

Study on the Development and Effects of A VR Educational Content for Nursing of Patients with Multiple Trauma

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Abstract

Nursing patients with multiple trauma requires competencies that can be earned from proper educational methods. This study is geared to use educational media to produce better effects on learning flow among nursing students. Therefore, this study developed a Virtual Reality (VR) educational content, which will create a simulation on nursing patients with multiple trauma and evaluated its effects to the users. This is an after only nonequivalent control group quasi-experimental study. First, the VR educational content on nursing patients with multiple trauma was developed based on ADDIE. Second, about 30minute program of the VR content was given to the experimental group while prints on multiple trauma situations were given to the control group. This study used SPSS 22.0 for Windows to analysis the data collected. The VR program developed in this study enhanced the competency on nursing patients with multiple trauma. However, it did not enhance the learning flow and knowledge on nursing trauma patients. Considering educational content, a visual limit of the existing simulation learning was supplemented. This study developed a VR educational content program on emergency service for patients with multiple trauma and assessed possibility and effects of the VR education, which is the first in Korea.

Keywords: learning, multiple traumas, clinical competence, nursing education, VR system

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1. INTRODUCTION

In Korea, more than 120,000 patients with severe trauma have been reported in a year, of which more than 10,000 (10%) were dead and as many as 3,500 might have survived if proper early intervention was given [1]. Medical personnel needs to quickly deal with multiple trauma situations to diagnose patients. Therefore, they should have extensive and organized knowledge on clinical situations so that they can identify and prevent potential risks in the patients [2]. When there are patients with multiple trauma on emergency situations, nurses classify the acuity should asses and manage the situations quickly and exactly [3]. They should be confident in

their capacity to deal with the patients calmly and effectively [4], which affects their judgement and nursing competency required in such clinical situations [5][6]. It is important for future nurses to have the said competencies in emergency situations [7].

However, due to the atmosphere of clinical situations where patients' safety and rights are emphasized, nursing students are faced with a number of limitations in applying nursing techniques and knowledge they learned [8]. The students' nursing practices are limited to prevent mistakes in judgement and nursing service, which have serious influence on prognoses of patients [9]. Therefore, to enhance nursing competence to

quickly and exactly cope with multiple trauma situations, nursing students should have nursing knowledge on patients with severe trauma. Also we should consider in developing educational methods and media that can enhance. For students to develop their skills quickly on coping with multiple trauma situations, the educational methods should be innovated using educational media with higher learning flow effect.

Previous studies focused on simulation education for which multiple trauma situations were applied: a study measuring emergency medical students' academic confidence and performance before and after the program based on a scenario of patients with multiple trauma in the head, the chest and the backbone[10]; the study measuring the performance of medical students after the program based on a scenario of patients with multiple trauma [11]; comparing the difference in post-knowledge and problem-solving ability between the test group and the control group after emergency medical students completed the program based on trauma situations outside hospitals[12], and; comparing the difference in knowledge on trauma patients and satisfaction in education of emergency medical students after they completed the program relating to assessment and treatment of trauma patients[13].

However, previous studies only on Emergency Medical Service or medical students and used high-fidelity mannequin simulators as a study method. As such simulation-based medical education provided safe environment to train students [14], it was a more effective alternative than traditional education methods, but it has a fatal limit because it could not realize peculiar things or changes in patients' conditions that required visual check in specific situations such as multiple trauma[15].

Therefore, whether a high-fidelity mannequin simulation is the most suitable educational method to maintain and train techniques to be acquired in diverse academic areas was questioned[16]. As an alternative of the existing mannequin-based simulation, a virtual reality simulation was developed. As technology advances and

accessibility to the virtual reality education media increases, its application area has been expanding[17][18].

In a virtual reality simulation, users representing individual avatars interact with experiences of objects and other subjects in three-dimensional virtual reality that realizes real scenarios in real-time simultaneously through the Internet or facility networks [19][20][21]. With the virtual reality technology, users who join the 3D virtual space can have diverse experiences in space as they want without time and spatial limits, and it can be actively applied in a number of areas including simulators, video industry, entertainment, medicine, construction and architectural design. The education sector has been using AI and digital education as central elements of the 4th Industry to nurture elites who have problem-solving skills, creativity and emotional intelligence rather than unilateral knowledge cramming education[22].

