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The Development of an Instructional Model of Holographic Standardized Patient-based Learning for Enhancing Clinical Reasoning skill in Undergraduate Healthcare Education

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Abstract

The use of holographic standardized patient (HSP) with mixed reality can provide students with the opportunity to enhance clinical reasoning skills. This is still relatively new, so there is a lack of guidelines for educators. Thus, we aimed to develop the instructional model of HSP-based education, for enhancing clinical reasoning skills in undergraduate healthcare education, which could systematically guide educators in designing and implementing HSP-based teaching and learning activities appropriately. Using a design and development research, a theoretically constructed initial mode in this study was iteratively improved and underwent validation through expert review and model usability test. Features of the model were discussed, along with theoretical and practical implications and suggestions for further research.

Keywords: *Holographic standardized patient-based learning, Clinical reasoning skill, Instructional model, Undergraduate healthcare education*

1. INTRODUCTION

Educators face the challenges in offering opportunities for students to practice and develop clinical reasoning skills in undergraduate healthcare education [1]. Clinical reasoning is defined as being the health professional thought process or the decision-making process [2]. Due to the COVID-19 pandemic, it is difficult for health students to practice their clinical skills with patients in hospitals.

As a type of mixed reality (MR), *HoloPatient* is a form of holographic standardized patient (HSP) produced commercially by GIGXR. *HoloLens* wearers can use this application in-person and/or remotely. It provides *HoloLens* wearers with access to a HSP displaying various symptoms and behaviors that can be downloaded and placed in any environment. Thus, it allows students to collect visual and aural cues while learning and developing assessment and clinical reasoning skills [3-4].

Recent studies have reported on the positive effects of HSP-based education on clinical reasoning skills in undergraduate nursing students [3-4]. Despite the benefits of HSP-based education in undergraduate healthcare

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education [3-4], it is still new. Thus, there is a lack of guidelines for educators who want to design and implement it in undergraduate healthcare education [5].

We aimed to develop an instructional model of HSP-based education, which will be significant to assist educators in teaching students clinical reasoning skills, using the HSP.

2. METHODS

2.1 Design

This study used a design and development research method to develop an instructional model of HSP-based learning for enhancing clinical reasoning skill, and to verify its validity. The model development procedure is as follows (figure 1).

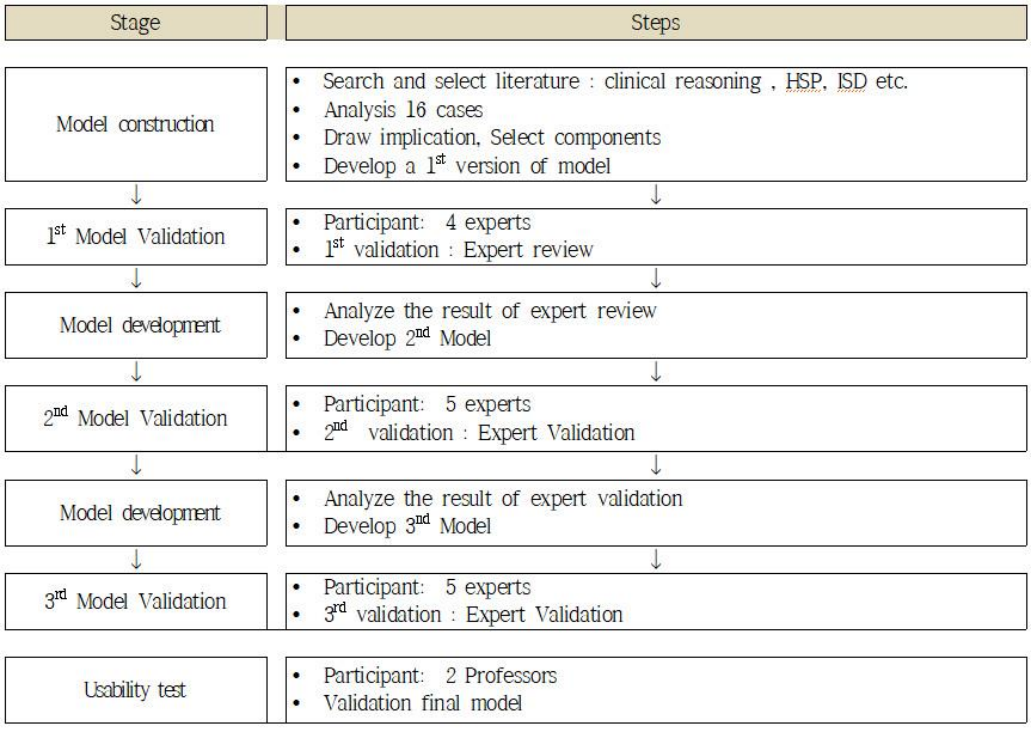

Figure 1. Research Procedures

2.2 Procedure

2.2.1 Development of the initial model

We developed the initial instructional model through literature analysis, considering the 8-step Clinical Reasoning Cycle [6]. We started the foundation of the initial instructional model to explore the models of clinical reasoning-based and HSP-based education. Then, we analyzed the instructional process of the 16 *HoloPatient* cases, and developed the initial model based on the framework of the 6-step Clinical Reasoning Cycle modified from the original one [6].

