ISSN 2288-4866 (Print)
ISSN 2288-4882 (Online)
https://www.jiisonline.org
J Intell Inform Syst 2023 March: 29(1): 175~201 http://dx.doi.org/10.13088/jiis.2023.29.1.175

Inclusive educational effectiveness through Metaverse for the disabled students and policy suggestions*

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In the midst of going through a non-face-to-face society, most of human activities narrowed down to the platform, restrictions on external activities are bringing the internal scalability of digital technology. Metaverse is virtually shifting reality and increasing the possibility of utilization in various areas. However, researches linked to the educational effects of metaverse, especially students with disabilities, are still an unknown area that lacks exploration. This paper focuses on the fact that metaverse-education is widening educational fields that meets the various needs of disabled students to realize social good and inclusive education, and communication effects such as resolving barriers to interaction are prominent. As a research method, examining literature research papers linked to AR/VR, metaverse with communication skills, interviews, articles, and columns by experts, and policy suggestions and implications for the special education was conducted. Although the limitations of research are confirmed, significant results are found on inclusive education, which provides educational maximizing effects and realizing human rights through direct immersive experience reflecting the Cone of Experience Theory. Hopefully follow-up studies on meta-edu for disabled students will be carried out in the future, and various interdisciplinary discussions are needed to carefully observe inclusive policies and benefits so that the socially vulnerable are not excluded from technologies in ICT society.

Key Words : communication, metaverse, special education, inclusiveness, social good

Received : November 14, 2022 Revised : December 11, 2022 Accepted : January 1, 2023
Publication Type : 학술대회 Fast Track Corresponding Author : Jinsoon Song

1. Introduction

UNESCO (2021) says that the 2030 agenda for sustainable development is inclusive educational practice, which focuses on ensuring that no one falls behind and provides special opportunities to create a more inclusive and fair society. Sustainable Educational Development is a lifelong learning process that respects cultural diversity, enables informed decision-making, responsible behavior with knowledge, skills, values, and attitudes for a fair society that empowers environmental integrity and economic viability for the future generations. It is the important agenda to implement policies of

* This is the paper funded by academic support from Dong-A University.

inclusive education to reduce alienation and exclusion of students with different learning preferences in an educational system that meets their needs. Special education reaches the comprehensive concept for the handicapped, especially who are unable to adapt to existing education systems due to a variety of physical, psychological or emotional problems. Each child should be guaranteed the right to be educated according to individual learning needs (Lindsay, 2018). The Ministry of Education in Korea revealed "2022 Revised Curriculum" that will promote the vision of realizing inclusive education that encompasses all and fostering self-directed innovative talents with future capabilities. The education that supports students' individuality and diversity and develops the ability to respond more flexibly to the rapidly changing social environment will become more important in the future(Korea Policy Briefing, 2022).

Advances in ICT have expanded their educational scope to e-learning through various online platforms (Lin et al., 2015) and provided various learning experiences in various ways like ubiquitous learning (u-learning), augmented reality(AR), virtual reality (VR), mobile learning(m-learning) and gamification. Similarly, the importance of human-robot interaction (HRI) and the interaction between humans and robots may appear in a direction which robots affect human cognition, or on the contrary, human cognitive changes affect robot control(Lee & park, 2021). Moreover, those are more frequently used in the special education(Autism, or Asperger, ADHD syndrome etc.) who are primarily disabled or require a variety of teaching methods (Lin et al, 2015). In particular, AR can combine and superimpose real objects and virtual objects with information, and augmented information is not limited to vision but can be applied to all five senses(Azuma et al, 2011). Favoring a number of ways to engage students in various emotional expression means, AR can be a preferred developmental strategy in the inclusive curriculum, behaviors, and learning processes (Sheey et al, 2014). This thesis purposes the special education with AR/VR (one of the techniques of using Metaverse) is intended to be linked to the utilization aspect of metaverse for disabled students. Currently, researches on the use of metaverse in education for disabled students lack empirical data and are still in the process of introducing and constructing educational resources. In order to ensure understanding and validity of the subject of the thesis, knowledge of technologies, terminologies and devices, those will be sufficiently offered first before discussing research methods. Chapter 2 examines the concept and versitility of metaverse as a user interface for special education including interoperability, examines The Cone of Experience Theory which can explain the effectiveness of direct and immersive experience. In Chapter 3, the necessity of metaverse education(thererafter meta-edu) for the communicative aspects of D.N.A. and metaverse ecosystem is emphasized by citing literature researches, expert interviews, articles and columns, and the functional aspects of metaverse for realizing social good. Chapter 4 presents the limitations and implications of meta-edu. In Chapter 5 is on policy suggestions. The conclusion is in Chapter 6.

〈Table 1〉 Four Types of Metaverse Classified by ASF

Sortation	Augmented Reality	Lifelogging	Mirror World	Virtual Reality
Definition	An environment in which virtual 2D and 3D objects are superimposed in real space and interacted	Technology to capture, store, and share daily experiences and information about things and people	Reflects the real world, but integrates and delivers external environment information	A Virtual World Built with Digital Data
Characteristics	Leverage location-based technologies and networks to create a smart environment	Use augmented technology to record information about objects and people	Leverage virtual maps, modeling, and GPS technology	Based on the interaction activities between avatars in which the user's ego is projected
Field of application	Smartphone, HUD for vehicle	Wearables, devices, black boxes	Map-based services	Online multiplayer games
Use Cases	Pokémon GO, Digital Textbook, Realistic Content	Facebook, Instagram, Apple Watch, Samsung Health, Nike Plus	Google Earth, Google Maps, Naver Maps, Airbnb	Second Life, Minecraft, Roblox, zepetto

2. User Interface for Disabled Students: Metaverse

2.1. Definition and Utilization

Metaverse is a newly coined word that combines the Greek prefix meta and universe, and is a higher concept of virtual reality and augmented reality, a system that extends reality to a digital-based virtual world to enable all activities in virtual spaces (Wiki). Adapted from Ernest Cline's 2011 novel and inspired by Neil Stephenson's 1992 science fiction novel Snow Crash, Metaverse is a place where players interact with other players representing avatars and experiences. The metaverse is that the sense of reality of the virtual space is maximized. This sense of reality is established by stimulating the brain of users in the physical real world. An important characteristic of virtual space lies in the spatialization of the imagined, which makes people believe that human imagination is real, that is, a virtual space. The Acceleration Studies Foundation(ASF), a non-profit technology research group that first presented metaverse classification criteria, classified metaverse according to whether the service target is person-centered or environment-centered by creating four types: AR, Lifelogging, Mirror Worlds, and Virtual Worlds(see table 1).