The virtual reality simulation has advantages of overcoming resource limitations of the existing simulation education and realizing interactive situations with sense of reality through extensive application of scenario design[23]. Also as it has high accessibility regardless of time and place, it can be used for long-distance education and repetitive learning and accommodate a number of students at the same time[24], Cook, et.al(2011)[25] suggested that the virtual reality simulation is appropriate to improve non-technical skills such as confidence, teamwork, communicative ability and clinical judgement ability.

When nursing students are employed, they require practical and effective education to enhance capability as nurses who are faced with emergency situations of patients with severe trauma. In consideration of advantages and limitations of the existing simulation education, it is believed that the virtual reality simulation that gives experiences of emergency situations and realizes clinical or visual changes in the conditions of bodies or patients with trauma is an appropriate education tool for clinical

practices of nursing students. However, there has been no case that it was systematically realized for nursing education in Korea.

Therefore, this study developed a virtual reality (VR) education content on nursing multiple trauma patients for which a multiple trauma situation scenario was applied based on ADDIE (analysis, design, development, implementation and evaluation) as a central development stage of teaching system design. It was tested among college nursing students and evaluated its educational possibility and effects. The results revealed that this study will prepare nursing students for clinical practice program and reinforce nursing capability and provision of high-quality nursing service [26]. It is suggested that the VR educational content on specific situations can enhance practical capability of preliminary nurses to manage emergency situations and make decisions real-time.

The aims of this study are to develop a VR educational content on nursing multiple trauma patients and identify its effects on learning flow, nursing knowledge on trauma patients, and confidence in nursing performance. The hypotheses are presented as follows:

Hypothesis 1. The experimental group who used the VR on multiple trauma patient nursing will have higher scores on learning flow than the control group.

Hypothesis 2. The experimental group who used the VR program will have higher scores on nursing knowledge than the control group.

Hypothesis 3. The experimental group who used the VR program will have higher scores on trauma patient nursing performance competence than the control group.

2. Materials and Methods

2.1. The Study Progress

To develop a VR program on nursing multiple trauma patients, this study used the five stages of ADDIE (analysis, design, development, implementation,

evaluation) Model [26].

2.1.1. The Analysis Stage

In this stage, the study analysed references and requirements of the focus group and interviewed a group of expert group. For the analysis of the references, this study pointed out VR keywords using an academic retrieval engine and analysed previous studies that have been published recent five years backwards. For the requirements analysis of the focus group, this study interviewed ten college nursing students who had experiences of emergency nursing practices while for the expert group interview, three emergency medical service professors were interviewed, both in a semi-structured method

2.1.2. The Design Stage

This stage designed educational goals and developed educational content based on the results of what was investigated in the analysis stage. The educational goals were to improve nursing knowledge on trauma patients and confidence in nursing performance. The educational contents were made up of inpatient situations, acuity assessment at the first sight, the first investigation results, frequently-complaining symptoms, the Korea Triage Acuity Scale (KTAS) stage and initial vitality signs and case information. They were developed into a scenario referring to the KTAS. The scenario described a 40-year-old man who fell from the 5m height and was transferred to the emergency by 119. Also, it provided an extra prescription and examination results according to the situation flow to control change in the patient. The study included the contents to judge the patient's condition in the VR program, preparing objects needed and deciding nursing intervention referring to educational textbooks relating to nursing care. To investigate whether the content reflected clinical fields and was suitable for educational goals, we consulted five medical experts were consulted (two emergency medical specialists and three nurses, both who had more than five years of career in emergency) and completed the contents based on the consultation.

2.1.3. The Development Stage

In this stage, the VR program was developed and

realized. First, as an educational material, this study developed a VR based content that can realize a clinical situation simulation according to the educational goals and applied it to actual education. The content was created based on VR development methodology and after consultation with a web programmer of VR producer. In the VR scenario, a patient visited the emergency due to severe multiple trauma for the first time in his or her life and nursing students judged acuity and provided proper nursing service to him or her. To investigate whether the VR scenario reflected the clinical field well and was suitable to enhance communicative skills, five clinical experts were consulted (two adult nursing professors, two basic nursing professors and one nurse, all who had more than five years of career in emergency) and completed the contents based on the consultation.

2.1.4. The Performance and Evaluation Stage

To know whether the educational goals and system of the developed educational program were good in effective composition and operation, a group of eight specialists consisting of two emergency medicine professors and five nurses, both who had more than 5 years of career in emergency service, joined in the content validity test and evaluation. All the specialists evaluated that they were good: the content validity index of the goals (CVI) was 1.0, and that of the educational system was 0.78-1.0.

