Evaluation of Online Virtual Patient Simulation for Emergency Patient Management Training Through Meaningful Learning
Çevrim içi Sanal Hasta Simülasyonu ile Yapılan Acil Hasta Yönetimi Eğitiminin Anlamlı Öğrenme Üzerinden Değerlendirilmesi

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Abstract

Aim: Virtual patients have started to be widely used in case-based education. Designing, developing, and evaluating the effectiveness of virtual patient-based education through meaningful learning are limited. This study aims to evaluate the effectiveness of on-line virtual patient-based emergency patient management training from the perspective of students' experiences in terms of meaningful learning.

Methods: The Acibadem University Emergency and First Aid Department (Paramedic) students participated in case-based education related to emergency patient management as part of their curriculum in the 2019-2020 academic year. The education was conducted on-line using the virtual patient simulation, which was designed according to the FTL (Facilitation, Education, Learning) model developed by Keskitalo. A total of 40 students were divided into four subgroups, and each group of 10 students participated in three different virtual patient sessions. Each group attended three sessions related to emergency patient management, and each participant actively participated in emergency patient management. Student opinions about the virtual patient education were evaluated through pre- and post-course questionnaires. The questionnaire used by Keskitalo included expectations and experiences related to meaningful learning. The data was analyzed using descriptive statistics. The differences between students' expectations and experiences were compared using the paired t-test.

Results: Thirty-eight students who participated in the course responded to the on-line questionnaires. The questionnaires had seven main headings and 14 subheadings, and a Likert-type evaluation was conducted. The evaluation was conducted under seven main headings: concrete experience, social constructivism, emotional dimension, metacognition, competence, individuality, and goal-orientedness. It was found that the students' experiences of meaningful learning, which were based on concrete experience, metacognition, individuality, and competence, exceeded their expectations (p < 0.05). However, the emotional and socio-constructive dimensions of meaningful learning did not show a significant difference between expectations and experiences after the education.

Conclusions: The use of on-line virtual patients in emergency patient management training structured according to Keskitalo's FTL model has met students' expectations in terms of meaningful learning.

However, more comprehensive research focusing on the emotional and socio-constructivist aspects of meaningful learning is needed during the process of integrating on-line virtual patient simulation training into the curriculum.

Özet

Amaç: Sanal hasta özellikle olguya dayalı eğitimlerde yaygın olarak kullanılmaya başlanmıştır. Sanal hasta temelli eğitimlerin planlanması, yapılandırılması ve anlamlı öğrenme üzerinden etkinliğine yönelik çalışmalar sınırlıdır. Bu çalışmada çevrim içi sanal hasta kullanılarak yürütülen acil hasta yönetimi eğitiminin anlamlı öğrenme yönünden etkinliğininin öğrencilerin deneyimleri üzerinden değerlendirilmesi amaçlanmıştır.

Yöntem: Acıbadem üniversitesi Acil ve İlk Yardım Bölümü (Paramedik) öğrencilerinin katıldığı müfredatın bir parçası olan acil hasta yönetimi ile ilgili olguya dayalı eğitimler 2019-2020 yıllarında bir kolaylaştırıcı rehberliğinde sanal hastalar kullanılarak çevrim içi olarak gerçekleştirildi. Eğitim Keskitalo'nun simülasyona dayalı eğitim yönteminin yapılandırılması için geliştirdiği FTL (kolaylaştırma, eğitim, öğrenme) modeline uygun olarak tasarlandı. Toplam 40 öğrenci dört alt gruba ayrıldı ve 10 kişiden oluşan her grup üç farklı sanal hasta oturumuna katıldı. Her grup acil hasta yönetimi ile ilgili üçer oturuma katıldı ve her katılımcı aktif olarak acil hasta yönetiminde görev aldı. Eğitim öncesi ve sonrası öğrencilerin anlamlı öğrenme yönünden sanal hasta eğitimi hakkındaki görüşleri beklenti ve deneyim ölçekleri ile değerlendirildi. Keskitalo'nun anlamlı öğrenmeye yönelik geliştirdiği beklenti ve deneyimlerin değerlendirmesini içeren ölçek kullanıldı. Veriler tanımlayıcı istatistikler kullanılarak analiz edildi. Öğrencilerin beklentileri ve deneyimleri arasındaki farkları karşılaştırmak için eşleştirilmiş örnekler t testi kullanıldı.

