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Path Model for Presence Factors Affecting Expectations and Concerns of Using Virtual Simulation in Special Education

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가상 시뮬레이션의 특수교육 활용 기대감에 영향을 미치는 현존감 요인의 경로 분석

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Abstract The purpose of this study is to analyze the paths of the presence that influences the use of the virtual simulation in the special education classrooms. The participants consisted of 76 students who majored in special education in J and K universities. Participants took a three lectures of 3-h. that addressed the theory and practice of virtual technology such as virtual reality(VR) and augmented reality(AR), and then completed the questionnaires on participants' presence level and expectation level of virtual simulation for special education. Study results were as followings: (1) Enjoyment and Communication have direct effects on positive expectation, while Immersion has a direct effect on negative concern; (2) Reality, Accessibility Performance, Communication, and Immersion have indirect effects mediated by Enjoyment on positive expectation; and (3) Communication and Reality have indirect effects mediated by Immersion on negative concern. Lastly, the implications and suggestions for future research were presented.

Key Words : Virtual Reality(VR), Augmented Reality(AR), Special Education, Presence, Technology Convergence

요 약 이 연구의 목적은 가상 시뮬레이션의 특수교육 활용에 영향을 미치는 현존감 요인의 경로를 분석하는데 있다. 이 연구의 목적을 달성하기 위해 C 지역 J 대학교와 K 대학교 예비특수교사 76명을 참여자로 선정하였다. 참가자들은 각 3시간으로 구성된 3개 강의를 통해 가상 시뮬레이션 이론 및 실습을 진행하였으며, 이후 현존감 검사와 가상 시뮬레이션의 특수교육 활용 기대감 설문지에 응답하도록 하였다. 이 연구의 결과 가상 시뮬레이션의 특수교육 활용 기대에 영향을 미치는 현존감 요인은 다음과 같다: 첫째, 현존감 요인 중 '재미'와 '상호작용'은 긍정적 기대에, '몰입'은 부정적 우려에 각각 직접 효과를 나타냈다. 둘째, '사실성' '접근성' '수행' '상호작용' '몰입'은 '재미'를 매개로 긍정적 기대에 간접 효과를 나타냈다. 셋째, '상호작용'과 '사실성'은 '몰입'을 매개로 부정적 우려에 간접 효과를 나타냈다. 마지막으로 연구결과에 따라 논의하고 제언하였다.

주제어 : 가상현실, 증강현실, 특수교육, 현존감, 기술융합

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1. Instruction

Information and communications technology (ICT) is improving, and the dissemination of digital contents has been consistently improved. The development of smartifacts marks the development of a ubiquitous educational world, where education is available to anyone and anywhere. The most salient area of ICT is virtual simulation with virtual reality (VR) and augmented reality (AR).

With VR, people can experience a virtual environment that is similar to a real environment. By contrast, AR provides an interactive experience by providing information based on the real world. VR and AR have received attention in entertainment fields, including games. The educational usability of these technologies can be established by generating educational content. The use of VR space in education to teach content—difficult to visualize and learn—and abstract concepts is a high-risk and high-cost experiment[1,2].

Virtual simulation can be helpful for people with special educational needs. Social adjustment training programs adapting virtual simulation are beneficial to people with disabilities and are cost-effective as well as time- and space-efficient. VR technology was effectively used in the recovery of movements, balancing, and ambulation and was advantageous in clinical rehabilitation treatments for various problems, such as acrophobia, depression, and lack of interpersonal skills[3,4]. AR is less prominently used than VR; however, some studies[5,6] have reported its positive adaptation effects. AR can be useful with advances in mobile technology and increased industrial demands[7]. AR is more widely recognized than VR because it allows users to utilize a wider platform than VR and to experience virtual simulation by using various devices, including smartphones, tablets, and wearable smart devices[8].

Virtual simulation has the learning effect because a learner in a virtual space is engaged in a reflective thinking process of acquiring knowledge through the experience and prediction of the effect and result of an action. The learning effect is based on experience, which indicates that the learning effect depends on the learner's interpretations of the experience. [9] reported that simulations, algorithms and procedures, and parallelization of computational thinking are crucial for software developers, and simulation has the strongest impact on learning.

For effectiveness, virtual simulation must ensure that users experience 'Presence'. Presence is the state or feeling of 'being a part of the VR'[10,11]. Presence is a crucial psychological component that must be considered when developing educational content using VR and AR. The application of AR in special educational environments that consider factors of Presence, such as enjoyment and communication, would be effective[12]; in [12], the corresponding regression equation focused on positive expectations of applying AR. However, excessive immersion of AR can have adverse effects.