Four experts within a research team who have expertise and experience in HSP-based education conducted the first expert review to verify its validity.

2.2.2 Second and third expert validation

Five professors who have expertise and experience in HSP-based education completed the validation tool [7] for second and third expert validation (Table 1). This tool was a 5-point Likert scale, containing items related to content validity, comprehension, explanatory power, usefulness, and universality of the design model.

We used the content validity index (CVI) and inter-rater agreement (IRA), which represent the integrity of a model. It means the validity of the components of a model.

Table 1. Expert profiles of 2nd and 3rd expert validation

Participants	Position	Years of teaching experience	Expert field	Second	Third
A	Professor	21	Medicine	√	√
B	Professor	19	Medicine	√	√
C	Professor	20	Nursing	√	√
D	Professor	20	Nursing	√	√
E	Professor	19	Medicine /Instructional Design	√	√

2.2.3 Model usability test

The model following the third validation process underwent a usability test. One medical professor and one nursing professor who have expertise and experience in HSP-based education participated and completed open-ended questions to evaluate its usability.

3. RESULTS

3.1 Initial instructional model

The initial model was based on the framework of the six-step Clinical Reasoning Cycle [6]. In the first step, students are to consider the overall situation, meeting the HSP as health professionals. This includes the circumstances in which students understand and describe the HPS's situation and list what they see, hear and feel.

In the second step, students are to collect information, observing the HSP, and identify main cues from collected information.

In the third step, students are to systematize the information and derive the HSP's problems and major issues based on it. They also need to infer causes and results of the problems based on identified information with relevant evidence.

In the fourth step, students are to set goals for the expected outcomes, and suggest plans (i.e., treatment, test and care) for HSP, synthesizing identified information and contents.

In the fifth step, students are to suggest the expected outcomes and describe the effect of whether the HSP's condition can be improved through suggested plans.

Finally, students are to reflect on the whole process and summarize what has been learned newly through this process. They are also to think about what they could have done differently from what they learned in this process, completing the entire 6-step process.

3.2 Secondary instructional model

The initial model was revised via expert review. Through reflecting on its process and sharing their insights, major improvements were conducted as follows: intuitiveness to be increased by displaying the overall flow of the instruction in steps, guide of the teaching-learning process in detail, description of the facilitator role, and guide for HSP and learning resources each clip. The secondary model was as follows (Figure 2).

HSP Learning cycle		T/L Activity	Learner	Facilitator	
Consider the situation	1	Analyze situation before Meeting the HSP	Brief analyze situation with case scenario (clustering data/potential problem/action)	Present a brief scenario	Scenario Guided Q P or Group
		Meet the HSP	Observe Assess: Physical, Lab., Environment Sense -Take note	Have the leaner view Clip ! Remote or online Observe learners Trouble-shooting	MR HoloLens/ PC HSP Clip !
Collect cues/information	2	Collect cues/ information	Collect information: Review current event, Gather new information Select cues Recalled knowledge on the specific case - Group discussion	Facilitating for group discussion (step-by-step discussion)	Guided Q
Identify problems/issues with potential cause	3	Identify problems/ Issues with potential cause	Analyze data (normal and abnormal signs & symptoms) relevant information/ important information Cluster relational data/cues together Match current situation to past Synthesize cues/information Logical inference Suggest potential cause Define diagnosis of the HSP's problems	Facilitating for group discussion	Guided Q
Action plan with rationale	4	Action plan with rationale	Establish goals Desired HSP's prognosis or outcome		
			Suggest actions with rationale Select and suggest actions to implement treatment, test, and care		
			assessment changes/possible causes		HSP Clip 2
Expected outcomes	5	Expected outcomes	Predict HSP's outcome with suggested actions		
			Find assessment findings/Physiologic effect		HSP Clip 3-N
Reflection	6	Reflection	Debriefing: Reflect on the process and new learning and beyond it		

Figure 2. Secondary Instructional Model of Holographic Standardized Patient-based Learning for enhancing Clinical Reasoning skills in Undergraduate Healthcare Education

3.3 Final instructional model development and validation

Five experts were asked to complete the validation tool regarding secondary model. The CVI for each item and the CVI in this study were 0.8 or higher following two expert validations (Table 2). It indicates that the validity of the final model is acceptable [8].