Bulgular: Eğitime katılmış öğrencilerden 38 kişi ölçekleri çevrim içi yanıtlamıştır. Bu ölçeklerde yedi ana başlık ve 14 alt başlık bulunmaktaydı ve likert tipi değerlendirme yapıldı. Somut deneyim, sosyal yapılandırma, duygusal boyut, üstbiliş, yeterlik, bireysellik ve hedefe yönelik olma konularını içeren toplam yedi temel başlık altında değerlendirme yapıldı. Somut deneyim, üst-biliş, bireysellik ve yeterliliğe dayalı özellikleri içeren anlamlı öğrenme deneyimlerinin beklentilerinin çok üstünde çıktığı (p<0,05) ancak anlamlı öğrenmenin duygusal ve sosyal-yapılandırmacı boyutlarının beklentileri karşıladığı ama deneyimler sonrası anlamlı bir farklılık olmadığı tespit edilmiştir.

Sonuç: Keskitalo'nun FTL modeline uygun olarak yapılandırılmış acil hasta yönetimi eğitimlerinde çevrim içi sanal hasta kullanımı öğrencilerin anlamlı öğrenme üzerinden beklentilerini karşılamıştır. Ancak çevrim içi sanal hasta simülasyon eğitimlerinin müfredata entegrasyon sürecinde, özellikle anlamlı öğrenmenin duygusal ve sosyal-yapılandırmacı yönlerine odaklanan daha kapsamlı araştırmalara ihtiyaç duyulduğu düşünülmektedir.

INTRODUCTION

Technological advancements have paved the way for innovative alternatives to simulation-based educational tools, offering a safe and immersive learning environment that actively engages learners and enhances the learning process (1-4).

Especially the changes in the education world brought by the pandemic have led to the rapid increase in interest and widespread use of on-line and virtual patient, virtual reality and similar simulation education tools (5-7).

Virtual patient (VP) technology refers to interactive computer simulations of authentic clinical scenarios, designed to be utilized in healthcare education for both teaching and evaluation objectives. This comprehensive description encompasses a range of systems that utilize diverse technologies and provide different learning requirements (8-11). This diversity in training methods and tools has led to the need to develop new instructional models (12,13).

Several research share the view that the use of simulation technology alone does not ensure effective learning(1,14). The implication is that structured models and approaches are necessary to assist educators in devising, coordinating, and assessing instruction in learning environments that are supported by technology. These structured models need to emphasize the importance of activities, experiences, reflection, knowledge construction, collaboration, and situational factors as essential components that contribute to meaningful learning (14-16).

When looking at the literature, it can be observed that there are limited studies related to the evaluation of on-line virtual patient simulation trainings specific for paramedic students education.(9,17-20).

Therefore, the aim of this study is to evaluate the on-line Virtual Patient -based simulation course in terms of student expectations and experiences via surveys. This course is conducted to enhance critical decision-making skills of 2nd year students in the Emergency and First Aid Department at Acibadem University and structured accordance with FTL model of Keskitalo.

The study's findings can offer healthcare educators valuable insights into the benefits and limitations of using virtual patient simulation for training in emergency patient care. This information can guide the development and implementation of impactful virtual simulation-based training programs focused on meaningful learning.

METHODS

This study aimed to evaluate of on-line virtual patient based simulation course which is designed according to FTL Model of Keskitalo. In the initial phase, referred to as the "Facilitating" phase, the facilitator introduces the course topic and the essential concepts, providing an overview of the simulation session to the students. During this phase, participants also become acquainted with the simulation and get practical experience with the environment and equipment. By the end of this phase, students should have a clear understanding of their responsibilities and expectations. Moving on to the second phase, known as the "Training" phase, students actively participate in the simulation, with the facilitator supervising and guiding their performance. The facilitator ensures that students are on track and provides necessary feedback. Finally, in the last phase, called the "Learning" phase, the debriefing takes place, where the facilitator encourages students to reflect on the learning process, analyze their experiences, and potentially establish new learning goals. This phase is crucial for students to consolidate their learning and identify areas for improvement.