The positive and negative effects of technology used in educational fields must be considered. The positive effects of educational technology must be enhanced, whereas the negative effects should be minimized to amplify synergy. Rather than making vague claims that virtual simulations are either positive or negative for education, identifying the factors having positive and negative effects is essential. To analyze psychiatric traits influencing positive and negative effects of virtual simulations, such as VR and AR, developing educational content that apply these simulations is crucial.

This study used smartphones with virtual simulation, head-mounted display, and laptop. The participants were preservice teachers within an education recognition program. The study examined the perspectives of preservice teachers

on key concepts regarding future technology integration. These concepts affect future choices on the integration of technology and teaching. This study examined the psychiatric characteristics of preservice special education teachers by analyzing the paths of Presence factors influencing the positive and negative effects of virtual simulation.

1.1 Contents

The study method was as follows: First, a hypothesis path model of Presence factors influencing the positive and negative effects of virtual simulations in special education was proposed; second, the model was modified by verifying the goodness-of-fit; third, the path model for the Presence factors affecting expectations of the use of virtual simulation in special education and effect index of variables were proposed.

1.2 Definition of Terms

1.2.1 Virtual Simulation

Virtual simulation is an ICT that allows people to experience a virtual world. VR and AR are two conventional forms of virtual simulation. Although these two are different concepts, both these technologies can help experience a virtual world.

1.2.2 Presence

Presence here refers to telepresence, which is a phenomenon that enables people to interact with and vicariously experience the virtual world through technology. Presence is defined as a person's subjective sensation of experiencing a virtual scene depicted by a medium[13]. In this study, Presence factors refer to Enjoyment, Immersion, Reality, Performance, Accessibility, and Communication, which are examined using a factor analysis[12].

1.3 Hypothetical Path Model

The Presence factor of Experience in virtual simulation does not refer to the possibility of educational availability of this technology. The negative effects of the use of virtual simulation cannot be neglected. A previous study[12] reported that enjoyment is the most positive effect of virtual reality. By contrast, excessive immersion is the most negative effect, causing the inability of distinguishing between the real and virtual worlds. Therefore, this study conducted a path analysis with enjoyment and immersion as mediator variables that mediating the positive and negative effects of using virtual simulation in special education.

2. Method

2.1 Procedures and Participants

The participants were preservice teachers taking a class on special education technology at K and J university. Three lectures were conducted on this topic in total by the researcher. The complete subject comprises 9 teaching hours, which are categorized into three lectures of 3 hour.

The first lecture included a lecture on 'The Flow of Recent Educational Technologies.' The second lecture introduced applications of virtual simulation in special education. In the third lecture, preservice teachers were guided to experience VR and AR by using a smartphone application. Preservice teachers shared their views on the applicability of special education in the use of virtual and augmented reality applications. The main applications used in this study were as follows: (1) VR: "Roller Coaster VR" by Fibrum Limited (2) AR: "3D Augmented Reality" by Augment.

After the classes, they answered a questionnaire. Table 1 presents the participants of this study.

Table 1. Information on research participants (N = 76)

Division		*n*	%
Gender	Male	14	18.4
	Female	62	81.6
Major	Early-childhood special education	11	14.5
	Elementary special education	24	31.6
	Secondary special education	30	39.5
	Double majors	11	14.5
Grade	First	20	26.3
	Second	18	23.7
	Third	32	42.1
	Fourth	6	7.9
Total		76	100.0

2.2 Tools

2.2.1 Presence

Presence factors have been evaluated using tools developed by [12] based on [14] and [15]. The six factors were evaluated using 27-item tools: Enjoyment (8 items), Immersion (4 items), Reality (5 items), Performance (3 items), Accessibility (4 items), and Communication (3 items). The reliability (Cronbach's Alpha) of the tool was .617-.778.

2.2.2 Expectations of Use of Virtual Simulation Technology in Special Education

Expectations of using virtual simulation in education comprised 13 items, which were modified based on the items used in [12]. A factor analysis (principal component analysis and oblimin rotations) was conducted based on the data collected in this study and comprised 12 items representing positive expectations and negative concerns. The reliability of the factors for positive expectations and negative concerns was α = .870 and α = .799, respectively.

2.3 Analysis

The data were analyzed using a path analysis with AMOS v.23.0. The goodness-of-fit of the model was evaluated using $\chi 2$, NC(Normal Chi-square), TLI(Turker-Luwis Index), CFI(Comparative Fit Index), SRMR(Standardized Root Mean-square Residual), RMSEA(Root Mean Square Error of Approximation), and the direct, indirect, and total effects in the path model were evaluated based on the standardized β coefficients.

3. Results

3.1 Verification of Hypothetical Path Model

Figure 1 presents the hypothetical path model. The study examined the significance of the path of this model.