Taking this interaction further than immersion with 4 types above is combingother advanced technologies such as the blockchain, Web 3.0 and the next-gen internet technology. Those will provide solutions for governance, value transfer, digital evidence of ownership, and interoperability, to name a few. The Metaverse is the network of 3D virtual worlds where anybody anywhere can interact in real-time to form an internet economy that spans and links the digital and physical world. Think of the Metaverse as an internet that you are inside rather than one you are merely viewing

from the outside. In there you can be who you want to be, create what you want, where you want, for whom you want, and how you want. This complete freedom for creators will undoubtedly lead to some fascinating experiences for which the metaverse has the unique characteristics for like persistence, synchronicity, availibility, interoperability, economy, avarta etc(see Table 2).

2.2. Why is the metaverse importance : as the interoperability in AR/VR

The metaverse is a vision of what many in the computer industry believe is the next iteration of the internet such as a single, shared, immersive, persistent, 3D virtual space where humans experience life in ways they could not in the physical world. Some of the technologies that provide access to this virtual world, VR headsets and AR glasses, are evolving quickly. Other critical components of the metaverse, like an adequate bandwidth or interoperability standards, are probably years off or might never materialize. Management consultancy McKinsey & Company has bullishly predicted that the metaverse economy could reach $5 trillion by 2030. E-commerceis expected to be the dominant engine, with gaming, entertainment, education and marketing in the metaverse also becoming important sectors. Today, companies use the term to refer to many different types of enhanced online environments. These range from online video games like Fortnite to fledgling virtual workplaces like Microsoft's Mesh or Meta's Horizon Workrooms to virtual dressing rooms, virtul classrooms and virtual operating rooms. Rather than a single shared virtual space, the current version of the metaverse is shaping up as a multiverse: a multitude of metaverses with limited interoperability as companies jockey for position. The metaverse is a digital ecosystem built on various kinds of 3D technology, real-time collaboration software and blockchain-based decentralized finance tools. Factors like the degree of interoperability among virtual worlds, governance, data-portability, and user interfaces will depend on how the metaverse pans out. Lauren

〈Table 2〉 Metavers characteristics

characteristics	explanation
persistence	The metaverse continues to exist regardless of time and place. When users come back to metaverse, there is continuity rather than a reboot.
synchronicity	A consistent living experience that allows interactions between participants and the virtual environment in real-time.
availability	There will be no cap on concurrent users; hence everyone can be a part of metaverse.
interoperability	Allows users to use their digital assets and items across their metaverse experiences.
economy	Individuals and businesses will be able to invest, own, create and sell a wide range of goods and services in exchange for value recognized by other participants.

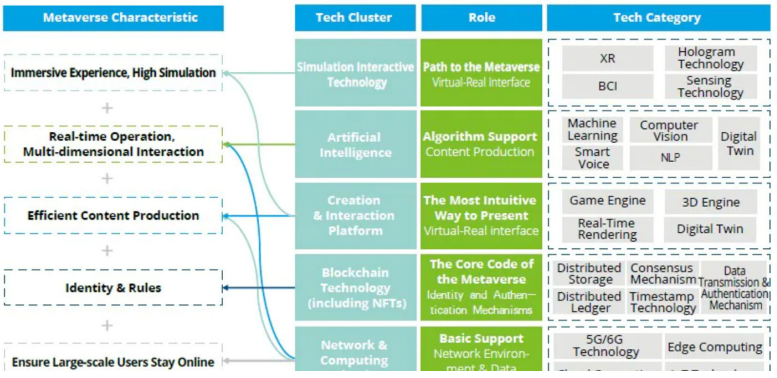
https://smartvalor.com/ko/news/virtual-platforms-and-the-metaverse

Lubetsky, senior manager at Bain & Company, speaking in a session on the metaverse at the 2022 MIT Platform Strategy Summit, outlined three possible scenarios: ① The metaverse remains a domain of niche applications, used by consumers for entertainment and gaming but stopping well short of an all-encompassing virtual reality. ② The metaverse is controlled by large competing ecosystems -- for example, Apple and Android meta worlds -- with limited interoperability. ③ The metaverse is a dynamic, open and interoperable space, much like the internet but in 3D(TechTarget, 2022).

Especially AR/VR technologies considered important to the development and growth of the metaverse(Figure 1). VR is a simulated 3D environment that enables users to interact with a virtual surrounding in a way that approximates reality as perceived through our senses. This approximation of reality is now typically accessed through a VR headset that takes over a user's field of vision. Haptics, including gloves, vests and even full-body tracking suits, enable more lifelike interaction with the virtual environment. AR is less immersive than VR. It adds digital overlays on top of the real world via a lens of some type. Users can still interact with their real-world environment. The game Pokémon Go is an early example of AR. Google Glass and heads-up displays in car windshields are well-known consumer AR products. Gartner senior principal analyst Tuong H. Nguyen told Lawton, adding that what we have now are precursors or pre-metaverse solutions. At present, many of the metaverse-like experiences offered by gaming platforms such as Roblox, Decentraland and Minecraft can be accessed through browsers or mobile devices and a fast internet connection (Techtarget, 2022)

2.3. Metaverse Education: The Cone of Experience Theory and XR+D.N.A

The difficulty of face-to-face communication due to the pandemic and the transition to an untact



〈Figure 1〉 Metaverse Technologies

https://www2.deloitte.com/cn/en/pages/technology-media-and-telecommunications/articles/metaverse-report.html