In the FTL model, the introduction and simulator briefings are led by the facilitator, whereas the training is student-centred. Therefore, the extent to which the experiences of paramedic students met their expectations was assessed through questionnaires aligned with meaningful learning characteristics (14).

Following Question Was Investigated and Discussed Throughout the Study

Was there a significant statistical difference between the experiences and expectations of students regarding meaningful learning characteristics?

Ethical approval was received from the Acibadem University Ethics Committee (2023-05/165). Prior to the training at the simulation center, each student was informed and their consent was obtained.

Participants

Out of a total of 54 students in the 2nd year of the Emergency and First Aid Department of Acibadem University, only 40 students (18 male, 22 female with an average age of 21) were able to participate in the training due to technical difficulties such as internet connectivity issues and limited resources in some students' rural areas and economic conditions.38 of these students answered to the pre and post course questionnaires. All students

had prior experience with manikin-based simulation-based training.

Course Design

In order to improve the critical decision-making and problem-solving skills included in the curriculum of the 2nd year Emergency and First Aid Department students at Acibadem University, due to the pandemic, case-based trainings were conducted on-line using a Virtual Patient Simulator (Body Interact®). Body interact is an innovative platform consisting of real life cases and these cases can be used to enhance desicion making and critical thinking skills in a varity of environments.

The participants were divided into four groups (10 students per group). Each group attended three separate sessions on respiratory emergencies, cardiac emergencies, and central nervous system emergencies. A total of 12 courses, each lasting two hours, were conducted on-line using the Virtual Patient Simulator, with the same fascilitator leading all sessions. Three different scenarios were implemented for each topic in each session. Each scenario was conducted by groups of three students. During each virtual patient (VP) session by using virtual patient simulator (Body Interact®), students were presented with progressively challenging and intricate clinical cases, followed by guided discussions in small groups. These sessions were conducted in accordance with Keskitalo's FTL model designed for simulation-based learning environments, while adhering to the principles of meaningful learning. During fascilitating phase, fasciliator presented the course topic, informed the students about course objectives, goals, roles and rules and students familiarized with virtual patient simulator via on-line platform. During training phase; students participated in on-line virtual patient scenarios within groups under the guidance of group leader of the scenario. Fascilitator also attended to all the on-line scenario sessions in order to observe the whole process without any intervention. During the learning phase at the end of each scenario

students attended to debriefing sessions, with the guidance of fascilitator via on-line platform. A comprehansive evaluation, reflection and critical analysis of the process was done providing individual feedback.

Data Collection

The data in this study consists of the questionnaire results completed before and after the training sessions at Acibadem University Simulation Center in the years 2019-2020. The pre- and post-questionnaire's statements were created by Keskitalo, based on the characteristics of meaningful learning (Table 1) (21, 22). Tuulikki Keskitalo's meaningful learning questionnaire is designed to evaluate the characteristics of meaningful learning within various educational contexts, particularly in simulation-based and virtual environments. It includes several Likert-type items that assess different dimensions of the learning experience. This tool has been applied in studies involving simulation-based learning environments to analyze and enhance students' educational experiences by aligning them with principles of meaningful learning. In this study this questionnaire was translated into Turkish using the "back translation" method. By following this process, discrepancies between translations can be identified and resolved, ensuring the survey questions accurately reflect the original meaning across different languages. This process was established with an expert panel. First, a panel of four experts with extensive experience in virtual patient training and translation were selected. The experts were provided with a comprehensive definition of the construct and the set of survey items. The experts translated each item into Turkish and rated each item for relevance, clarity, and representativeness. After incorporating the experts' suggestions, a second round of review was conducted to ensure the final set of items comprehensively covered the construct. The Cronbach's alpha for the pre-questionnaire and for the post-questionnaire, was 0.90. This Likert-type questionnaire consisting of 14

items was used to determine the students' expectations and experiences regarding on-line virtual patient simulation-based learning sessions, with a rating scale of 1 (does not define my expectations at all) to 5 (defines my expectations very well). The pre-questionnaire was administered to evaluate expectations before the training, and the post questionnaire was administered to evaluate experiences at the end of the training. (Supplement 1). The surveys were distributed on-line using learning management system of the university.

