or include persuasive ads that pop up to distract [learners] to buy a different app.*

- *The app should tap into something meaningful for the [learner]. There should be some point of connection that will allow [learners] to relate the content of the app to what they know, rather than to start de novo in a foreign space.*
- *…the app should encourage social interaction inside or outside of the app space, not just playing solo.*
- *Learning should be iterative, such that an app would encourage [learners] to achieve a learning goal through a number of different pathways or allow for a similar but slightly different experience on each encounter.*
- *Lastly, the experience should also be joyful.* (Adapted from Hirsh-Pasek et al., 2022, p. 4)

The above principles for educational app development correspond with the principles of agile universities adapted by the authors from Steve Peha's twelve principles of agile schools (2011). The principles of agile universities include:

- *Flexible itineraries and fluid curricula to respond confidently to change and unexpected situations in the future.*
- *Participation in decision-making processes… to develop self-agency.*
- *Self-engagement and continuous development of sustainable lifelong learning processes.*
- *Emphasis on self-imposed high standards, critical thinking, and creative analysis of continuous possibilities for rigorous improvement of technical quality.*
- *Participation in teams and groups that self-organize to implement simple, creative responses and sustainable innovative solutions.*
- *Development of inquiring minds by participating in regular collaborative self-evaluation sessions in order to propose improvement.* (Lorenzo Galés & Gallon, 2019, pp. 101–102).

Responses to date from universities seem to indicate that even though the COVID-19 pandemic has forced them to think about metaverse technologies and issues, rather than inspiring innovation and agility, institutional inertia has prevailed.

What Some Universities Are Doing

This informal survey by the authors does not pretend to give the full story. It presents some initiatives that show promise or interest, but do not yet, for the most part, go far enough in the directions advocated in this paper.

A Pre-COVID-19 Initiative

Despite earlier comments about Second Life not being a paradigm of the metaverse, some applications developed in Second Life might presage how a persistent, pervasive metaverse could help the teaching and learning experience. Tahani Aldosemani, in her 2014 research, used Second Life to create a *third place*, as defined by sociologist Ray Oldenberg (1989, cited in Aldosemani, 2014, p. 22). Dr. Aldosemani organised a café-like informal, public, neutral, and inclusive space in Second Life to facilitate contact between American students and Saudi English language learners studying in the U.S. The Saudi students often felt separated from their U.S. counterparts because of dress and differing social customs, and were often afraid to make contact. The café-style space established in Second Life offered a safe environment for social encounters, conversation, and mutual understanding. The American students in the space were chosen for their interest in learning about other cultures.

A third place in the metaverse would provide a much more accessible environment in which such encounters could take place, assuming that the problem of access for all had been resolved.

Reactivity

The Virbela (https://www.virbela.com) company produces software designed to facilitate remote working, meeting, and learning. They teamed up with the Rady School of Management at the University of California in San Diego (U.S.) to create a virtual campus during the COVID-19 epidemic. The project "replicate[d] the dynamics and design of their physical university in a virtual world" (Virbela, 2022). While this re-creation of physical space helps students, especially in finding social spaces in which to interact that are often lacking during a lockdown situation, it uses only a small fraction of the possibilities for enhancing learning inherent in the metaverse. Rather, this virtual campus attempts to maintain current teaching processes in a virtual space. It is interesting to note that when the authors searched the Rady School of Management website for information on the virtual campus project, they were unable to find even one article or mention.

Two locations using more interesting applications of Virbela software are El Tecnológico de Monterrey in Mexico and Davenport University in Michigan, U.S. At the El Tecnológico de Monterrey private technical university in Mexico, avatars in a virtual campus are used to unite students from 26 different physical sites. This system also permits rapid configuration of virtual classrooms for different types of learning and social situations. Again, the authors could find no references to this virtual campus on the university's website, but there is a YouTube video of testimonials from students and professors about the virtual campus (Mostla ITESM, 2021). Davenport University is a small multi-campus private university in the U.S. state of Michigan. Their "global" online campus includes devices intended to preserve a proactive campus culture, and incorporates mechanisms for signalling emotional states and interacting on multiple levels. Davenport has now integrated the global campus as one of its principal offerings (Davenport University, 2022).

All three of these examples show different levels of proactivity and engagement with metaverse technology, although they remain essentially attempts to maintain status quo from a pedagogical point of view.

More Proactive Applications

The city of Barcelona in Catalonia, Spain has become a centre of intense technological development and start-up activity, and the city is the host of the annual Mobile World Congress. As of September 2022, the city also boasts a Metaverse University, a private initiative of the Horizon Metaverse company and the Nubi. City software platform. Courses offered include blockchain, bitcoin, tokenization, non-fungible tokens (NFT), metaverse, and technologies for legal professions. Lex Moga, the founder of this initiative, has stated that only 6% of young adults are interested in attending a "normal university" (the source of this figure is not given), and that a university diploma does not guarantee a decent job. He states that Metaverse University is open to all people between 18 and 54 years of age who "need to adapt themselves to the digital transformation" (Noticia Cripto, 2022). Training to be offered at the Metaverse University ranges from micro-credentials that take one week to complete, to masters that take four months. The university anticipates matriculating 460 students per month and a profit of more than one million euros in the first year (Noticia Cripto, 2022).

This is a perfect example of a for-profit initiative trying to circumvent the traditional university system. What we don't know about this effort is whether it is based on sound pedagogical principles, and what ethical standards are imparted as part of its teaching. We do know that its founder plans to expand the idea to other cities in Spain and other European countries.

