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Research Article

Development and Initial Validation of an Innovative Virtual Reality Simulation in Teaching Fetal Development of Midwifery Students: Qualitative Analysis

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Abstract

Objective: The aim of this pilot study is to teach midwifery students fetal development with the Fetal Development Application created by virtual reality (VR) technology, an innovative application, and to acquire their reflections on their experiences.

Methods: A descriptive qualitative research design was used. The VR application was created by visualizing the fetal development, umbilical cord and placenta localization week by week and transferring them to the virtual environment. Forty-two midwifery students who experienced the practice were included in the study. Students who had previously taken fetal development in the normal pregnancy course were shown the application with VR glasses in the laboratory environment. Data were collected through face-to-face interviews with a semi-structured interview form and a Presence Questionnaire developed by the researchers. They evaluated students' perceptions of the practice's strengths and weaknesses and whether the game would be useful as a learning too.

Results: The thematic analysis resulted in the following components of the practice experience: interaction, motivation, knowledge, and realism. Students reported that it is effective for understanding fetal development and can be used in lessons. These results highlighted students' acceptance of technology as a teaching and learning resource and showed potential for future developments.

Conclusion: In line with these results, it was seen that the effect of the application was permanent. It has been seen that the VR method has a good practice effect in teaching fetal development and midwifery practice. More research is needed to assess whether students' learning and retention of knowledge are improved using this new technology.

Keywords: virtual reality, midwifery, fetal structures, fetus, growth development

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1 INTRODUCTION

The use of virtual reality (VR) in education dates back to the 1970s. In this period, it started to be used for pilot training[1,2]. Simulation-based learning is one of the most widely used and blended learning methods in midwifery education. Simulation-based education is a technique that tries to emulate the same features with the real world in order to achieve specific goals in learning education[3-5]. Although the history of simulation education in the field of health dates back to the 1940s, it was specifically integrated into midwifery and nursing education in the 2000s[6-8]. It has been an important training strategy for the development of midwifery and nursing skills[5,9]. The use of simulation in midwifery education gives students the opportunity to experience non-technical applications that are less likely to be seen in clinical conditions, as well as technical knowledge[10-12]. There are few quality studies using VR applications in midwifery education. The "road to birth" project, which is in the new design phase of these studies in the field of pregnancy, newborn resuscitation application in VR environment, midwifery training with VR glasses, virtual birth clinic trainings[7,13,14].

Teaching of fetal development is of great importance in midwifery education. The learning of fetal development also affects the learning of the knowledge that the student will benefit from in each period. It has been observed that there are augmented reality applications in fetal development teaching[15,16]. In addition, the existing application in which the teaching of fetal development is shown is not only VR application, but also applications with mixed and augmented reality[14,15]. In the application developed by Ismail[15] for the teaching of fetal development to students, adolescents, adults and mothers, the week-by-week development of the fetus is visualized with 3D pictures. It has been seen that the application is effective and usable. VR applications are aimed to learn what is difficult to show or impossible for participants to see in real life. It is aimed for students to see the development of the fetus more closely by providing the application in the teaching of fetal development in the field of VR and entering an area that is impossible to see.

2 METHODS

2.1 Research Design

So far, little has been known about the use of VR-based applications in the teaching of fetal development, so a pilot study was conducted to describe fetal development in midwifery students with VR technology and to describe their experiences. This pilot study used a qualitative descriptive design that revealed various perspectives and common themes, allowing "to examine something in its natural state as much as possible in the context of the research area"[17]. The data of the study were collected between 10 April, 2021 and 15 May, 2021.

The fetal development practice created with virtual reality technology (FDAC-VRT), developed by the researchers to learn about fetal development, was written week by week in line with the literature. The created FDAC-VRT content was terminated at the 40th gestational week, starting from the 6th gestational week (the last two weeks of the embryonic period and the beginning of the fetal development period). In this content: fetal week, height and weight of the fetus, and the developmental process in weeks were explained. In the VR environment, fetal heartbeats (FHA) heard by abdominal ultrasonography after the 6th gestational week of the fetus were added as sound. FHA varies between 120-160 beats per minute according to the gestational week. In practice, FHA was placed in accordance with the weeks. Fetal development visuals of the application were prepared with reference to the literature and defined week by week[18-20]. Research specific models were made in line with the references.