As a result of analysing the evaluations of the VR content made by the subjects of the preliminary test, it was discovered that they were positive to the VR experiences and suggested that flow-related elements in its realization should be enhanced.

They also positively expressed their opinions that they would have more confidence in clinical performance and achieve higher academic results through the entire curriculum. Therefore, the study considered their suggestions and evaluations on the preliminary implementation in patients, objects and situations for final revision of the scenario.

2.1.5. The Program Decision and Application

After evaluation and preliminary implementation of the program, the VR educational content on nursing patients with multiple trauma was

developed and realized. The time required to achieve the educational goals with the use of the VR content program was about 10 minutes and the time for debriefing of the evaluation results was about 30 minutes. Both the experimental group and the control group were given information on the scenario of multiple trauma situation. The educational process was applied for the experimental group for about 30 minutes while printouts on the multiple trauma situation were given to the control group. The VR program was applied and evaluated in the school VR room and after the application, the subjects were asked to submit self-reported answers on the degree of learning flow, nursing knowledge on trauma patients and confidence in nursing performance.

2.2. The Study Design

This is an after-only non-equivalent control group quasi-experimental study to develop a VR educational content on multiple trauma patient nursing for nursing students. It tests its effects on learning flow, nursing knowledge and competence in nursing performance.

2.2.1. The Subjects and Data Collection

This study subjects were selected among the 3rd and 4th grade college nursing students from the same university through convenient sampling. The number of samples considered was 52 (26 for each group), based on the significance level (α) of .05, statistical power ($1-\beta$) of .80, and effect size of .70 [27], as presented in Table 2. Considering the drop-out rate, this study decided that both groups should have about 30 subjects - 32 in the experimental group and 31 in the control group. One from the experimental group refused to participate in the study and two from the control group dropped out. Therefore, the final subjects consist of 31 from the experimental group and 29 in the control group, a total of 60 subjects.

2.2.2. The Study Tool

After the subjects used the VR content, the learning flow, nursing knowledge, and confidence in nursing performance were measured. The learning flow indicates optimal experience where students

completely concentrate on their learning [28]. The tool used was modified and supplemented by Lee Seong Hun to fit Korea's education based on Csikszentmihaly's nine sub-factors of learning flow, which appeared in the learning situations. The tool was self-reported type and was composed of 13 questions with five-point Likert scale. The higher the scores, the higher the learning flow. The reliability of the previous study [29] and this study was both Cronbach's $\alpha = .79$.

To evaluate trauma patient nursing knowledge, this study developed 10 questions on diagnosis, care and nursing of multiple trauma situations based on the Trauma Nursing Core Course (TNCC) [30]. To investigate the content validity of the tool, a group of eight specialists joined the test consisting of two professors on Emergency Medical Service, one Emergency Medical Specialist, and five nurses, all of whom had more than five years of career in emergency unit. The Content Validity Index [CVI] of the whole questions was 0.75. As for the nursing knowledge the subjects acquired after the VR learning, they were asked to answer in two ways: right or wrong. One-point score was given to the right answer and zero score to the wrong answer. The scores ranged from 0 to 10 indicating the level of their acquired nursing knowledge. The reliability of the tool was KR-20 = .77.

The questions of the confidence evaluation tool were based on the VR content on multiple patient nursing developed. The same set of eight specialists, as mentioned earlier, analysed the content validity of the tool. The self-reported type tool was composed of 10 questions with four-point Likert scale. The higher the scores, the higher the confidence they have. Its reliability was Cronbach's $\alpha = .79$.

2.2.3. The Data Analysis Method

This study used SPSS 22.0 for Windows to analyse the data collected. First, general characteristics of the subjects were analysed with the use of real number and percentage. Second, normality of the variables both in the experimental group and the control group was analysed with the

use of the Kolmogorov-Smirnov test and it was confirmed that all the variables followed normal distribution. Third, the hypotheses were analysed with the use of an Independent t-test. Fourth, the reliability as internal consistency of the research tool was calculated into Cronbach's alpha.

3. Results

3.1. Development of a VR Educational Content on Nursing of Multiple Trauma Patients

The VR educational content program on multiple trauma patient for nursing students was finally completed via the five-stage process of the ADDIE model from October 2017 to December 2018.

