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Article

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Abstract: 1) Background: Several studies have shown the benefit of drawing when learning anatomy. Virtual Reality (VR) also appears to be useful to increase the understanding of the location of anatomical structures. This study aims to describe how students in an Operating Room Nursing (OR nursing) master study program perceive the benefit of active learning methods, including drawing and the use of VR. 2) Methods: We combined these two methods in a class of 29 students. 38 half-finished drawings of anatomical structures were made. The students were to complete these during lectures with guidance from the teacher. The students also attended a two-hour VR session where they were to find various anatomical structures. A paper questionnaire was applied to evaluate the teaching program. Data were analyzed statistically. 3) Results: The students highly appreciated these learning methods. They reported that drawing made them work more actively during lectures and increased their learning outcome. They also perceived that the use of VR technology increased their understanding of the location of anatomical structures. 4) Conclusion: The combination of drawing and VR technology may be of benefit to OR Nursing students when learning anatomy by both increasing student activity and learning outcomes.

Keywords: operating room nursing; education; anatomy; active learning; immersive virtual reality; learning by drawing

1. Introduction

An operating room nurse (OR nurse) has an independent responsibility for the patient in surgery. When positioning the patient for surgery, knowledge and skills related to anatomy are essential. In order for the patient to be optimally exposed during surgery, the patient may be positioned in many different and sometimes unnatural body positions. To be able to do this safely, the OR nurse must be familiar with the anatomical structures and how they work through a surgical procedure [1]. Devlin and Nanavati claim that for positioning the patient, OR nurses need to know the cardiovascular system, respiratory system, skin and underlying tissue, musculoskeletal system, and nervous system [1].

An OR nurse works as part of the surgical team. When assisting in the sterile field, the OR nurse must have knowledge about the various organs, where they are located, and how to treat them. Different instruments and equipment are used on the different organs, and incorrect use of instruments can damage the organs [2]. Thus, both for positioning the patient correctly for surgery

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and for assisting during operation, knowing anatomy is crucial for students who want to become OR nurses.

However, learning anatomy and other bioscience subjects may be challenging [3], and it has been argued that the use of traditional teaching methods may be one of the reasons for this [4]. Although students learn in various ways, many students seem to prefer active and varied learning methods rather than traditional lectures when studying anatomy and other bioscience subjects [5–7].

The term "active learning" may be understood in different ways. Freeman et al collected written definitions of active learning from 338 participants in a seminar on active learning. After coding the elements that emerged in the definitions, a consensus definition was formulated. The main elements in this definition are that active learning involves learning through classroom activities and discussions, and group work is often part of the active learning process. The importance of emphasizing higher-order thinking is also highlighted in their definition [8].

A combination of various active learning methods seems to be beneficial for students' learning of anatomy [9]. Thwin et al suggest several approaches to obtain effective and efficient anatomy teaching. This includes the use of active learning strategies both during lectures and in small group teaching [4], in accordance with the definition formulated by Freeman et al.

One of the learning methods suggested when studying anatomy, is coloring diagrams in workbooks [4]. Several studies have shown the benefit of drawing when learning anatomy. It has been argued that drawing may support students' understanding and visualization of anatomical structures and thus facilitate their retaining of knowledge [10,11]. It has also been proposed that drawing may have an impact on a memory trace by combining elaborative, motoric, and pictorial elements [12]. Students' drawing skills are probably not essential for their learning, as the aim is to draw anatomical key points rather than to create perfect drawings of anatomical structures [10].

Drawing as a pedagogical tool may be used in different ways. Noorafshan et al applied an interactive model where students were to draw simple anatomical sketches simultaneously with the teacher. This made the students participate more actively during lectures, and most of them found that this facilitated their learning of anatomy [13]. In a study regarding obstetric and gynecological clerkship sessions for medical students, the students were required to draw anatomical structures, and subsequently explain their drawings to fellow students. Most of the students found this interactive session helpful for their understanding of anatomical structures [11].

Virtual Reality (VR) technology is another learning method that has gained significant attention in higher education and training across various disciplines in recent years. Kyaw et al. (2019) describe VR as a technology that allows the user to explore and manipulate computer-generated real or artificial three-dimensional multimedia sensory environments in real-time [14]. Several systematic reviews have consistently demonstrated that students who engage with VR achieve higher learning outcomes and retain information better compared to control groups using different mediums [14–16].