3.4 Results of model usability test

The usability test was conducted to evaluate its applicability in a teaching-learning context [9]. Two educators designed and implemented a 3-hour course in adult health nursing and emergency medical practice, respectively, using the instructional model and anaphylactic shock HSP case. They started with a 20-minute orientation, including the course outlines that describe the learning objectives, process, methods, assessments, and students' roles. Then, twenty five students formed a group of 5 persons in group (i.e., 5 groups in total) and educators provided students with guides to use *HoloPatient* and *HoloLens.*

For the next 130 minutes, students were engaged in HSP-based learning activities through interactive learning and active participation. The interactive approach was facilitated with HSP observation and assessment, group discussion, selected presentations, and non-judgmental feedback from educators as a facilitator. Before observing CLIP 1, educators explained the brief scenario about anaphylactic shock, facilitated students to discuss in groups, using guided Q1 and then participated in a whole discussion and selected presentations for 10 minutes. They assisted students in groups in observing and assessing CLIP 1 of the HSP experiencing anaphylactic shock for 15 minutes, and then facilitated them to discuss in groups, using guided Q2 and participated in a whole discussion and selected presentations for 15 minutes. Educators assisted students in groups in observing and assessing the CLIP 2 for 10 minutes and let them discuss in groups, using the guided Q 3, 4, and 5, and then participated in a whole discussion and selected presentations for 25 minutes. They assisted students in groups in observing and assessing the CLIP 3 for 20 minutes and let them discuss in groups and then participated in a whole discussion and selected presentations for 15 minutes.

At the end of course, students participated in a 30-minute debriefing following the 20-minute self-reflection.

Regarding participating educators' perspectives on the instructional model, they generally reported satisfaction with the instructional model of HSP-based learning. They reported that the process of activities each clip facilitated active learning and deep learning (i.e., problem solving). They also mentioned that the final step of debriefing helped summarize the whole case of HSP:

The process of small group discussion, selected presentation, and discussion in whole was helpful to identify areas that were not identified or should be kept in mind. (Instructor A)

…, it was a good opportunity for students in groups to share their thinking about symptoms and signs of the HSP change according to the level of severity. It helped them get to know how colleagues solve problems and recognize other perspectives in the same situation. (Instructor B)

Educators made some recommendations for its improvement. They suggest that the writing method needs to be specified, depending on observing method of the HSP to facilitate active and deep learning:

3.5 Final instructional model

The final model has six steps as follows (Figure 3).

3.5.1 Step 1: Consider the situation

In order for students to understand the HSP's situation before meeting it as health professionals, educators present the HSP's situation briefly to students. Students think about what problems the HSP has and what to do.

Then, educators assist students in groups in meeting the CLIP 1 of the HSP directly or indirectly. The educator (or students) wears the *HoloLens*, providing students with an opportunity to meet the CLIP 1 of *HoloPatient*. Students write what they understand about the HSP's situation and assess, seeing, hearing, and feeling individually or in group, as well as the test results and environmental conditions around the HSP Depending on the severity of the HSP and the level of the student, students can observe one or several CLIPs in module step by step. In this process, educators need to monitor the learning environment (e.g., solving technical problems).

Table 2. Result of Validation

	Questionnaire	Respondent					CVI	IRA
		A	B	C	D	E		
Validity	All steps were suitably presented in this model	5	4	4	5	4	6/6=1	9/9=1
	The phases in this model were arranged in an appropriate order	5	4	4	5	4	6/6=1	
	This model includes all the components for instruction of HSP-based learning for undergraduate class	4	4	4	5	4	6/6=1	
	This model includes guideline of each phases for instruction of HSP-based learning	5	4	3	5	4	5/6=0.8	
Comprehensibility	The activities and procedures of the instructional of HSP-based learning were explained clearly in this model	4	4	4	5	4	6/6=1	
Explicability	The HSP-based learning class activities and procedures are easy to understand.	4	4	3	5	5	5/6=0.8	
	This model was helpful to draw a big picture of the instructional phases and activities of the instruction of HSP-based learning	5	5	4	5	4	6/6=0.8	
Usability	This model was valuable to use for implementing the instruction of HSP-base learning	5	5	4	5	4	6/6=1	
Generality	This model could be generalized and/or applied to other HSP-based learning instructions besides an instruction of clinical reasoning skills	5	4	4	5	4	6/6=1	

3.5.2 Step 2: Collect cues and information

Students conduct a small group discussion to collect information they observed from the HSP and identify information that can be a major clue to the HSP with prior knowledge. Educators present prepared questions and proceeds step-by-step, or two or three questions at a time according to a pre-planned time. Then, the educator selects two groups to present their discussion in whole. Thus, students can share and summarize the information and cues in whole. Educators also provide feedback on this and allocates time according to the operation guideline.