3.1.1. Patient Information: Condition Check

When a multiple trauma situation occurred, the VR program provided evaluation information on the first impression of the patient, frequent complaints and nursing inspection results (information on accidents, vitality signs, pain and results of physical examination).

3.1.2. Preparation for Emergency Supplies and Objects Check

The VR environment showed emergency supplies and facilities including patient monitoring equipment, injection pumps, emergency carts and defibrillator. What was seen in the screen where emergency objects were prepared was composed of emergency medicine used for multiple trauma patients and emergency care activity. Click the parts of medicine or care, and pop-up windows were opened.

3.1.3. Emergency care Preparation : Prioritization

After emergency care objects were checked up, the subjects were asked to prioritize the objects and care steps. For the sense of reality, the part they selected was visually applied to the patient.

3.1.4. Emergency care Completion

If the subjects applied all the care required for the patient in the VR and the patient got better, emergency care ended. After the situation was completed, nursing records that were arranged hourly were shown to them so that they could recall the situation and organize it efficiently.

3.2. The Subjects' Demographical Characteristics

The number of the subjects in the study was 60 consisting of 10 male subjects (16.7%) and 50 female (83.3%). Their average age was 23. From the previous semester, 21 of them (35.0%) had below 3.0, 30 (50.0%) had over 3.0 and below 3.5, 13 (21.7%) had over 3.5 and below 4.0, and 8 (13.3%) had over 4.0. For major satisfaction, 5 (8.3%) chose low, 30 (50.0%) chose medium, and 25 (41.7%) chose high. For practice satisfaction, 3 (5.0%) resulted low, 30 (50.0%) resulted medium, and 27 (45.0%) resulted high.

3.3. The Effects of the VR Educational Content Application

Hypothesis 1. To verify the hypothesis that the experimental group who used the VR-tool will have higher scores in learning flow than the control group, this study analysed the scores of learning flow of the two groups after they used the VR. However the learning flow score of the experimental group was $3.43(\pm.59)$ and that of the control group was $3.19(\pm.48)$. As there was a significant difference between the two groups ($t=1.703$, $p=.094$), Hypothesis 1 was rejected (Table 2).

Hypothesis 2. To verify the hypothesis that the experimental group who used the VR-tool will have higher scores in nursing knowledge than the control group, this study applied the program for the two groups and analysed their nursing knowledge scores. As a result, as it was discovered that the learning flow score of the experimental group was $7.71(\pm1.53)$ and that of the control group was $7.00(\pm1.79)$. As there was not a significant difference between the two groups ($t=1.652$, $p=.104$), Hypothesis 2 was rejected (Table 2).

Hypothesis 3. To verify the hypothesis that the experimental group who used the VR-tool will have higher scores of nursing performance competence than the control group, this study applied the VR for the subjects and analysed their scores. As a result, it was discovered that the learning flow score of the

experimental group was $3.37(\pm.24)$ and that of the control group was $2.88(\pm.26)$. As there was a significant difference between the two groups ($t=7.484$, $p<.001$), Hypothesis 3 was accepted (Table 2).

4. Discussion

The results of the study revealed that there were no significant differences in the learning flow between the two groups after the VR program was applied. Although direct comparisons and analysis were not available as there were no previous studies that verified the effects of the VR educational content on learning flow, some of the previous studies on the correlations between learning flow of elementary school students and factors of virtual reality media [31] reported that there were high correlations between learning flow and virtual reality. They also reported that as there were positive correlations between learning flow and a virtual reality education when the subjects understood characteristics of the media very well, the factors that have effects on learning flow in virtual reality space should be analysed [31]. Therefore, it is suggested that in respect to the VR content on nursing multiple trauma patients, further studies should deal with personal characteristics of students and teaching design factors. For effective design of the VR program, frameworks should be organized to increase learning flow and virtual reality should have higher sense of reality.

In terms of nursing knowledge, there were statistically no significant difference between the two groups after the VR program was applied. As there were not previous studies that verified the effects of the VR content for nursing students on learning flow, direct comparison and analysis were not available. The previous studies on the VR program on tooth extraction for Dental Science students [32] reported that there were no significant differences in dentistry knowledge between the experimental group and the control group, which was similar to the results of this study. That is, as it can be inferred that knowledge applied for special

situations such as multiple trauma patient nursing did not change according to the types of learning media, therefore, new education contents should be developed for which diverse contents are combined with learning media and accumulate relevant data through studies to verify the effects of improvement of knowledge.