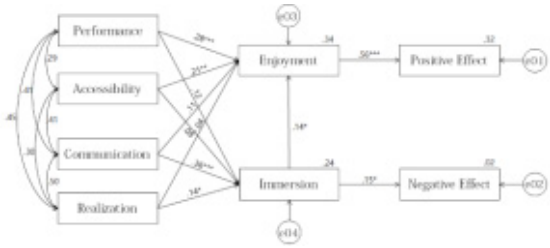

Fig. 1. Hypothetical Path Model

The results show that Enjoyment has a direct effect on positive expectations of applying virtual simulation technology in special education (β = .56, p < .001). Performance (β = .28, p < .001) and Accessibility (β = .21, p < .01) have direct effects on Enjoyment and indirect effects on positive expectations of applying virtual simulation technology in special education mediated by Enjoyment. Communication (β = .36, p < .001) and Realization (β = .14, p < .05) has direct effects on Immersion (β = .14, p < .05), which has a direct effect on Enjoyment and has an indirect effect on positive expectations of applying virtual simulation technology in special education. Moreover, Immersion has a direct effect on negative concerns of applying virtual simulation technology in special education (β = .15, p < .05). Communication (β = .36, p < .001)

and Realization (β = .14, p < .05) have an direct effect on Immersion (β = .14, p <.05) and have an indirect effect on negative concerns of applying virtual simulation technology in special education, which was mediated by Immersion.

3.2 Modification of Hypothetical Path Model

The following method was used to modify the hypothetical path model with reference to the theoretical explanation possibility and modification index. The non-significant paths were deleted, whereas significant paths that directly affected positive expectations and negative concerns about applying virtual simulation technology in special education were included. The covariance between positive expectations and negative concerns was set.

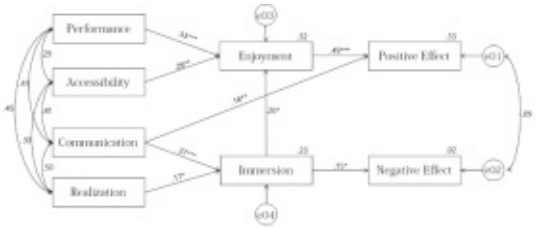

Fig. 2. Modified Path Model

Figure 2 shows the results of path model modification. First, Interaction (β = .49, p < .001) and Fun (β = .16, p <.01) have direct effects on positive expectations about applying virtual simulation technology in special education. Performance (β = .33, p < .001) and Accessibility (β = .26, p < .001) have an indirect effect on positive expectations mediated by Enjoyment (β = .49, p < .001). Communication (β = .37, p < .001) and Realization (β = .17, p < .05) have an indirect effect on Enjoyment mediated by Immersion (β = .20, p < .01) and have indirect effects on the positive expectation. Second, Immersion (β = .15, p < .05) has a direct effect on negative concerns about applying virtual simulation technology in special education. Communication (β = .37, p < .001) and Realization (β = .17, p < .05) have indirect effects on negative concerns mediated by Immersion.

Table 2 shows that both the hypothesis model and modified model were a good fit. However, the goodness-of-fit index of the modified model was better than the hypothetical model.

Table 2. Fitness comparison between hypothetical model and modified model

Model	$x^2(df)$	NC	TLI	CFI	SRMR	RMSEA	
						Lo	Hi
Hypothetical	16.652 (11)	1.514	.958	.984	.039	.000	.100
Modified	15.841 (13)	1.219	.982	.992	.037	.000	.084

3.3 Effects of Presence Affecting Expectation about Applying Virtual Simulation Technology in Special Education

Table 3 shows the direct, indirect, and total effects of presence affecting expectation about applying virtual simulation technology in special education.

Table 3. Effects of Presence Affecting Expectation about Special Educational Applying of Virtual Simulation Technology

(N = 76)

Dependent \ Independent		Realization	Communication	Accessibility	Performance	Immersion	Enjoyment
Positive-Effect	DE*	0	0.16	0	0	0	0.49
	IE	0.02	0.04	0.13	0.16	0.10	0
	TE	0.02	0.20	0.13	0.16	0.10	0.49
Negative-Effect	DE	0	0	0	0	0.15	0
	IE	0.03	0.06	0	0	0	0
	TE	0.03	0.06	0	0	0.15	0
Enjoyment	DE	0	0	0.26	0.33	0.20	0
	IE	0.03	0.07	0	0	0	0
	TE	0.03	0.07	0.26	0.33	0.20	0
Immersion	DE	0.17	0.37	0	0	0	0
	IE	0	0	0	0	0	0
	TE	0.17	0.37	0	0	0	0

* DE: Direct Effect, IE: Indirect Effect, TE: Total Effect

The results are as follows: The Presence factor with the strongest influence on the positive expectation of applying virtual simulation technology in special education is Enjoyment. The order of influence after Enjoyment is as

follows: Communication, Performance, Accessibility, Immersion, and Realization. Immersion has the strongest influence on negative concerns for applying virtual simulation in special education, followed by Communication and Realization. Factors influencing the Enjoyment experienced through virtual simulations are Performance, Accessibility, Immersion, Realization, and Communication. Factors influencing the Immersion experienced by using virtual simulations are Communication and Realization.