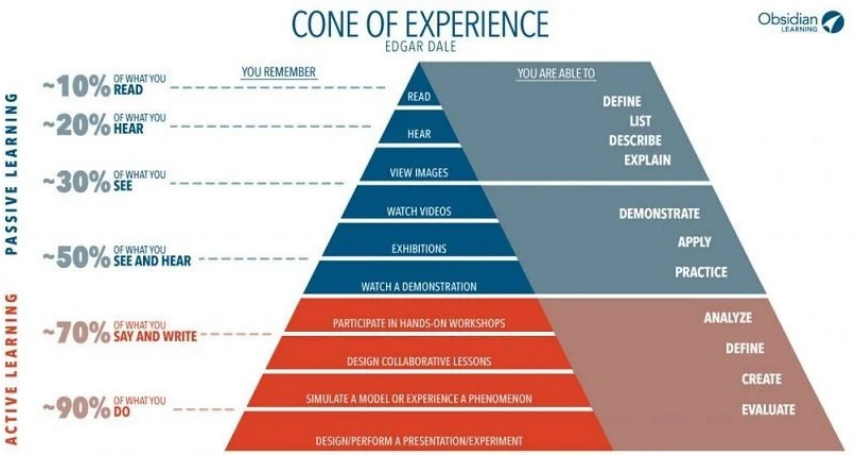
society are shifting to virtual world, and classes using metaverse based virtual spaces are drawing attention to the rapid expansion of non-face-to-face education. Virtual space utilizing special education can increase immersion and maximize learning effects with realistic technology as an alternative to overcoming the limitations of non-face-to-face remote education. Using your avatar, it is basic to take classes and ask questions in a virtual space. It is possible to create content directly with production tools and create a sense of realism with special effects as well(University Intelligence, 2021). Esther Ajao, TechTarget news writer, reported that enterprise applications of the metaverse is slow but close, that some hospitals are already using VR/AR to train for common medical procedures in. Enterprises are experimenting with metaverse applications in the workplace that deployed during the pandemic to support remote work. An early application of metaverse technologies involves workplace training. Especially Digital twin avatars will not only exist on computer screens but will be rendered as AI-powered holograms or holographic images that are assigned tasks. A CEO, for example, could activate an AI-powered hologram of himself to engage with multiple stakeholder groups at once. Moreover metaverse for work collaboration are starting to add an element of realism to remote work experiences. This includes setting up 3D rooms where employees can collaborate(Forrester, 2022).

The new generation of VR headsets is the portal to the metaverse. Head-mounted VR displays engulf the senses and offer an unrivaled sense of embodied presence. Users can move freely through a 3D scenario and interact with the world around them with their hands, just like real life. VR technology is mature enough that it's no longer part of Gartner's Hype Cycle, and it is becoming affordable enough (under $300) to address global capability gaps. An internet connection is not even necessary for single-player sessions. VR engages the brain's motor system and builds muscle memory. Just like a flight simulator prepares pilots for emergency landings, VR can train anything, from farming skills to fire fighting. Skills that play to the unique strengths of the metaverse include spatial training, such as involving the hands and body for tasks that are too dangerous, expensive, inconvenient, or simply impossible to practice in real life. Other examples include simulating scenarios for routine and abnormal operations, emergency response, stressful workplace situations, critical procedures, and high consequence events(see Figure 2). All in a safe and controlled environment that can then be repeated until it becomes second nature(Worldbankgroup).

〈Figure 2〉 Metaverse classroom

https://olc.worldbank.org/about-olc/education-meets-the-metaverse-reimagining-the-future-of-learning

Edgar Dale, an American educator who developed the Cone of Experience, also known as the Learning



〈Figure 3〉 Cone of Experience

https://elearningindustry.com/cone-of-experience-what-really-is

Pyramid, argued that audiovisual media should be divided into abstraction and concreteness according to the degree of experience, and abstraction increases as it goes up, concrete increases as it goes down, and school education should use various audio-visual media and select and use media suitable for learners' levels. In general, it is effective to start from a specific experience and gradually move to an abstract experience, and more preferably, it is possible to promote the formation of learners' concepts by integrating and using specific and abstract media. Therefore, it is explained that if a learner can learn through the medium at the top on the Cone of Experience, the physical time to learn the learning material is shortened, and if the medium at the bottom of the cone is used, successful learning can be achieved. People remember 10% of what they read and 20% of what they heard, but 90% of what they actually experienced(see Figure 3). What you have experienced in the metaverse world can lead to empathy. For example, those who experienced Homeless with virtual reality have seen a significant increase in the consent rate of residential support petitions since then, and those who have experienced Manhattan helicopter tours have seen a 190% increase in their actual New York travel contract rate. Our society has various problems such as disability, discrimination, and social isolation. You can understand the other person through the metaverse. Through understanding and empathy, metaverse can be a driving force for social innovation (Kyunghyang Newspaper, 2021).

In 2021, the government proposed the Korean version of the Four New Deal, and. will invest the a total of 12.7 trillion won in strengthening the digital new deal project. D(Data) N(Network) A(A.I) ecosystem, fostering industries and infrastructure (SOC) for general untact environment.

One of the reasons using Digital Twin is gaining attention to the model and platform for effectively collecting, simulating, analyzing, utilizing vast amounts of real-time data in real space, using AI to solve problems in metaverse, virtual reality etc. (Korea Cultural Information Service, 2021). If the digital twin based on 'D.N.A.+ XR' and the Cone of Experience theory, the educational effect can be expected for students with disabilities who are socially vulnerable. By experiencing the other person's situation, it can provide an opportunity to reduce social conflict, prejudice, and discrimination. For example, prejudice and discrimination against black and other races are unresolved challenges in our society. If you put yourself in the person's shoes, you can understand the others. "Traveling While Black" allows people to experience vertual travel from a first-person perspective as black people. Therefore, it is directly exposed and can understand the discrimination and their thoughts. As another example, in a project called '1000 cut for Journey' developed by Stanford University's Virtual Human Interaction Research Institute, A 15-year-old boy meets the police on his way to play basketball with his friends and can learns how he would feel if he was overpowered by polices. Through this virtual experience, it is possible to increase the understanding of discrimination, prejudice, physical assault, and social exclusion that black people experience. Experimental analysis from both of those showed that white people's racism and prejudice against black people decreased significantly (metaquest).

3. Research methods and theoretical frameworks

3.1. Inclusive education tool as the social good practice

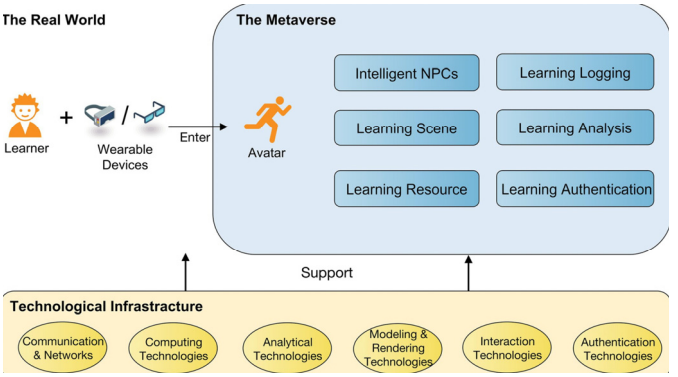
Around 240 million children worldwide are living with disabilities who have ambitions and dreams for the future. Therefore, high-quality education is needed to develop potential abilities and to maximize their potential skills. However, disabled students are often overlooked in the policymaking process, limiting their access to education and their ability to participate in social, economic, social, cutural and political life. To be discrimination, stigma to them, and the day-to-day failure of decision-makers to integrate disabled students into school services regards as a lasting barrier to be educated from their rights. The disability is one of the most serious barriers in the worldwide(unicef, 2019). The inclusive education is to keep all students being assigned to general education classes in their region, no matter what difficulties they face, to receive high-quality education, intervention, and support to improve academic achievement through core curricula(Alquraini & Gut, 2012). Schools and classrooms should be operated on the premise that they are useful places that guarantee essentially equal learning rights for all regardless of disability. The legal guarantee ensure that all students be educated in the Least Restrictive Environment(LRE) where a priority option to be included in general education (Alquraini & Gut, 2012). However, the prejudice against the disabled is still very serious.