Table 1. Outline of the Study
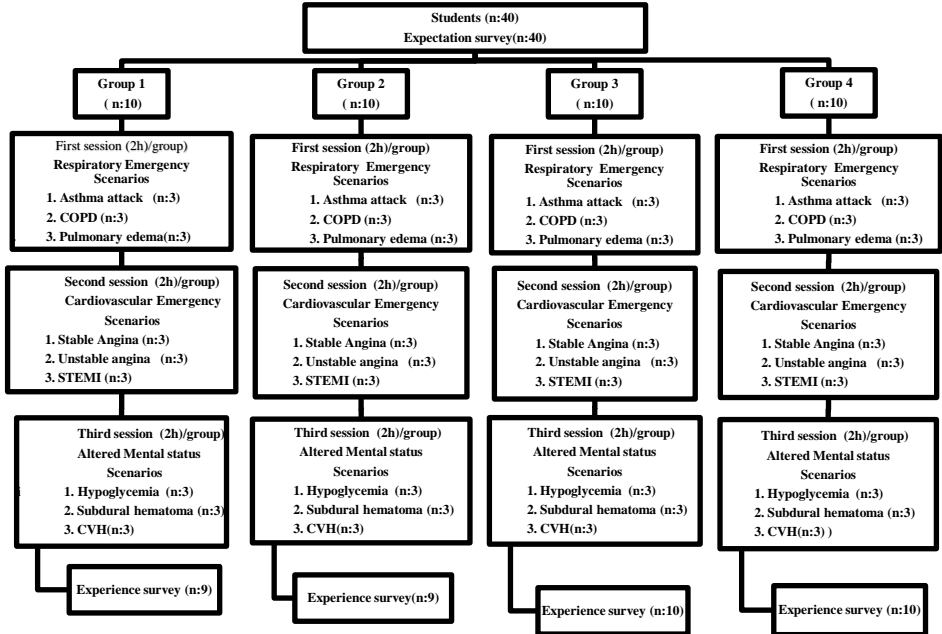
Data Analysis

The survey responses were analyzed using SPSS-23, setting the significance level at $p < 0.05$. The data were examined through frequencies, means, and standard deviations of individual responses. The paired samples t-test was employed to compare differences between students' expectations and experiences.

RESULTS

The evaluation of training in virtual patient simulation for emergency patient care, focusing on meaningful learning, was conducted by analyzing students' experiences obtained through questionnaires containing seven specific characteristics and 14 statements.

The results revealed that students had the highest expectations regarding the intentional aspects of meaningful learning (M = 3.68; SD = 0.91), while their lowest expectations were related to the concrete aspects of meaningful learning (M = 3.28; SD = 0.86). The mean ratings obtained from the pre-questionnaire and post-questionnaire demonstrated statistically significant differences for concrete, metacognitive, competence, and individual characteristics of meaningful learning. This indicates that students' actual experiences surpassed their initial expectations in these areas. However, no statistically significant differences were observed between expectations and actual experiences concerning

the emotional, socioconstructive, and intentional characteristics of meaningful learning (Table 2).

Table 2. Results of Meaningful Learning Charecteristics

Main Statements in the Questionnaire	Expectation			Experience			P	Cohen's d
	Means	SD	Mode	Means	SD	Mode		
Concrete (experiential and experimental)	3,28	0,86	4	3,59	0,52	3.5	**0.035**	**0.44**
Emotional	3,51	0,94	3.5	3,78	0,82	4	0.109	**0.31**
Socio-onstructive (socio-constructive and collaborative)	3,63	0,81	4	3,78 0,66		4	0.200	**0.20**
Intentional (active, responsible, goal-oriented, and self-directed)	3,68	0,91	4	3,86	0,68	4	0.219	**0.22**
Metacognitive (reflective and critical)	3,58	0,81	4	4,01	0,59	4	**0.002**	**0.61**
Competence-based (competence-based and contextual)	3,31	0,92	3	3,78	0,83	4	**0.002**	**0.54**
Individual	3,63	0,80	4	3,99	0,54	4	**0.003**	**0.53**

In terms of spesific items for concrete characteristics of meaningful learning, students expressed the highest expectation that they would be able to apply their prior knowledge and experiences during the course, with an average score of 3.62 and a standard deviation of 0.96, and a mode of 4. This expectation was also reflected in their actual experience, with an average score of 3.87 and a standard deviation of 0.77, and a mode of 4. The results suggest that students appreciate the opportunity to use their prior knowledge and experiences as a foundation for learning new concepts and skills. Furthermore, the study found that students were able to acquire new information and apply it to real-life cases, indicating that the course provided a meaningful learning experience that allowed for the integration of prior knowledge and the acquisition of new skills (Table 3).