A hologram clock has been added to the right controls (right arm) part of the application. Your fetus at this hour: height, weight and development processes were included. After complete observance was completed (when the fetus reached the 40th gestational week), a round arrow was placed on the hologram clock to retrace the development of the fetus week by week, with an upper and lower arrow to retrace the application. This hologram clock was created for the user of the application to click interactively, to actively participate in the application and to watch the week they want (Figure 1). The created FDAC-VRT was presented to the opinion of five experts, including a lecturer in Midwifery (Professor and Associate Professor), Midwifery (Research Assistant and Lecturer), and a lecturer in Nursing. Feedback about the application was received from the experts and the final version of the application was given. The application is an original application that takes three and a half minutes.

2.2 Context

Students were taken to the application area for FDAC-VRT one by one and the application was introduced to each student for five minutes. VR glasses were put on after the briefing. Fetal development of the students was monitored from the 6th to the 40th week. Application after reaching the 40th week of pregnancy, the students were allowed to watch the content of each week step by step, by going back on a weekly basis with the

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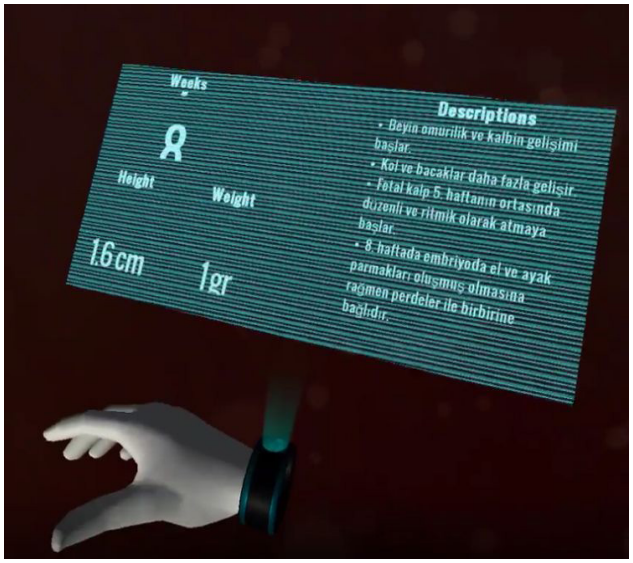

Figure 1. Hologram clock.

Figure 2. The moment of students experiencing the virtual reality application.

hologram clock or starting from the beginning again. Each student was given 25min for glasses. At the same time, students were given the autonomy to take off their glasses and leave the virtual environment when they wanted to quit on their own. After the application was finished, feedback was received on how they found the application.

2.3 Participants

The fetal development application prepared with VR technology was applied to the fourth-year midwifery undergraduate students who took fetal development course. In addition to the existing fetal development theory application, they participated in the FDAC-VRT application. On the day of the application, 42 midwifery students, who were in the fourth year and volunteered to experience the application, were allowed to experience the application in the laboratory (Figure 2). From their first encounter with this type of teaching, students were able to provide a rich source of assessment about the benefits or problems of viewing the work.

2.4 Data Collection

Before starting the study, approval was obtained from the institutional review board Institutional Review Board of Karabuk University (land number 2020/263 dated 09.06.2020). In addition, verbal and written consent was obtained from the participants. The trial was registered with the NCT04444258 ID number and the 2020/263 ID number on the International Clinical Trials Registry Platform. The study was presented as an oral presentation at 5th International 6th National Midwifery Congress (EBKO2021). Students who had previously taken the fetal development in the normal pregnancy course were shown the application with VR glasses in the laboratory environment. After the application, they were asked to answer open-ended questions using the sense of presence scale. It evaluated students' perceptions of the practice's strengths and weaknesses and whether the game would be useful as a learning tool. Data were collected through face-to-face interviews with a semi-structured interview form developed by the researchers.

2.5 Presence Questionnaire

The scale was developed by Witmer et al.[21] in 2005 to determine students' sense of presence after being exposed to immersive virtual environments. The Turkish validity and reliability of the scale was performed by Gökoğlu et al.[22] in 2019. The scale, which was originally 7 likert type, was reduced to 5 likert type in Turkish validity. The Cronbach's Alpha reliability coefficient was found to be 0.91 in the original scale, and 0.84 in the Turkish adaptation study. The scale measures the sense of presence in VR-based learning environments. The scale has 5 factors (sub-dimensions) namely Participation (Factor 1), Adaptation / Confinement (Factor 2), Sensory Engagement (Factor 3), Interaction (Factor 4) and Interface Quality (Factor 5) and consists of 29 questions.