Although discrimination against the disabled is legally prohibited, the level of public awareness of the their human rights is very low. According to survey by the Ministry of Health and Welfare, only 13.9% of the people recognized that there is the law against discrimination of the disabled in 2019. On-site adaptation training for adaptation training for disabled students has more barriers than in classroom. Foe example, it is common to teach disabled and non-disabled children in the same space from an early age in developed countries. Jacques Mikurovic, director of INSHEA[1], said, "France aims for inclusive education without distinction between disabled and non-disabled, who should take classes at general schools as much as possible according to the degree of disability." In addition, Nathan Yates, a teacher at Cypress Primary Special School in the U.S., said that the curriculum of the class focuses on communication rather than education for disabled and conducts in music and fireld-trip classes all together(Dong-A Ilbo, 2019). Inclusive education can be accomplished successfully only by accepting, understanding, and paying attention to each of student's difference and diversity in physical, cognitive, academic, social, and emotional aspects. Sometimes students have special needs such as language, physics, and emotional therapy, but this doesn't mean that they should be excluded from regular curriculum. Therefore the purpose of inclusive education is to provide fair opportunities for all students to learn and develop their skills needed and to grow on their willingness.

Education is one of the most significant applications of the metaverse with great potential in the coming future. The presence of the metaverse can be served as a new educational environment (Prieto et al., 2022, Rospigliosi, 2022). Therefore, the metaverse in education can be regarded as an educational environment enhanced by metaverse-related technologies which fuse with the elements of the virtual and the real educational environment. It enables learners to use wearable devices to enter the educational setting without being limited by time and locations and allows them to use digital identities to have real-time interactions with different forms of items (avatars, intelligent NPCs, or virtual learning resources). As a result, they can feel present as if they are in a real-world educational setting. From this standpoint, it can be seen that applying the metaverse in education can unlock a variety of fantastic learning experiences for learners. The metaverse framework with potential core stacks, including hardware, compute, networking, virtual platforms, interchange tools and standards, payments service, content, service, and assets, as well as introduced its reasons in brief(Kang, 2021). The metaverse into three essential components (hardware, software, and contents) and three approaches (user interaction, implementation, and application) for the metaverse in a general meaning(Park & Kim, 2022).

The biggest advantage and remarkable function of metaverse is to gurantee immersive experience which can improve people's capacity for social interaction, but access to the digital world for

1) it is an abbreviation of Institut national supérieur de formation et de recherche pour l'éducation des jeunes handicapés et les enseignements adaptés in France



〈Figure 4〉 The framework of the metaverse in education.

source: Zhang et al, 2022

disabled can be another barrier. it is necessary to practice responsible AI that ensures equal access to metaverse in order to protecting information access and learning rights(Song, 2022). AI technologies for responsible practice include image recognition (Look-eye, iPoli), sign language automatic translation models, intelligent exoskeleton robot arms that interact with the digital world, and brain computer interfaces. Web3.0 is generally an extension of context-aware function and human-computer interaction in Web2.0. Many people work where they want to, live the way they want to, and take this freedom for granted. Thus, metaverse is likely to realize a fairly positive effectiveness on a virtual world that reflects the reality considered human-centered computing, especially in terms of accessibility, diversity, equality, and humanity.

3.2. Research method

Fist of all, this study is a review of literature researches on the use of AR/VR in special education, and the overall results are summarized in Tables which analyzed the fields, purposes, results, and limitations of AR/VR. Second, by citing newspaper articles on the meta-edu for disabled students, Meaningful discussions was searched for the outcomes especially that interaction and communication of students with disabilities can be improved and promoted. The keywords like AR/VR, and meta-edu, disabled students, special education in Dbpia, scienceON, and Riss were investigated. Also, they were covered through database such as Web of science, ReserchGate, Springer, Scorpus, and SAGE journal(see Table 3). In the examining procedures, firstly, a study published between 2011 and 2022 (30 domestic and international) classified the effects of AR/VR applications, models, and education frameworks. second, AR/VR's strengths, limitations, effects, use, challenges and scope from assorted papers. Third, experiences of AR/VR in special education were checked. There were many studies related to aspects on technologies in Metaverse, although

〈Table 3〉 Review of literatures related to special education through AR/VR, Metaverse

Research Paper.	Contents of AR Study	Research results
Almutairi& Al-Megren (2017)	Applications including AR teaching Arabic to deaf elementary school students using the potential to combine video, image and audio with AR	Shows that teachers and parents of deaf children prefer to use multiple resources for learning (communication promoted)
Abas& Zaman (2011)	Making storybooks to motivate students to read. It consists of three stages: elementary, middle, and high level for students who do not have basic reading skills	Greater motivation, commitment, and enjoyable reading experience in the immersion of the curriculum
Mirzaei et al. (2014)	Combined with audio and video (AVSR Audio Visual Speech Recognition) to help deaf people. Voice recognition technology captures what the speaker says in text, not in sign language	By using the screen alone, the speech becomes a readable text displayed with AR, allowing deaf people to read and understand the communicated content better (communication promoted)
Kerdvibulvech (2016)	Conducting AR application studies, helping visually and receptively communicate with deaf children.Application of “T.Jacket” linked portable communication jacket	It uses sensor technology applied with AR and is easy to express emotions, so it has a wide range of applications for the disabled. The results of this evaluation confirmed the improvement of understanding and communication (communication promoted)
Bacca et al. (2015)	Introducing an application called “Paint-cAR” for students with diverse educational needs in the context of professional training, especially those with low basic skills and low motivation. The vocational education program supported the learning process of repainting cars.	Help students who cannot follow a long process because it is difficult to proceed with logical competence and follow-up courses.
Tobar-Muñoz et al. (2014)	Design digital games using Gremlings, AR	My Mirror, which was evaluated for children with various learning needs such as attention deficit hyperactivity disorder, autism, and Down syndrome, focused on the development of mathematical logic.
Phon et al. (2014)	Augmented Reality Education for Dyslexic Students	Provide opportunities for an interactive and enjoyable educational experience (communication promoted)
Santos et al. (2016)	Three things are: (1)AR application development, (2) usability testing, (3) effectiveness testing on learning	Since few literatures demonstrate the benefits of AR for learning, Tested the effectiveness of AR as a platform for memorization tasks and investigated its impact on student motivation
Diegmann et al. (2015)	To determine the benefits of AR, we report a systematic review of AR in five areas: discovery-based learning, skill training, training applications, games, and AR book.	AR is available in educational environments and identifies many applications that successfully apply AR to improve learning, such as language training, machine skills training, and spatial ability training, special user groups (e.g., disabled) benefit from learning methods and AR characteristics in additional ways(communicationpromoted).
Yoon. J & Kang. H (2021)	Provides reinforcement learning experience by presenting a smartphone AR application called AR-E-Helper that supports students’ learning in higher education lectures	The application program is maintaining students’ concentration in class, raising interest, and increasing satisfaction.