In terms of spesific items for emotional characteristics of meaningful learning students had high expectations for feeling safe and secure during the course, with an average score of 3.59 and a standard deviation of 1.02, and a majority of students expressing a mode of 3.

This expectation was reflected in their actual experience, with an average score of 3.67 and a standard deviation of 1.03, and a mode of 4. The study also found that students were motivated to learn and engage in the course, with an average score of 3.90 and a standard deviation of 0.91, and a mode of 4. Results indicated that students felt safe during the course and the learning environment facilitated participants' engagement and reflection by incresing the motivation (Table 3).

In terms of spesific items for socio- constructive characteristics of meaningful learning students held high expectations for applying their prior knowledge to the course content, with an average score of 3.90 and a standard deviation of 0.88, and a mode of 4. This expectation was also reflected in their actual experience, with an average score of 4.03 and a standard deviation of 0.67, and a mode of 4. However, students had lower expectations for developing communication and collaboration skills, with an average score of 3.08 and a standard deviation of 0.93, and a mode of 3 (Table 3).

In the assessment of intentional aspects of meaningful learning, students showed a strong expectation that their role would involve actively seeking, evaluating, and applying information during lessons, with an average score of 3.85, a standard deviation of 0.90, and a mode of 4. Similarly, their actual experience aligned with this expectation, as they reported actively engaging in finding, evaluating, and applying information during lessons, with an average score of 3.97, a standard deviation of 0.81, and a mode of 4. However, there were no statistically significant results for the overall evaluation or the subscale results, indicating that while students' experiences met their expectations, there may not have been significant growth or improvement in this area (Table 3).

When examining the metacognitive aspects of meaningful learning, the most significant expectation expressed by students was the development of their critical thinking skills throughout the course, with an average score of 3.67 and a standard deviation of 0.90. The most significant experience reported was the actual development of their critical thinking skills during the course, with an average score of 4.15 and a standard deviation of 0.63. These results suggest that students were able to enhance their critical thinking abilities through the course, which is a crucial aspect of meaningful learning (Table 3).

When examining the elements of competency-based characteristics of meaningful learning, students showed a notable expectation that their competence would be enhanced through training in virtual patient simulation settings, with an average score of 3.46, a standard deviation of 0.94, and a mode of 4. Similarly, the most significant experience reported was the actual development of competence through training in simulation settings, with an average score of 3.82, a standard deviation of 0.82, and a mode of 4. Overall, students' experiences with training in a simulated environment aligned with their expectations in terms of skill development and gaining competence (Table 3). In the evaluation of individual characteristics of meaningful learning, students had a notable expectation that the study skills they had adopted would be effective for them in the course, with an average score of 3.74, a standard deviation of 0.97, and a mode of 4. Similarly, the most significant experience reported was that the study skills they had adopted indeed worked for them in the course, with an average score of 4.02, a standard deviation of 0.63, and a mode of 4. These findings indicate that the course recognized and catered to the individual needs of students and their study skills, aligning with their expectations and supporting their learning effectively (Table 3).