2.6 Statistical Analysis

The quantitative data of the study were evaluated in the SPSS Windows 20 program. Open-ended questions were analyzed using thematic analysis based on the four analysis processes of Data, Morse and Field: Comprehension, Synthesis, Theorizing, and Recontextualization[23]. Survey comments were collected by the researchers. Interpretations were synthesized, sequenced, and final themes describing data "fit" for ad hoc themes were decided by the researchers.

3 RESULTS

3.1 Quantitative Results

The mean age of the students was determined as

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Table 1. Demographic Characteristics of Students

Descriptive Features	*n*	%
Age, Mean±SD	22.38±0.88	
Computer Game Playing Situations		
Yes	18	42.9
No	24	57.1
Frequency of Playing Computer Games*		
One day a month	7	38.9
One day per week	3	16.7
Every day	1	5.6
Very Rare	7	38.9
Knowledge of Virtual Reality		
Yes	13	31.0
No	29	69.0
Participation in Any Application Using the Virtual Reality (VR) Method		
Yes	3	7.1
No	39	92.9
VR Applications That Students Experience**		
A real environment	2	66.7
Funny	0	0.0
Influential	1	33.3
Total	42	100.0

Notes: * means the analysis was conducted on 18 students; ** means the analysis was conducted on 3 students.

Table 2. The Mean Scores of the Sub-dimensions of the Sense of Presence of the Students Who Experienced the Application

Sub-dimensions of the Presence Questionnaire	Mean±SD
Participation	4.67±0.44
Cohesion / Containment	4.44±0.54
Emotional commitment	4.66±0.42
Interaction	4.23±0.56
Interface quality	1.65±0.82

22.38±0.88. It was observed that 42.9% of the students played computer games, 31% had knowledge about VR, and 7% participated in an application related to VR application (Table 1).

After the application, the students' sense of presence was evaluated. The mean scores of the sub-dimensions of the sense of presence scale, respectively: Participation sub-dimension 4.67±0.44, Cohesion / Containment sub-dimension 4.44±0.54, Emotional commitment sub-dimension 4.66±0.42, Interaction sub-dimension 4.23±0.56, and Interface quality sub-dimension size was found to be 1.65±0.82 (Table 2).

3.2 Qualitative Results

Students' explanations addressed open-ended survey questions about the strengths and weaknesses of the VR application and its learning potential. From the responses,

Table 3. Quantitative Results

Theme	Subtheme
Interaction	(1) Having a lively environment
	(2) Feeling of being surrounded
Motivation	(1) Successful and effective application
	(2) Feeling of being inside
Realistic	(1) Show an unknown area
	(2) To experience for the first time
Information	(1) Visuality
	(2) Alternative and innovative learning

four main themes emerged from the FDAC-VRT: Interaction, Motivation, Knowledge, and Realism (Table 3).

3.3 Interaction

When responding to a question about the benefits of VR practice, students typically stated that their visualization experience was a very impressive, enduring educational model and they were able to interact with the fetus by seeing it up close.

One student said: "It was very nice to see the fetal development closely, to observe the movements of the baby, this must be what they say it can be experienced as soon as possible".

Similarly, another student noted: "It is a miraculous application that allows you to experience the develop-

ment of the fetus week by week, by watching it closely. It is an application that can be applied to reinforce fetal development especially after embryology classes".

Another student described it as follows: "It was a very beautiful and impressive experience, as if I had grown up with the baby in the mother's womb as if it were real".

3.4 Motivation

Students were asked to comment on their strengths and motivations about the VR experience. The students said that seeing the fetal development so closely motivated them. A student who said that the application was useful was as follows: "It is very useful for everyone to watch. Thank you, Professor".

One student who found her experience motivating and wonderful described the practice as follows: "It was an amazing and motivating experience. This was the closest to reality that could be achieved. It was a very good experience for me. Thanks a lot".

One student, who stated that the application was impressive and motivating, described the experience as follows: "I can say that I was fascinated from the moment I put on the glasses. It was very nice, very realistic and motivating to be able to observe fetal development in the mother's womb from the first weeks and to be able to go back to the week we wanted and watch it again. It has been an amazing job".

3.5 Realistic

The students stated that the practice they experienced was very realistic and that being in the womb was a realistic experience. Most of the students stated that they found the application realistic: "From the moment I put the glasses on, I was fascinated. It was very nice and very realistic to be able to observe the fetal development in the mother's womb from the first weeks and to be able to go back to the week we wanted and watch it again. It has been an amazing job".