It was also discovered that the subjects achieved statistically significant high competence scores after they were trained through the VR program. Although direct comparison and analysis were not available as there were no previous studies that verified the effects of the VR content on multiple trauma patient nursing competence. It was suggested that the VR program used in this study would have positive effects on nursing competence of nursing students.

5. Conclusion and Suggestions

This study developed a VR content program on nursing multiple trauma patients based on the ADDIE model and evaluated its effects on nursing students. The program improved nursing competence, but the effects on learning flow and nursing knowledge were not found.

For education of capable nursing students who can provide high-quality nursing service, diverse and advanced curricula are needed. Therefore, this study developed a VR program on nursing multiple trauma patients by supplementing the limitation of visual restriction in existing simulation education and evaluated its possibility as an educational material and its effects on quality improvement of nursing students. Furthermore, it is expected that the program will contribute to improve the clinical capability of future nurses through simulated experiences in the similar environment to clinical situations which will help preliminary nurses with provision of clinical safety for patients.

The results of this study are presented as follows: First, as the VR program can be used effectively in educational fields for nursing students and diverse clinical fields, the results of this study will be basic data for further development of VR contents.

Second, as clinical fields may be somewhat different according to medical environment of hospitals given, if only software is modified, clinical fields can be realized in diverse ways and if small investment to basic equipment is made, extra expenses are needed and maintenance and repair expenses will be saved. Third, it is expected that this study will provide a new horizon in the aspect of nursing research through academic exchanges and research as the cornerstone of multi-disciplinary research.

Based on the results above, this study made the following suggestions: First, this study verified only nursing knowledge and competence required in nursing service, but as effective communication with the subjects accompanied during nursing service is also important, further contents on integrated nursing capability should be developed. Second, additional VR contents are developed and studies to verify their effects should be continued.

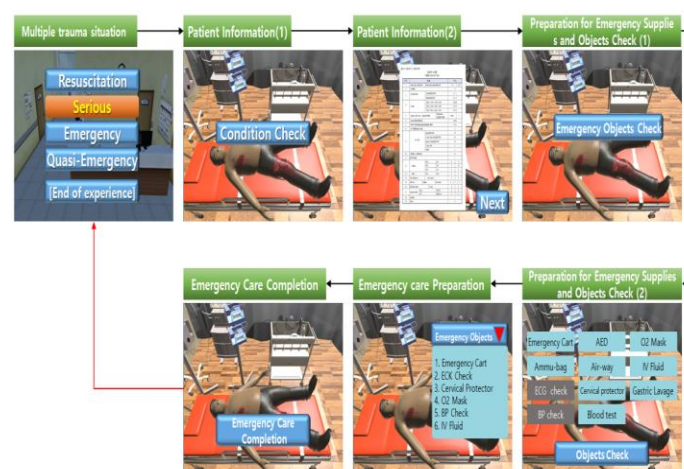


Figure 1. VR contents

Table I. Demographics

		N	%
Gender	Male	10	16.7
	Female	50	83.3
Age	≤20	21	35.0
	21-25	30	50.0
	≥26	9	15.0
credits of previous	≤3.0	18	30.0

semester	3.0-3.5	21	35.0
	3.5-4.0	13	21.7
	≥4.0	8	13.3
major satisfaction	low	5	8.3
	medium	30	50.0
	high	25	41.7
practice satisfaction	low	3	5.0
	medium	30	50.0
	high	27	45.0
experiences of simulation	no	52	86.7
	yes	8	13.3
experiences of VR education	no	59	98.3
	yes	1	1.7
VR experience	no	42	70.0
	yes	18	30.0
total		60	100.0

Table II. . Comparisons of learning flow, nursing knowledge, and nursing competence on trauma patients between Groups

Variables	Groups	M±SD	Levene		T	
			F	p	t	p
learning flow	Exp.(n=	3.43(±.	1.0	.3	1.	.0
	Cont.(n	3.19(±.				
nursing know ledge	Exp.(n=	7.71(±1	.03	.8	1.	.1
	Cont.(n	7.00(±1				
nursing comp etence	Exp.(n=	3.37(±.	.02	.8	7.	.0
	Cont.(n	2.88(±.				

Exp.=experimental group; Cont.=control group; VR=virtual reality

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