Table 3. Results of Meaningful Learning Characteristics of Subscale

Statements in the expectation questionnaire	Statements in the experience questionnaire	Expectation			Experience				
		Means	SD	Mode	Means	SD	Mode	P	Cohen's d
Concrete (experiential and experimental)		3,28	0,86	4	3,59	0,52	3.5	**0.035**	**0.44**
1 I will be able to utilize my prior experience during the course	I utilized my prior experience during the course	3,62	0,96	4	3,87	0,77	4	0.097	**0.30**
2 During the course I will be able to familiarize myself and practice with the technology needed for future work	During the course I was able to familiarize myself and practice with the technology needed for future work	2,95	1,05	3	3,31	0,92	4	0.086	**0.36**
Emotional		3,51	0,94	3.5	3,78	0,82	4	0.109	**0.31**
1 I will feel safe during the course	I felt safe during the course	3,59	1,02	3	3,67	1,03	4	0.651	0.08
		Expectation			Experience				

	Statements in the expectation questionnaire	Statements in the experience questionnaire	Means	SD	Mode	Means	SD	Mode	P	Cohen's d
2	The course climate will motivate me to learn	The course climate motivated me to learn	3,44	1,14	4	3,90	0,91	4	0.017	0.45
	Socio-constructive (socio-constructive and collaborative)		3,63	0,81	4	3,78	0,66	4	0.200	**0.20**
1	My collaboration and communication skills will develop during this course	My collaboration and communication skills developed during this course	3,36	1,01	4	3,54	0,97	4	0.313	0.18
2	I will be –able to utilize my prior knowledge relate to course content	I was able to utilize my prior knowledge relate to course content	3,90	0,88	4	4,03	0,67	4	0.268	0.16
	Intentional (active. responsible. goal-oriented. and self-directed)		3,68	0,91	4	3,86	0,68	4	0.219	**0.22**
1	The course objectives will be clear to me	The course objectives were clear to me	3,51	1,05	4	3,74	0,72	4	0.247	**0.26**
2	The student's role will be to actively find evaluate and apply information during the lessons	The student's role was to actively find evaluate and apply information during the lessons	3,85	0,90	4	3,97	0,81	4	0.527	0.14
	Metacognitive (reflective and critical)		3,58	0,81	4	4,01	0,59	4	**0.002**	**0.61**
1	My critical thinking skills will develop during the course.	My critical thinking skills developed during the course.	3,67	0,90	4	4,15	0,63	4	**0.006**	0.62
2	I will be able to critically evaluate my own learning during the training.	I was able to critically evaluate my own learning during the training.	3,48	1,00	4	3,87	0,70	4	**0.016**	0.76
	Competence-based (competence-based and contextual)		3,31	0,92	3	3,78	0,83	4	**0.002**	**0.54**
1	Training in simulation settings will develop my competence	Training in simulation settings developed my competence	3,46	0,94	4	3,82	0,82	4	**0.027**	**0.41**
2	The course will be applicable to my future work	The course were applicable to my future work	3,15	1,04	3	3,74	0,99	4	**0.002**	**0.58**
	Individual		3,63	0,80	4	3,99	0,54	4	**0.003**	**0.53**
1	The course will take the student's individuality into account	The course took the student's individuality into account	3,51	0,82	4	3,95	0,65	4	**0.005**	**0.59**
2	The study skills that I have adopted will also work for me in this course	The study skills that I had adopted also worked for me in this course	3,74	0,97	4	4,02	0,63	4	**0.062**	**0.35**

DISCUSSION

The objective of this study was to evaluate participants' expectations and experiences regarding a new educational platform based on on-line virtual patient simulation, as a training module for improving paramedic students' clinical decision-making skills on emergency patient management.

The hypothesis was that on-line virtual patient based simulation course, aligned with socio-constructivist, meaningful learning theories and the pedagogical simulation models (FTL Model), would enhance the attainment of meaningful learning. Student expectations and experiences regarding the educational environment serve as crucial indicators of learning effectiveness (23). Therefore, in this study, structured questionnaires were utilized to evaluate students' expectations and experiences in accordance with meaningful learning characteristics.

The study findings suggest that on-line virtual patient training can be considered highly meaningful. All students had prior experiences with manikin-based simulation training, leading to high expectations. The results indicate that expectations related to meaningful learning characteristics, including concrete,

metacognitive, individual, and competency-based aspects, were surpassed by the actual experiences ($p<0.05$). However, the experiential aspects of emotional, socio-constructive, and intentional meaningful learning were fulfilled but not exceeded by the experiences.