3.5.3 Step 3: Identify problems and issues with potential cause

Students are to systematize information collected through group discussion and identify major issues related to problems of the HSP. They elicit actual problems of the HSP and issues related to potential problems from the identified information. They present the relevant evidence, inferring the cause and result of the problem from the identified information, and diagnose the HSP's problem through logical reasoning.

Educators provide feedback, so that students can share the contents of small group discussion through discussion and presentation in whole. If necessary, students can meet the CLIP 2 of the HSP in advance.

3.5.4 Step 4: Action plan with rationale

Students set goals for expected changes, prognosis or outcomes in the HSP's situation, plan and suggest necessary treatments, tests, and care to be performed, synthesizing all information and problems found previously. They also find changes in HSP's severity and progress according to evidence and treatment. Educators conduct this process, guiding small group discussion and selected presentations in whole, and providing feedback.

3.5.5 Step 5: Expected outcomes

Students present expected outcomes from treatment or care they suggested, and predict the HSP's prognosis and results, predicting the HSP's outcomes, and evaluating the results.

Then, educators select two groups to present the discussion in whole, collect, and organize additional contents and give feedback on this.

3.5.6 Step 6: Reflection

Students reflect on the whole process and summarize what they have learned newly individually. Before debriefing, educators provide time for students to write and think about how to deal with a similar patient in future, and what can be done differently from what was learned this time.

During debriefing, students are to recall the learning process and reflect through discussion and presentation of new and additional learning, and educators provide feedback as needed. Debriefing tool prepared in advance should be used.

After completing the CLIP 1 of HSP-based learning in this way, students can meet CLIP 2 - CLIP N of the HSP through the above steps. A second or other CLIP of the HSP can be planned in advance and put into an appropriate stage for use. Educators do not need to go through all of the above 6 steps. Within the scope that can achieve learning goals, they can expand or reduce steps flexibly depending on the planned HSP-based learning hours in courses, the number of students and devices, internet conditions, etc.

4. DISCUSSION

This study was a developmental investigation of a process for constructing and validating an instructional model of HSP-based learning for enhancing clinical reasoning skill. The instructional model developed in this study has six steps and includes the teaching and learning activities required in each step.

The model developed in this study is meaningful in that it specifically suggested the teaching and learning activities educators could take during the HSP-based education to improve students' clinical reasoning skills. This study verified the applicability of the model through expert review and usability test in undergraduate healthcare education. Thus, it is significant to provide theoretical and practical guidance on HSP-based learning for enhancing clinical reasoning skill.

Step		**Activity**	
		Learner	**Facilitator**
Consider the situation	Analyze situation before meeting the HSP	- Brief analyze situation with case scenario (clustering data/potential problem/action)	- Present a brief scenario
	Meet the HSP	- Observe and assess a HSP in-person or remotely - Take note what is observed and assessed	- Have the learner view Clip 1 in-person or remotely - Monitor leaners' activity - If needed, trouble shooting solving
Collect cues/ information		- Collect information: Review current event, and gather new information - Select cues - Gather recalled knowledge on the specific case - Group discussion	- Facilitating for group discussion, selected presentation and feedback in whole
Identify problems/issues with potential cause		- Analyze data (i.e., normal/abnormal sign & symptoms), relevant and important information - Cluster relational data/cues together - Match current situation to HSP's background - Organize cues/information - Logic inference - Suggest potential cause - Define diagnosis of the HSP's problems and potential problems	
Action plan with rationale		- Establish plans for HSP - Establish desired HSP's outcome	
		- Suggest actions with rationale - Select and suggest action plans for diagnosis, treatment, care and management.	
		- Find assessment changes / possible causes	
Expected outcomes		- Predict HSP's outcomes with suggested actions	
		- Gather assessment findings and improved	

	outcomes	
Reflection	- Debriefing : Reflect on the process and new learning and beyond it	Debriefing provided with debriefing tool

Figure 3. Secondary Instructional Model of Holographic Standardized Patient-based Learning for enhancing Clinical Reasoning skills in Undergraduate Healthcare Education

5. CONCLUSION

As the HSP-based education is a new technology-based educational methods, this study focused on developing an instructional model for educators who would like to design and implement it in undergraduate healthcare education practically. Future studies should focus on evaluating the impact of the instructional model of the HSP-based learning on clinical reasoning skill.

The model developed in this study was designed and implemented from a single case. Thus, more cases of the HSP in various courses need to be use for confirmation in more.

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