The academic interest in VR is further fueled by continuous advancements in visualization and interaction capabilities [16]. Moreover, as the technology continues to evolve, the costs of high-performance devices, such as Pico [17] and Meta Quest series [18], have become increasingly affordable for educational institutions. Given the aforementioned factors, we were drawn to the appeal of this technology and decided to explore its implementation within students' learning process.

An additional justification for incorporating VR into our lessons stemmed from the notion that similar to drawing, interacting with a 3D model in VR promotes active learning. By physically engaging and interacting with the learning materials through body movements, students activate sensorimotor areas within their brains [19]. This active involvement facilitates improved learning outcomes.

A study among nursing students showed that a VR-based program significantly improved students' anatomy learning compared to traditional learning methods [20]. A systematic review, a meta-analysis covering 15 studies regarding the effectiveness of VR on anatomy teaching concluded that VR can potentially improve anatomy teaching. However, there was some uncertainty about the

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results, partly due to the heterogeneity of the studies, and further research on how VR can be integrated into the teaching of anatomy was encouraged [21].

In the present study, we combined drawing and VR in the anatomy teaching for OR nursing. This study aims to describe how students in an OR Nursing master study program perceive the benefit of active learning methods, including drawing and the use of VR technology. To our knowledge, this is the first article describing the combination of these two learning methods in the learning of anatomy in health education.

2. Materials and Methods

Design and Participants

We developed a new teaching program in anatomy for students in the master's degree program in OR nursing at a university college. This was implemented in the autumn semester of 2023. Altogether 29 students, spread across three different campuses, participated in the program. The new teaching program consisted of:

1. A physical gathering at one of the campuses with:
   - A two-hour session of interactive lectures where students had to draw and name various anatomical structures, guided by the teacher.
   - A two-hour session where students were to find different anatomical structures using VR sets and '3D Organon' – a VR application about human anatomy.
   - Demonstration of positioning of patients on the operating table.
2. Three two-hour sessions with drawing of anatomical structures, guided by the teacher. These sessions were conducted physically at one of the campuses with digital transmission to students at the two other campuses. Students on these campuses were able to communicate with the teacher via microphones in the classrooms.

For the drawing lessons, the students were given a total of 38 half-finished drawings of various anatomical structures, made by the teacher. These were collected in two drawing pads and covered topics from the respiratory system, the circulatory system, the nervous system, the musculoskeletal system, organs in the abdomen, and organs in the pelvis. The drawing pads were made available to the students electronically, so they could print them out and bring them to class. During the lessons, the students had to complete the half-finished drawings by drawing in different anatomical structures and adding names to the drawings, guided by the teacher. Simultaneously, the teacher showed the same drawings on a screen in the classroom using a document camera and drew and wrote together with the students. When students participated digitally from other campuses, what was shown on the screen was also transmitted digitally. Drawing and naming of anatomical structures were done in a dialog with the students, as they were encouraged to suggest for instance names to be written on the drawings.

For the VR session, we applied portable and cableless Head Mounted Display (HMD) devices, more specifically - Pico Neo 3. These VR sets consist of the "glasses" that cover the entire field of view of the user and provide stereoscopic vision and a sense of depth, and two controllers held in hands that help navigate the virtual environment and interact with the objects in it.

Portable HMD devices offer the benefit of providing fully *immersive virtual reality* (IVR). This technology creates an environment that surrounds viewers, enhancing their sense of presence. By adopting a first-person perspective, users can interact with the virtual environment in real-time, resulting in a heightened and realistic experience [22].

Research shows that immersion and interactivity of VR have a generally positive effect on students' learning outcomes when compared to the other teaching methods. For example, Di Natale et al. (2020), in their systematic review analysis, looked at the use of IVR in higher education through the lens of Dalgarno and Lee's (2010) framework of affordances for 3D virtual learning environments. They discovered that VR's immersive and interactive nature has several *characteristics that enable*

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certain types of learning behavior (affordances) [15]. For our purposes, the most important of those affordances were:

1. Spatial knowledge - IVR provides spatial knowledge representation and therefore allows for a better understanding of the spatial relationships,
2. Experiential learning - IVR allows students to perform tasks that would be impossible or impractical to perform in the real world,
3. Intrinsic motivation and engagement - IVR improves the motivational appeal of instructional material promoting increased student interest.