4. Discussion

This study aimed to provide fundamental information to develop educational content for employing virtual simulation in special education by conducting the path analysis of expectations of utilizing virtual simulation in special education.

In the path model, the Presence factors that directly affect positive expectations of applying virtual simulation in special education were enjoyment and communication. Therefore, although other factors have effects, the characteristics of virtual simulation can be sufficiently explained with only enjoyment and communication factors. These results are consistent with those in [12], which included research on AR. The enjoyment factor is crucial for developing the corresponding educational content. The positive effects of learning can be predicted by ensuring that education is fun and enjoyable as characterized by Edutainment. However, appropriate and meaningful content is required for individual students with special needs based on their cognitive and physical limitations as well as situational contexts. That is, educational content for children with special needs must not only consider fun but also ensure meaningful learning.

The Communication factor is thus a crucial variable in employing virtual simulation in special education. Considering special education for children from a social integration and generalization orientated perspective, communication is a meaningful educational subject for children with special needs and serves as an educational target. For children with special needs, who have severe developmental disabilities, cognitive development is stunted in the preoperation stage, and thus, these children require considerable time for learning social and cognitive interaction in the real world. The development of virtual simulations that can help children learn various social skills, such as following rules, learning playing skills, cooperating, and coping with conflicts, is essential to help them overcome developmental disabilities.

In addition to positive expectations of using virtual simulations in special education, negative concerns are also observed. Immersion is a psychological induction state that is considered crucial for the effective application of virtual simulation. Immersion is a mental state, wherein the person performing the activity is actively focused, actively involved, and enjoying the activity. Nevertheless, immersion is considered a negative effect of virtual simulation, and thus, excessive immersion is a concern. Apart from virtual simulation in education, excessive immersion is also a negative effect of computer games[16]. Such a negative influence of immersion may deteriorate the real life, causing physical and health problems, such as stunted growth.

The negative concerns regarding the excessive immersion of virtual simulation are attributed to the attractive and addictive nature of these simulations. If virtual simulation is used to induce immersion in children with special needs, a psychological state enhancing the learning effect can be induced. This effect can be utilized for attention-focused training among children with special needs having low awareness and attention. When immersed in a smart interface,

the brain regions necessary for learning, such as the occipital and parietal lobes, are activated[17].

Immersion is the key predictor of successful learning[18]. Learners immersed in the learning process are self-directed with interests and challenges in learning, whereas those who are not immersed encounter difficulties when performing learning tasks and passively complete the learning process. To bring human beings into a state of immersiveness through virtual simulation, we can provide suitable content that is similar to reality. That is, things that are not a reality must be made to look and feel realistic. However, learners are excessively focused on immersiveness, and they may experience difficulties in distinguishing reality from virtual situations, which may hinder their learning.

Although the magnitude of the effect on positive expectations about using virtual simulations in special education is different for all the six components, they were set as variables influencing positive expectations. Therefore, the Presence factors act as psychological mechanisms and parameters to characterize the positive expectations of using virtual simulation in special education.

5. Conclusion

The following conclusions can be derived based on the previous discussions. These days the commercial content development and dissemination of virtual simulation, such as VR and AR, are rapidly developing, and their use in education is actively discussed. We can observe both positive expectations and negative concerns about using virtual simulations in special education. Considering enjoyment and communication as crucial psychological factors in the development of educational content for virtual simulation and inducing appropriate immersion are essential. Virtuality should be used for supplementing activities in reality or for improving life in reality. It should not be a substitute for reality and should be used as a tool to expand experience and supplement weaknesses caused by the cognitive and social limitations of children with special needs.

This study provided fundamental information to develop educational content for applying virtual simulation in special education in the future based on the path analysis of the expected effect of using virtual simulation in special education. In order to utilize virtual simulation in special education, a follow-up study must be conducted. First, to apply virtual simulation in special education, basic studies implementing customized provisions for individualized demands of children with special needs are necessary. Second, developing and applying teaching-learning materials for children with special needs by using virtual simulations and analyzing the effects are crucial. Third, research must be conducted on the degree of preparation for virtual simulation in special schools (such as special classes).

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