Stanford University in California, U.S. has initiated the first class in the world about VR that actually takes place in metaverse technology. The class covers VR technology, its influence in society, and its use cases. It has drawn students from diverse disciplines including economics, political science, communication, anthropology, biology, computer science, film and media studies, comparative literature, art practice, psychology, and sociology. In 2021, students using head-mounted displays shared 3,500 hours in the metaverse, exploring the technology and its implications. "Nobody [else] has networked hundreds of students with VR headsets for months at a time in the history of virtual reality, or even in the history of teaching," says Dr. Jeremy Bailenson, who teaches the course (IBL News, 2022).

Here we have a case in which a traditional university took initiative and initiated a study on how metaverse technologies can be effectively used in educational settings. The study is carried out by Stanford's Virtual Human Interaction Lab, and relies on Dr. Bailenson's 20 years of experience teaching about VR.

In contrast to Stanford University, which is a well-funded private university, Arizona State University is a public MSI. Arizona State University has partnered with the Dreamscape VR entertainment company to develop a nine-module zoo simulation for biology lab students. The university reports that this program produced higher engagement among students, with 15% of students in the program earning higher grades. Arizona State University students are now creating new VR learning experiences across disciplines. For example, engineering and art students are collaborating to create new environments. Arizona State University is also helping many local community colleges with smaller budgets do the same (Turner Lee et al., 2022).

Concluding Discussion

The challenge for institutions of higher learning is to turn away from modern, gamified versions of "publish or perish," and foster a spirit of design thinking, inquiring minds, and critical thinking amongst ourselves as pedagogues and researchers. Only then, can we genuinely communicate that spirit to our students. As the Brookings Institution policy paper states:

> *Make no mistake that the metaverse is coming. It is our job to specify how engagement in this always-on, virtual universe augments education rather than detracts from it and how it can preserve the key socially interactive qualities that are core to how humans learn* (Hirsh-Pasek et al., 2022, p. 2).

We also have an obligation to present alternative models to the one being promoted by large commercial interests such as Meta and Microsoft. The university, as a centre for new thinking and serious reflection, must lead the way towards understanding the new context the metaverse brings. Within that context, we must do our maximum to foster principles and values that are essential to building knowledge and cementing ethical, sustainable practices, as identified in a UNESCO report:

- *Awareness, adaptability, agility to adapt*
- *Innovation empowerment, social justice*
- *Productivity sustainability, efficiency*
- *Justice, democracy, good governance*
- *Social cohesion, equity and inclusion, citizenship*
- *Domain specialisation, human resources, human capital*
- *Functional literacy, digital society, health, and well-being* (Marope et al., 2017, pp. 31–34)

If we cannot do this, we will miss out on the opportunities metaverse has to offer, but our students will not. They will be immersed in it, and they will explore and learn guided by whatever and whomever they encounter there.

Long Description of Figure 1

Impact of School Closures Due to COVID-19 on Global Education in 2020

Bar graph: At the end of March 2020, 1.38 billion learners were already impacted by national school closures, worldwide. Figure refers to learners enrolled at pre-primary, primary, lower-secondary, and upper- secondary levels of education, as well as at tertiary education levels. Data source from UNESCO. [Back to Figure 1]

Long Description of Figure 3

Technologies, Concepts, Activities, and Interactions in the Metaverse

An atomic model of the metaverse as the nucleus, with several electrons orbiting around the nucleus. The electrons in this model represent the many potential facets or uses of the metaverse, including:

- Social/ entertainment events
- Online shopping
- Workplace
- Social media
- Digital humans/ artificial life
- Natural Language Processing
- Digital assets
- Gaming
- Device independence
- Digital infrastructure
- Digital commerce
- Digital currency/ NFT's

[Back to Figure 3]

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Authors

Ray Gallon is president and co-founder of the Transformation Society, which develops strategies for humanist digital transformation and organizational learning, and researches the theory and practice of smart pedagogies. He teaches at the Universitat de Barcelona (Spain) and the Université de Strasbourg (France). For over 50 years, Ray has worked as a communicator, educator and trainer in fields ranging from radio production and journalism to technical communication, to management training and consulting.

Ray is a fellow of the Society for Technical Communication (STC), on whose board he has also served, and was a co-founder and former president of The Information 4.0 Consortium. He serves as co-chair of the Transformation and Information 4.0 Research and Development Group of the World Federation of Associations for Teacher Education, and is a frequent speaker and keynoter on communications topics at conferences and seminars around the world. He has contributed to numerous books, journals, and magazines, and is the editor of *The Language of Technical Communication* (XML Press). In 2022, Ray received an Award of Merit for Instructional Design from the Canadian Network for Innovation in Education. Email: ray@transformationsociety.net

Dr. Neus Lorenzo is co-founder of the Transformation Society, and vice-president for research of the Catalan Pedagogical Society (Societat Catalana de Pedagogia) at the Institute of Catalan Studies (Institut d'Estudis Catalans). She teaches in the Education Faculty of the University of Andorra, and is the co-chair of the Transformation and Information 4.0 Research and Development Group of the World Federation of Associations for Teacher Education. She is a former inspector of education in Barcelona (Spain), and has held many positions in the Catalan Education Ministry, including Subdirector General for Educational Transformation, Subdirector General for Support and Attention to Diversity, Head of the Language Service and Head of the Foreign Language Service.

Neus has worked as a training advisor with the Council of Europe, the Anna Lindh Foundation, Fundación Telefónica (Spain), Fundació Bofill (Catalonia), and at the Inspectorate of Education in the Generalitat de Catalunya (Catalan Government). She has also represented the Spanish autonomies before the education committee of regions at the European Parliament. She is an author and co-author of educational material and textbooks for Oxford University Press, Richmond-Santillana, Oceano, the Organization for Economic Co-operation and Development, and McGraw Hill. She is also an author and co-author of articles published by Springer, IGI-Global, and Cambridge Scholars Publishing, among others. Email: neus@transformationsociety.net