These three affordances held particular significance for our anatomy teaching process, as we utilized a VR application called 3D Organon [23]. This application enabled students to engage with 3D models of various human anatomy systems. Through 3D Organon, students could examine the anatomical systems both together and individually, navigate around the models, and turn them along both horizontal and vertical axes. They could also magnify the model, disassemble it, and explore its components individually.

The topics chosen for the VR session were the skeleton, muscles, arteries, and nerves in the upper and lower limbs. These were also the themes of the preceding teaching with drawing on the same day. The subsequent demonstration on the operating table also focused on how patients must be positioned to prevent damage to anatomical structures in the upper and lower limbs.

At the beginning of the VR session, we gave short instructions on the use of the software-relevant buttons. During the two-hour VR session, students worked in small groups, two or three students together. One of the students in each group wore HMD. What was shown in VR was transmitted to a pc-screen, and that way made available for the other student(s) in the group. The students took turns wearing HMDs and looking at the computer screen, so everyone got to explore the 3D models and anatomical structures in VR. This also meant that each student did not have to wear HMD all the time. This may be an advantage, as dizziness and other discomfort symptoms are reported when using HMDs [20,24–26].

The students evaluated the teaching program using a paper questionnaire made by the teachers, consisting of check-off questions, some open-ended questions, and fields where they could write other comments.

Statistical Methods

Descriptive statistical analysis was performed for ordinal variables using frequencies and percentages. To test the positive relationship between two ordinal variables we used the chi-square test for linear-by-linear association with exact one-sided p-value. All the data from the evaluation forms were analyzed in SPSS.

Ethics

Written information was provided on the questionnaire that participation in the evaluation was voluntary and that names should not be written on the evaluation form. Subsequently, we also contacted the Norwegian Agency for Shared Services in Education and Research (SIKT) to assess whether the project was notifiable to them. Their assessment was that if the submitted questionnaires did not contain information that could identify individuals, the project was not notifiable. This type of information did not appear in the submitted questionnaires.

3. Results

28 out of 29 students (96.6 %) completed the questionnaire used to evaluate the teaching program. All 28 respondents had participated in the physical gathering at one of the campuses. 27 respondents participated in all three following two-hour sessions (either physically or digitally), while one respondent participated in two of these sessions.

16 of the respondents (57.1 %) thought the distribution of two hours of exercise with VR and eight hours of lessons with drawing was appropriate. 6 respondents (21.4 %) preferred to have more

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VR exercise and less teaching with drawing, while 5 respondents (17.9 %) preferred to have less VR exercise and more teaching with drawing. Some respondents commented that they would have liked to have more of both.

The students were asked to indicate the extent to which they agreed or disagreed with various statements regarding the interactive lectures with drawing. These results are shown in Table 1.

Table 1. The extent to which 28 respondents dis/agreed to six statements related to the use of drawing in the teaching in the master's degree program in operating room nursing at a university college in Norway, autumn semester of 2023.

Statement	Extent to which respondents agree, n (%)					
	Totally agree	Partly agree	Not sure	Partly disagree	Totally disagree	Total
The drawing pads made me more active in class	27 (96.4)	1 (3.6)	0 (0.0)	0 (0.0)	0 (0.0)	28 (100)
The drawing pads made it easier to understand the subject matter	25 (89.3)	3 (10.7)	0 (0.0)	0 (0.0)	0 (0.0)	28 (100)
The use of drawing pads increased learning outcomes in lessons	27 (96.4)	1 (3.6)	0 (0.0)	0 (0.0)	0 (0.0)	28 (100)
I would have preferred to use PowerPoint rather than drawing in the lessons	2 7.1)	1 (3.6)	1 (3.6)	3 (10.7)	21 (75.0)	28 (100)
I have also benefited from the drawing pads when I have worked on subject matter outside of class	23 (82.1)	1 (3.6)	2 (7.1)	2 (7.1)	0 (0.0)	28 (100)
The drawing pads have contributed to me also using drawing myself in my work with the subject matter outside of class	15 (53.3)	7 (25.0)	0 (0.0)	5 (17.9)	1 (3.6)	28 (100)

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There was no significant correlation between the students' experience of teaching with drawing and their use of drawing when working with the subject matter outside of class (Table 2).