studies linked to special education began in 2013, it was slowed down and activated since 2018. Many fields of culture, history, art, and medical science, and engineering, manufacturing, and construction have been in the development stage until now. Participants in the most studies were mainly children with autism, dyslexia, disabilities of hearing, vision, and developmental disorder, not for higher education. However, most of the studies were replaced into interviews and surveys rather than practical experiments. Except for the general education, the special education fields were hardly found out among relating to domestic papers. Moreover, it can be refered only 「Understanding and Teaching of Augmented Reality and Virtual Reality Content」 in 2017 and 「Possibility of Educational Use of Metaverse」 in March 2022 published by KEDI as the domestic reports, which is sum them up in Table 4.

3.3. Results

Most of AR/VR, metaverse studies had samples group of hearing, visual impairment, autism, ADHD, and dyslexia. The results represented do not feel environmental and barrier restrictions in learning, and have been shown to promote and improve motivation and interaction and communication (Bacca et al., 2014; Diegmann et al., 2015). Other benefits include attracting students with disabilities (Diegmann et al., 2015), motivation, interest, and vision devices such as some Quests are expensive, but they can use apps through their own smartphones in the classroom, which is low cost and efficiency of the learning process (Fernandez et al, 2015), Cognitive ability development (Benda et al, 2015), short-term memory effects(Martin-Sabariss, 2017) were found. Therefore, it can be concluded that it can be concluded that it is a meaningful point that it is a useful learning tool for improving and promoting communication. The limitation of this study was a lack of case studies that considered various attempts or measures to link other metavers techinques to special education except AR/VR. In general, there were only partial questionnaires and interviews, and the difficulties for recruiting and selecting the subjects(mainly, existing studies were conducted on a small scale of 10 or less), pre-education for conducting, parental awareness and consent procedures, insufficient educational conditions, physical environment, lack of manpower in conducting experiments, and lack of guiding technitions.

Considering a preliminary streams for the development of inclusive education from the results, first of all, when focusing on students with physical or mental disabilities, students' level of frustration should be controlled during the experimental process (Sytwu & Wang, 2016). In this sense, the preparation and planning for the AR experience should be thorough and detailed. Second, inclusive education through mobile devices such as metaverse requires a lot of research support and environment creation for participation of students with disabilities from various groups (Sheehy et al., 2014). Unlike advanced countries, which provide integrated education that allows most disabled and non-disabled people to learn in the same classroom,

〈Table 4〉 Domestic AR/VR, Metaverse applicated-class examples and teaching methods

AR/VR Techs	researcher	Metaverse	researcher
3D virtual class Museum education	Yoo. S.(2017) Kim. M(2012)	History	Choi H, Kim.S(2017)
Contents			
To practice responding to problem behaviors that teachers may face in classrooms, virtual classrooms are decorated in three dimensions, and students are written in avatar form to perform exercises by wearing HMD. Human manager observes pre-service teacher's course progress		History education contents using metaverse elements (lifelogging, AR, holograms, etc.) provide various contextual information on historical resources, which is an effective tool for developing historical judgment as well as structural imagination and historical empathy	
Teaching Methods			
Individual learning			
HMD[2)]	Moon.S et.al.(2016)		
Contents			
It creates a virtual reality-based dental implant surgical environment and implements it to experience surgery within a 3D environment using Oculus VR and Lipmotion. Step-by-step scenario from incision to implant completion in game form			
Game type			
Second Life, Computer	Kim.D & Jeon. S(2014)		
Contents			
Conduct a field trip to find out about Dokdo in the second life space, examine Dokdo in the second life, and solve the problems presented. Following the teacher's guidance, the virtual space is searched, searched, and then organized in the form of an overall presentation			
Problem-solving learning			
The imaginary Earth and the Moon Vive HMD	Kwon. J(2017)		
Contents			
A game-type program that lands on the moon in a spaceship and performs gravity tests. The learner can manipulate the object by moving the virtually implemented hand with the Vive controller. a partial experience of touch			
Game learning			
Google Art Project Google Card Board	Park. J et al.(2016)	art	Lee. K(2021)
Contents			

AR/VR Techs	researcher	Metaverse	researcher
Using art projects provided by Google, exhibition planning classes at your own art museum. Enjoy using Google Cardboard		It is set as 'virtual space Odyssey' and 'Avatar Life' and presents an interface from the perspective of art education. The significance of metaverse use in art education is analyzed in terms of the use of virtual platforms, big data and artificial intelligence, expanded fantasy, and augmented reality	
HMD	Ryu. J et al.(2017)		
Contents			
Learners can look at a variety of tools			
HMD	So. Y(2017)		
Contents			
Build a virtual experimental environment that can analyze bacteria; conduct experiments to identify bacteria by manipulating the environment			
Experiment			
medical education	Yeom.S(2011)	athletic rehabilitation	Yang. J& Lee.S(2021)
Contents			
How to teach and test anatomical knowledge, especially in the abdomen) Interactive 3D anatomy		Virtual reality or metaverse-related technologies have been developed and specialized in a form suitable for exercise rehabilitation. In the case of studying abroad, it is analyzed that exercise rehabilitation using virtual reality and metaverse games for rehabilitation of disabled and elderly patients can help improve brain, physical ability, and anti-aging by activating the body and mind	
Illustration and tactile feedback/application			

only about 70% of those eligible for special education receive integrated education. It shows that discrimination against disabilities is still severe in our society (Dong-A Ilbo, 2019). Raising social awareness and creating an environment where students with disabilities can be viewed without prejudice should be the biggest role in the realization of inclusive education. Third, it is necessary to have qualified employees and assistants in the environment to educate Metaverse (Colpani & Hamme, 2016). Although basic digital knowledge is required, special educators and school assistants are inevitably lacking in technical capabilities. Fourth, each disabled student has a different requirement. There is a limitation that the specificity of education should be reflected in the production of the program, but it cannot be repeated for students with different educational environments or conditions. Recognizing that an app with the same scenario cannot be used repeatedly for disabilities