"I was very happy to watch the development of the baby in the womb very closely according to the weeks. It was very surprising and fascinating. I will never forget this feeling. It was beautiful and everyone should experience it".

"The application was very realistic and easy to control. It was nice that the information passed week by week and the reality of the voices heard. The virtual environment was easy to adapt to and there were no irritating features. Thanks for letting us experience it".

"It was just perfect. It was as if the baby was growing right next to me, not in the mother's womb. All of his organs became more prominent as the week progressed, and everything became clear. Everything was so clear, down to the movements on his face. It was also very nice to listen to the heart sounds along with the development. Absolutely all midwifery students should experience it with their parents. Thank you very much to our teacher for giving us such an opportunity".

"The first time I experienced virtual reality, it was very impressive. From the moment I put on the glasses, I felt completely involved in the event. Everything was very realistic and it was a very nice experience. Thank you, sir, for giving us this wonderful experience"…

3.6 Information

The purpose of VR applications is to increase the permanence of education and to provide realism in addition to the existing education model. The students evaluated the parameters such as baby movements and umbilical cord that they watched in practice, and it was seen that they were pleased to see these parameters. It was observed that the students found the application to strengthen and support their knowledge: "It was a very nice experience. We were able to see the baby's movements (kicking, smile, etc.). We could see the umbilical cord".

"It was very realistic and informative. It strengthened the theoretical knowledge".

"It was very realistic and informative. An application that can be developed further. It can be done in any field and is instructive. It provides reinforcement of theoretical information with realistic visuals. It's more catchy and educational than it is visual".

4 DISCUSSION

The results obtained from the research showed that the students found the learning activity of the application beneficial. Since there was no similar application evaluating fetal development in the field of midwifery, when the results were evaluated within the framework of different VR applications in the field of midwifery, it was seen that they were compatible and meaningful with the literature[24-26]. Students reported that the usability of the fetal development application prepared with VR technology should be expanded and used in other courses throughout their curriculum.

Moro et al.[27], in their study examining the effectiveness of VR and AR reality models in medical anatomy, stated that students' verbal statements about the application found the application impressive and magnificent. It has also been reported that the application is more intuitive thanks to the visualization.

In their qualitative study of nursing students (n=26),

Saab et al.[26] examined their views on VR application, identified the fascinating, innovative and empowering nature of VR, contextual transfer, difficulties and threats to realization. While some of the students in the study found the application innovative, a few students reported that the application did not allow them to ask questions[26].

In our study, the students felt as though they were in the womb, where they observed the baby's movements closely, and approached the baby by moving in the environment enabled them to interact with the FDAC-VRT. Positive feedback was received from the students in these actions and our study showed compatibility with the literature.

4.1 Limitations

This study is a targeted pilot study developed to improve the quality of teaching and learning. It resulted in a sample size of volunteers to study. These results reflect the feasibility of an innovative application of VR in midwifery education designed for teaching fetal development. The application defined fetal development week by week and made it ready for students' learning. It is limited to only the student group where the application is made. However, since the application is prepared only in accordance with the teaching of midwifery students, the results should be evaluated carefully, since it does not represent all health education students or pregnant women. Similar studies could be conducted with larger groups and students outside the midwifery department, such as nursing and medical faculties, to determine its effectiveness in different fields. These feedbacks received from midwifery students significantly support the use of the application in the education of midwifery students.

5 CONCLUSION

The results of the study provided an important teaching technique regarding the use of FDAC-VRT in midwifery education, which will shed light on future developments and the use of visualization in teaching. The findings highlighted students' acceptance of technology as a teaching and learning resource and showed potential for future development. It is recommended to use FDAC-VRT, which was developed for fetal development teaching, as an alternative teaching tool. It can be used as educational material of VR modeling for applications where it would be difficult to observe students in real life, such as fetal development. The developed application should be applied in different sample groups with according evaluationg of the results and be used in addition to the theory education in midwifery education. It is suggested that the VR field in midwifery education should be supported by further studies.

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Conflicts of Interest

The authors declared no conflict of interest.

Author Contribution

Doğan RA designed this study and wrote the article. Doğan RA and Yazıcı S collected the data and performed the statistical analysis. All authors contributed to the manuscript and approved the final version.

Abbreviation List

FDAC-VRT, The fetal development practice created with virtual reality technology

FHA, Fetal heartbeats

VR, Virtual reality

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