Table 2. Associations between students' opinion on the drawing sessions and their use of drawing when working with the subject matter themselves (n = 28) in the master's degree program in operating room nursing at a university college in Norway, autumn semester of 2023.

Statement	Exact 1-sided p-value[a)]
The drawing pads made me more active in class	0.214
The drawing pads made it easier to understand the subject matter	0.370
The use of drawing pads increased learning outcomes in lessons	0.214
I would have preferred to use PowerPoint rather than drawing in the lessons	0.464

a) Chi square test for linear-by-linear positive association between ordinal variables with 5 levels.

When it comes to the text comments in the questionnaire regarding the drawing lessons, many students expressed in different ways that they appreciated this active learning and that they learned a lot this way. Some also specifically expressed the advantage of this form of teaching over PowerPoint, and some mentioned that it made it easier to remember the matter. Some students expressed that the drawing pads could have been better organized, and one student recommended using PowerPoint in addition to drawing, to show anatomical figures. This student also mentioned that in retrospect, the VR teaching provided a more comprehensive understanding of anatomy that might otherwise have been lacking.

The students were also asked to indicate the extent to which they agreed or disagreed with various statements regarding the exercise in VR. These results are shown in Table 3.

Table 3. The extent to which 28* respondents dis/agreed to five statements related to the use of VR in the master's degree program in operating room nursing at a university college in Norway, autumn semester of 2023.

Statement	Extent to which respondents agree, n (%)					
	Totally agree	Partly agree	Not Sure**	Partly disagree	Totally disagree	Total
It was easy to use the anatomy program used in the exercise with VR	9 (32.1)	14 (50.0)	3 (10.7)	2 (7.1)	0 (0.0)	28 (100)
It was easy to find the anatomical structures we were to find on the models	6 (21.4)	15 (53.6)	5 (17.9)	2 (7.1)	0 (0.0)	28 (100)

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The use of VR made it easier to understand the subject matter	14 (50.0)	10 (35.7)	4 (14.3)	0 (0.0)	0 (0.0)	28 (100)
The use of VR gave me a better understanding of the location of anatomical structures	20 (71.4)	7 (25.0)	1 (3.6)	0 (0.0)	0 (0.0)	28 (100)
The use of VR provided great learning outcomes	11 (40.7)	12 (44.4)	4 (14.8)	0 (0.0)	0 (0.0)	27 (100)

*27 respondents on the fifth statement. **For the first two statements the category in this column was the Norwegian expression 'både/og' which means something in between "agree" and "disagree".

Most of the respondents had no previous experience with VR, and none of them had tried HMDs more than five times before (Table 4). Previous use of VR may have given a slight advantage when students were to find anatomical structures on the 3D models, but this finding is statistically uncertain (p = 0.045). Previous experience with VR did not significantly affect students' ability to use the anatomy program itself, their understanding of the subject matter, or their learning outcomes when using VR (Table 5).

Table 4. Participants' previous experience with VR in 28 respondents in the master's degree program in operating room nursing at a university college in Norway, autumn semester of 2023.

Experience with VR	Respondents n (%)
Have not tried it before	23 (82.1)
Have tried it 1 - 2 times before	4 (14.3)
Have tried it 3 - 5 times before	1 (3.6)
Have tried it more than 5 times before	0 (0.0)

Abbreviation: VR = Virtual Reality.

Table 5. Associations between the students' previous experience with VR and their ability to use the anatomy program and their perceived benefit of using VR in 28 respondents in the master's degree program in operating room nursing at a university college in Norway, autumn semester of 2023.

Statements regarding the use of and the benefit of VR in the learning of anatomy	Exact 1-sided p-value[a]
It was easy to use the anatomy program used in the exercise with VR	0.191
It was easy to find the anatomical structures we were to find on the models	0.045
The use of VR made it easier to understand the subject matter	0.199

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The use of VR gave me a better understanding of the location of anatomical structures	0.138
The use of VR provided great learning outcomes	0.053

Abbreviation: VR = Virtual Reality. a) Chi square test for linear-by-linear positive association between ordinal variables with 5 levels.