Regarding emotional characteristics, the study revealed that the course climate fostered participant engagement and reflection, with students feeling motivated to learn. Challenges such as technical issues in the on-line setting and the absence of physical presence were noted to potentially impact the course climate negatively. This aligns with previous research indicating increased frustration in on-line learning due to technical challenges compared to traditional in-person settings (24,25). Additionally, the lack of emotional interaction and complexity in virtual patients compared to real-life patients may affect emotional engagement negatively (19). The findings highlighted the importance of designing educational interventions that prioritize emotional and social learning, as well as cognitive learning, to create optimal learning experiences.

In the intentional category, it was found that course objectives were clear, and students actively gathered and utilized patient-related data for making diagnoses. Teamwork and active participation in scenarios facilitated active engagement in the on-line learning environment (4). The findings suggest that educators should continue to emphasize the importance of active learning and encourage students to take an active role in their own learning. Additionally, the study highlights the need for more research to better understand the impact of active learning on student outcomes and to identify effective strategies for promoting active learning in various contexts

Within the concrete characteristics, both the expectation of applying past experiences and acquiring new knowledge were notably fulfilled The findings highlight the importance of

designing educational interventions that build upon students' prior knowledge and experiences and provide opportunities for experimentation and application (26). Additionally, the opportunity to apply different skills with different tasks in various scenarios which facilitates the integration of prior experiences, reflection on new encounters, and the active engagement of newly acquired knowledge with existing knowledge support experiential learning(27).

In the metacognitive category, students' experiences exceeded expectations in developing critical thinking skills and critically assessing their own learning. The educator supported the students in their reflection by employing techniques such as questioning, clarifying, expanding, and guiding. Reflective practices within a secure environment enhance metacognitive skills by encouraging reflection on feelings and learning processes (25,28).

Regarding competency characteristics, students recognized scenarios as realistic and relevant to real-life competencies, enhancing clinical reasoning skills. Furthermore, the course content was delivered in different clinical scenarios, while the learning environment incorporated authentic tools and devices such as real patient vital signs display and medical equipment. Acquiring competencies in real-like scenarios contributes to clinical reasoning skill development (29-32).

In the socio-constructive characteristics, students' experiences met expectations but were not statistically different, suggesting the importance of emphasizing communication and collaboration skills in educational settings. The findings highlight the need for educators to emphasize the value of communication and collaboration skills in academic and professional settings, and to provide opportunities for students to develop these skills in meaningful ways. The students directed the collaborative activities and the construction of knowledge, actively participating in interactions, joint activities, and discussions.

Collaborative activities and knowledge construction through active participation are vital for enhancing socio-constructive learning characteristics (33-35).

This study's significant contribution lies in demonstrating that on-line virtual patient-based simulation courses, designed in alignment with the FTL model, have the potential to facilitate meaningful learning. Further research is needed to enhance emotional engagement, socio-constructive, and collaborative skills in on-line virtual courses.

Limitations

Implementing an on-line virtual patient-based simulation course has challenges, particularly in maintaining students' emotional engagement in learning, especially for institutions like medical and vocational schools where practical clinical experience forms a significant part of the curriculum. As a result, future studies should aim to confirm the applicability of these findings to diverse student populations both within and outside of Turkey.

To validate the reproducibility of the hypothesis, forthcoming research could adopt experimental designs that facilitate the measurement of meaningful learning in on-line settings, incorporating more objective performance metrics and increased sample size. The total number of our participants were diminished because, students who had no internet access at home could not attend to the course.

Furthermore, the outcomes of the quantitative investigation should be expanded through qualitative research methods.

The other limitations observed in our study were technical issues. Internet connectivity problems caused a negative effect on students' motivation and teamwork.

CONCLUSIONS

The use of virtual patients in emergency patient management trainings has been found to be effective. The integration of structered on-line VP simulation trainings into the curriculum is thought to require more extensive research especially focusing on emotional and socio-constructive aspects of meaningful learning.

Declarations
Data availability
The datasets generated during the current study are available from the corresponding author on reasonable request.

Ethics
Ethical approval was obtained from the local ethical committee of Acibadem Mehmet Ali Aydinlar University (ATADEK) and all methods were performed in accordance with the Declaration of Helsinki.

This paper does not report any experiments on humans and/or the use of human tissue samples. Informed consent was obtained from all students (to use their feed-back and academic grades for program evaluation).

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