2) The HMD head mounted display (HMD) is a display device that is mounted on the head and can present images directly in front of the user's eyes. In 1968, the first HMD was created by Ivan Sutherland of the University of Utah (Wiki).

or special education, it is required to develop various educational apps. Fifth, there is a need for a way to overcome the difficulty of recruiting research participants. Long-term results require students' time, persistence, and enthusiasm, but the physical and emotional conditions of disabled students do not reach this. For these experiments, there are also complications in the need for digital competency training in advance and the acquisition of prior explanations and consent procedures, including data necessary for research to parents of disabled students. It seems that discussions on how to solve this problem should be made first. Sixth, it is also an important future issue to induce research in the fields of metaverse app development in engineering, agriculture, forestry, management, fisheries, and veterinary medicine in consideration of students' various learning and education. The seventh task is Markerless Tracking Technology[3] to support education inclusion, it is the interworking nature of various types of devices and apps such as smart glasses and smart mirrors that can be used. It should be driven with the aim of helping students with disabilities communicate and interact without barriers. The ease of use of devices is most widely preferred for tablets and smartphones due to the high use of applications (Hsiao & Rashvand, 2015 In particular, when caring for children with autism spectrum disorder (ASD) or intellectual disabilities, PCs and webcams, hearing and vision impairments, head-mounted devices or screens (Fernandez et al., 2015) and smart glasses are used to improve communication among deaf students in general schools (Parton, 2017). Hrishikesh and Nair (2016) show that AR enables children with disabilities to understand concepts faster and better, and provides interesting and fun educational aids to students with special needs. Table 3 shows that students' motivation has been improved by positively influencing students' educational experiences, increasing confidence, increasing achievement and interest levels, providing self-directed learning opportunities, strengthening cooperative learning, and improving satisfaction and education levels. As a result, metaverse can provides the value chain, the seven layers for maximizing experiences which can be appied in special education as the biggest advantage(see Figure 5).

4. Implications and limitations of metaverse education for students with disabilities

In the pandemic situation, education had a burden on both teachers and students to quickly acquire and handle skills, and under the restrictions

3) Markerless tracking technology, also called "feature-based tracking". Feature points are extracted from the image and coordinate systems are extracted based on these points. Unlike markers that implement augmented reality based on markers with regular patterns such as QR codes, markerless tracking technology uses data from the target itself to implement augmented reality. It is used to recognize cultural heritage itself as a technology suitable for recognizing cultural heritage because the object can recognize the form of images or objects
http://wiki.hash.kr/index.php/%EB%A7%88%EC%BB%A4%EB%A6%AC%EC%8A%A4

of non-face-to-face classes, students needed to participate in learning and expand the external educational context. It was necessary to present a strategy to cope with the crisis by providing a new level of understanding in non-face-to-face and a sphere to continue education under constraints. For example, Sookmyung Women's University held the 2021 Together Job Fair in December, a metaverse-based online job briefing that considers the characteristics of students with disabilities in the COVID-19 and MZ generation in cooperation with the Korea Employment Agency and Korea Welfare University.

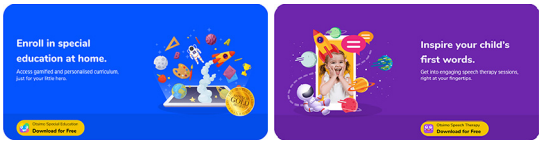
4.1. Metaverse experiences for the effective communication in the special education

Using an online-based program (platform) in October last year, 'School For You' expanded students with health disabilities' The World Athletic Conference(Metaverse) was held in 2021. The event was designed to provide psychological and emotional support and restoration of stability by using the extended virtual world to students with physical disabilities who are restricted from participating in outdoor activities such as sports competitions. The Ministry of Education presented that it will also strengthen remote classes and educational support projects to minimize academic deficits. Consequencely, Table 4 shows that it can work for improving students' learning effects by changing their learning environment, developing and training their talents and aptitudes to cope with language and world challenges outside. Above all, the Meta-edu has the great educational potential. VR content and metaverse space eliminate the fear of failure, and immersive experiences have the ability to make digital interactions feel more human. Therefore, the use of metaverse technologies such as AR/VR can be a preferred educational tool in specific situations or special needs educatedly. Strong applications for learning is still being developed with a lot of interest and expectations. Learning experts focus on efficiency, for example, when training to make lattes, failure is very common, and tools in apps make up for mistakes and correct mistakes, making trainees feel comfortable.

Another advantage is the safe accessibility. When they handle hot water and coffee near 100°C during espresso extraction training, you may burn your hand, but there is no burn accident in virtual training using VR. In addition, the infinite repetitive training is usually important for disabled children having difficulties to memory. But if they use AR/VR contents, they can effectively repeat learning upon their interest and fun. it can be a game without any pressure on education and doesn't matter if you make a mistake while trying something (Yirounnet, 2021). VR-trained learners have up to 275% higher confidence in acting on what they have learned after training, the improvement of 40% over by face-to-face classroom learning and 35% over by e-Learning (pwc, 2021). Although e-Learning often suffers from inequality to access technology, studies show that meta-edu is dynamic, highly interactive, easy to convey emotions, and realistic content can reach users in a more meaningful way. Metaverse's learning can empower learners around the world

to interact, while connecting and providing unprecedented access(see Table 4).

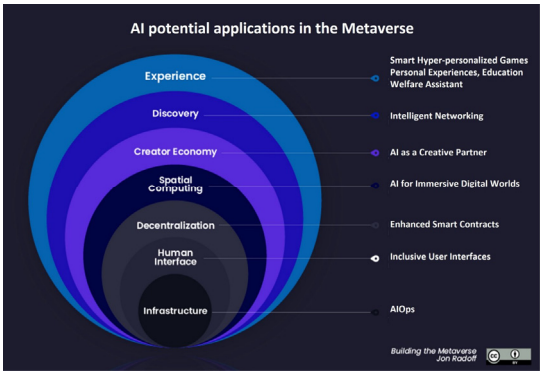
Third, It can be the communication method. It is proposed that providing learners in high school with access to immersive learning skills will have a positive effect on their ability to develop the necessary skills. For instance, “Skill Immersion Lab” program in fastcompany website shows that more than 85% of learners felt more confident in talking to others after completing their immersion learning experiences, improved ability to find the right words to express ideas during the program in 85%, and 90% of learners checked their answers again to find out how to improve after class. Moreover, Participation combined with acceleration of learning ability expands the communicative function of metaverse, which was previously imagined, highlighting the learning content effect (fastcompany.com). Otsimo.com, which developed an app for education for autistic children, guides them to download it as a free open-source ACC for special education, reflecting the expensive and difficult communication app so far. it will be a very meaningful and useful means of communication (see Figure 5).



〈Figure 5〉 Otsimo app for special education

https://otsimo.com/en/

Fourth, human relationships can be expanded. Not only people’s lifestyles today represent a microcosm of digitized life like video conferencing and SNSs but also Students live with school assignments and homework, school web portals, social media, text messages, FaceTime, and video games. Metaverse is designed to mimic and properly express human interactions to convey presence and emotional realism through avatars in communication, can creat a difference from thier condition in present. In addition, the spatiality in the metaverse provides familiarity by reflecting the physical world among avatars, all cognitively and emotionally connected, our communication skills improve and we can create productive conversations. It provides a balance that offsets the negative effects of digitalization, spending online feel more humanly connected and allowing us to enjoy life away. Meta-edu, the gateway to a better future, offers tremendous opportunities and is valuable for being mutual communication. Therfore, it is the useful communication channel for disabled students to reflect their lives and opinions and coordinate other people’s opinions in the aspect of the experiences(see Figure 6).



〈Figure 6〉 The seven Layers of the metaverse

https://medium.com/building-the-metaverse/the-metaverse-value-chain-afcf9e09e3a7

4.2. Implications for Metaverse Education for Disabled Students

VR provides freedom to people with disabilities in various ways, helping them cross borders that cannot be crossed on their own. It can serve as a great equalizer for education, training, socialization, and even ordinary fun. Virtual reality eliminates all the differences and limitations of participants and allows them to learn and play in a safe and immersive environment. Let's take a look at some of the possibilities of using metaverse in education that attempts to change learning and outcomes. First, the new technologies must always keep pace with education in changing world not to be one step behind. Meta-edu has the potential to develop a classroom environment. Second, it motivates MZ generation who are familiar with games for focusing on teamwork and completing the tasks using Quest 2 interestingly. Third, it promotes interdisciplinary learning and encourages practical application of theories. VR-based education shows how to break down barriers between subjects and application of various theories from real-world situations. In addition, real-world tasks such as plug wiring, drainage pipe installation, surgery, and chemical experiments can be taught using VR, allowing learning to be integrated without feeling free of actual results or risks. Fourth, it is possible to provide a customized program that meets various requirements. VR is its flexible content and customization options to adjust each of them. According to LG CNS, students at Seoul SaeRom School, a special school for physical disabilities, participated in the 20 th AI Genius program in 2022. In total, lectures on SW and AI , AI and art experience, AI autonomous vehicles were held and students made their own avatars and learned AI through games and quizzes in the metaverse space including composing songs, drowing pictures, making music or graffiti into pictures and driving AI self-driving car by driving self-driving robots (MoneyToday, 2021). Fifth, it helps to strengthen skills and improve training performance and methods in the safe place. In particular, disabled students need to gurantee the safety to learn and improve their skills as they grow up such as learning how to navigate a grocery store, use a wheelchair, or drive. Many special educators can use VR to provide a safe, controllable and undistraced environment to learn, fail and practice for being alert to unpredictable variables and dangers. Meta-edu can all be simulated and practiced, anticipated and prepared for changes and emergencies in our normal life such as crossing the street, using public transportation, and going to a post office. This kind of learning is very necessary for children to survive in the real world without fear of failure or embarrassment in front of others and helps to boost confidence and freedom. Sixth, it can be expected the disabled students to foster awareness, self-confidence, and self-esteem as a social being. No one should deprive them of this opportunity. For instance, long-term hospitalized due to incurable diseases, VR is the only way out of isolation. An interactive environment where you can talk to other family members or friends and explore the virtual world

can also be used to teach positive social interactions and improve behavior. In 2006, researchers at the University of Southern California used VR classes to provide classroom experiences for ADHD students. introduction step-by-step is possible for students to gradually adapt their environment to daily-like noise and disturbances while learning how to control impulse control, attention duration, and hyperactivity. Finally, it can be a channel for communication that reduces conflicts between generations and classes. This provides an opportunity to restore the basic rights of disabled students through metaverse, such as learning rights, self-determination, and freedom of expression, which are self-directed for the first time in their lives, to talk to others equally, express their opinions, and to make decisions and act. Equal opportunities are realized to meet the specific learning requirements of disabled students, keep pace with colleagues in a controlled environment that fits them, and actively participate in their favorite subjects. In addition, students with disabilities in isolated and confined wheelchairs or severely disabled students will learn how to make friends, talk, and communicate in a metaverse, sympathize with the generation, and enjoy freedom and happiness.

5. Policy suggestions

Non-face society has provided an opportunity to recognize that there are many deficiencies in the inclusive educational environment that guarantees students with disabilities' right to learn, and various discussions are taking place. Due to the sudden non-face-to-face education, families clearly showed unprepared technical and environmental conditions for disabled students, and various problems such as a lack of manpower were exposed. Other findings are the barriers prejudice and perception, lack of research, difficulty in selecting and recruiting subjects, lack of complex consent procedures and awareness of educators and guardians were examined. While Meta-due unveiled the positive aspects of the internal expansion of communication and interaction opportunities for them to realize and practice inclusive education. If so, social consensus and inclusive policy are supported. Next, let's take a look at some of the things that the government needs to conduct policy discussions.

First of all, it is a discussion of ethical issues. In Metaverse, it is highly likely to trigger new legal system problems and ethical issues while interacting with each other, such as platform providers and service users. Based on criminal acts such as violence, sex crimes, and illegal transactions that can easily occur in virtual spaces, personal information protection issues due to automatically collected information such as the place and time of user stay are mentioned first. The necessity of the standard for ownership of works in Metaverse for digital asset transactions and issues related to changes in the working environment are also expected to be publicized.(Digital Daily, 2021).

Second, it is necessary to protect and take measures to protect the digital alienation and information gap of the socially vulnerable class, and guarantee the human rights of the disabled.

The development of digital technology, which spurred the advent of the information society, has created a new communication environment that provides more information to many people and shares various cultural experiences(Song, 2022). Social alienation, which occurs in the absence of means and methods such as channels provided by digital media or devices, is a problem that society must overcome in the future.

Third, the government should focus its efforts on creating a sustainable metaverse ecosystem based on public-private cooperation as the paradigm shift of ICT such as data, network, artificial intelligence, XR, and digital twin requires the establishment of a new Web 3.0 platform to revitalize the D.N.A ecosystem. In particular, according to the principle of private-led and government-supported, the public plans to actively open data so that the private sector can use it for service development and use private platforms first when delivering public services (Korea Policy Briefing, 2022)

Fourth, professional developers for implementing the metaverse world and creators who will be active based on their content production capabilities on the metaverse platform should be trained, and comprehensive infrastructure that supports corporate growth should be expanded to contribute to the expansion of the base. In particular, considerable manpower should be allocated to the education sector to train specialized manpower for the education of disabled students.

Fifth, a pan-government consultative body should be formed that reflects public consensus on metaverse and practical efforts to raise awareness. In order to innovate the metaverse platform and enhance social acceptability, a pan-government consultative body is needed to establish principles of self-regulation, minimum regulation, and preemptive regulatory innovation while researching legislation on unethical behavior, illegal behavior, digital assets, and copyright.

Sixth, it is necessary to prepare measures for personal information and cybersecurity and strengthened digital privacy policies. The most vulnerable thing to grafting AI technologies is that they are exposed to hacking(Song, 2022). There are various authentication methods such as password, PIN, smartphone, biometric authentication, text authentication, and QR authentication.

Seventh, there are concerns that Metaverse may cause problems such as escape from reality and disability (DPDR) due to high immersion as it is connected to daily life with an expansion beyond reality. If the obsession with this becomes stronger and the amount of use increases excessively, not only will you feel tired due to SNS addiction. As SNS addiction is deeply related to human mental activities such as interpersonal relationships, it has shown various psychological factors and relationships, including depression and loneliness, extroversion and low sincerity, and anxiety(Lee & Nam, 2021).

Finally, the establishment of digital governance is creating new means for various stakeholder groups to participate at low cost through the development of intelligent information technology. As a result, information access rights[4], information self-determination rights, freedom of information

communication, information property rights, information security rights, and information sharing rights are essential rights for people to live freely and equally in the information age(Song, 2022).

6. Conclusion

A total of 50 studies were analyzed by applying content to research methods on how AR/VR-included metaverse can be used as a useful tool to promote communication in the education of disabled students. There were many technical studies on metaverse which were the most active in 2015, starting with Second Life in 2013. It has been in earnest since 2018. But studies related to education, and education for the disabled are very rare. Only there have been studied mainly in culture, history, art, and medical fields, and engineering, manufacturing, and construction and most of tries have been in the development stage. Researches on the autistic children, dyslexia, auditory, blind, and developmental hadicapped were the mainstream, not for higher education. The advantages of meta-edu were motivation, interaction, communication, attention and attraction, and the limitations of researches existed in various ways such as only conducting through partial questionnaires and interviews, recruting sample experimenters(small scale of 10 or less), pre-education, parental awareness and consent procedures etc. Applications of Metaverse were created in diverse in 2021 because of appearing non-face society including schools and academies for educations but the educational introduction for disabled students is still insufficient. As a result, the development of a framework for inclusive education should continue in ICT society as a sustainable education method in the D.N.A ecosystem. The establishment of an inclusive education system requires changes in each part of society as well. School teachers should receive technical training, and the building structure should be changed and renovated to install physical learning facilities to access learning materials to suit their needs. Stigma and discrimination should be handled at the community level, at the national level, the government should sign agreements on the rights of persons with disabilities and regularly collect, analyze and provide data so that students can continue to receive effective services

In particular, the greatest effect was to improve communication skills of handicapped students, and meta-edu can realize a great contribution to their lives by expanding the horizon of opportunities to interact with others beyond many constraints and biases in reality. This study contributes to identifying and expanding the current state of research in AR/VR and metaverse applications as inclusiveness. I hopes to be a compass for further studies on the benefits and effects of protecting not only disabled students but also socially vulnerable groups. In addition, if

4) Information access rights, information self-determination rights (information self-access, information self-access, information self-government, information self-delete rights), freedom of information communication, information property, information security rights, and information sharing rights are also essential rights for people to live freely and equally in the in the information age (Hwang Joo-sung, Lee Min-young, 2004).

it starts to be used as a universal learning tool for disabled students in meta-edu, the expectation to see how much communication utility they have and their dreams have expanded their interaction areas is growing.

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국문요약

장애학생 메타버스 교육의 포용적 공공소통적 효과성과 정책적 제언

송진순*

인간 활동의 대부분이 플랫폼 안으로 빠르게 좁혀지는 비대면 사회를 지난 몇년간을 지나오면서 외부 활동에 대한 제약이 결국은 디지털 기술의 내부 확장성을 가져왔다. 그 중 메타버스는 사실상 현실을 대체하며 다양한 분야에서 활용 가능성을 높이고 있다. 그러나 메타버스, 특히 장애학생의 교육적 효과와 관련된 연구는 여전히 부족한 미지의 영역이다. 본 논문은 메타버스 교육이 사회선과 포용적 교육을 실현하기 위해 장애학생들의 다양한 요구에 부응하는 교육분야를 확대하고 있으며, 상호작용의 장벽 해소 등 소통효과가 두드러진다는 점에 주목한다. 연구방법으로는 의사소통적 기능에 중점을 준 장애학생 교육방법과 AR/VR, 메타버스를 연계한 논문에 대한 문헌연구와 전문가 인터뷰, 기사, 칼럼 등을 살펴보고, 특수장애교육에 대한 정책 제언과 시사점을 살펴본다. 연구의 한계가 확인되고 있지만, 원추이론을 통한 직접적인 몰입형 경험이 교육적 효과의 극대화를 제공하고, 사회적 선의 실천 차원에서 학습의 동기부여, 흥미, 접근성, 학습권확보 등 장애학생들의 인권을 실현하는 포용적 교육에 유의미한 결과가 있음을 발견한다. 향후 장애학생을 위한 메타버스 교육의 발전적 활용에 대한 후속 연구가 진행되길 바라며, ICT 사회에서 사회적 취약계층이 기술에서 소외되지 않도록 포용적 정책과 혜택을 꼼꼼히 관찰하기 위한 다양한 학제간 논의가 이루어지길 바란다.

주제어 : 소통, 메타버스, 특수교육, 포용성, 사회적 선

논문접수일 : 2022년 11월 14일 논문수정일 : 2022년 12월 11일 게재확정일 : 2023년 1월 1일
원고유형 : 학술대회 Fast Track 교신저자 : 송진순

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동아대학교 행정학과 조교수로 재직중이며 주요 관심연구 분야는 디지털 정부 속 공공소통론의 학문적 저변 확대와 인공지능 기술 매체를 매개로한 정부-시민간의 공공소통 증진 방안과 다양한 채널 연계 등이다