We also investigated how students' responses to questions regarding learning outcomes and improved understanding related to how they managed to use the anatomy program in VR (Table 6). As the table shows, there was a significant positive association between students' perceived learning outcomes and how they managed to use the program and find anatomical structures. Students who to a great extent perceived that the anatomy program was easy to use and the anatomical structures easy to find, also reported to a greater extent that the use of VR made it easier to understand the subject matter. This was statistically significant. However, there was no significant association between students' improved understanding of the location of anatomical structures and their perceived ability to use the anatomy program or to find anatomical structures on the models.

Table 6. Associations between students learning outcome and improved understanding and how they managed to use the anatomy program and find the different anatomical structures in 28 respondents in the master's degree program in operating room nursing at a university college in Norway, autumn semester of 2023.

Statements regarding learning outcome and improved understanding	**Statements regarding the use of the anatomy program**	**Exact 1-sided p-value[a)]**
The use of VR made it easier to understand the subject matter	It was easy to find the anatomical structures we were to find on the models	0.003
The use of VR made it easier to understand the subject matter	It was easy to use the anatomy program used in the exercise with VR	0.020
The use of VR gave me a better understanding of the location of anatomical structures	It was easy to find the anatomical structures we were to find on the models	0.074
The use of VR gave me a better understanding of the location of anatomical structures	It was easy to use the anatomy program used in the exercise with VR	0.053
The use of VR provided great learning outcomes	It was easy to find the anatomical structures we were to find on the models	0.001
The use of VR provided great learning outcomes	It was easy to use the anatomy program used in the exercise with VR	0.005

Abbreviation: VR = Virtual Reality. a) Chi square test for linear-by-linear positive association between ordinal variables with 5 levels.

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The form contained two open-ended questions regarding the VR exercise. The students were asked if there were other topics they would have liked to have included in the exercise, and if there were topics that could have been omitted. The answers to these questions revealed that many students would have preferred to include organs of the thorax and abdomen. When asked about topics that could have been omitted, several respondents mentioned nerves, and it was commented that they were difficult to grasp due to their small size.

4. Discussion

This study aimed to describe how students in an OR Nursing master study program perceive the benefit of active learning methods, including drawing and the use of VR technology.

The results show that a great majority of the students appreciated the use of both learning methods. The combination of drawing and VR in learning is, as far as we have revealed, scarcely studied. In art education, combining VR and painting has been used [27], but we have not found any research articles describing the combination of drawing and VR in health education. Nevertheless, combining various approaches to active learning is recommended in anatomy teaching [4,9]. In our teaching program, we chose to combine various methods regarding the same topic at the physical gathering at one of the campuses. Here, we chose the same topic in the drawing lessons, the VR exercise, and the demonstration of positioning the patient on the operating table. In all three sessions, we focused on anatomical structures in the upper and lower limbs. In this way, the learning was integrated by allowing the students to encounter the same topic in three different arenas, the last of which was close to practice. The combination of various active approaches and integrating them into nursing have proven to be success factors when teaching anatomy to bachelor nursing students [9]. It seems likely that this combination may be a useful approach also when teaching anatomy to OR nursing students, as these students need even deeper knowledge of anatomy for several reasons [1,2]. This is also in line with what one of our respondents expressed, that VR in addition to drawing provided a more comprehensive understanding than drawing alone.

When it comes to drawing, the benefit of this learning method in anatomy is also supported by other studies [5,10,11,13]. When respondents in our study clearly reported that the drawing pads made them more active in class, it is in accordance with Freeman et al's definition of active learning, where activities and discussion in class are emphasized [8].

The students also reported that drawing made it easier to understand the subject matter and increased their learning outcomes. One reason for this may be that the activity of drawing forces students to pay attention to what they are doing, as they have to concentrate on what they draw, and thus cannot be passive listeners [28]. In addition to the effect of the activity itself, the pace of the teaching may have contributed to improved learning outcomes. When drawing together with the students, the teacher is forced to slow down, as drawing takes time. This means that the amount of information the students must deal with during a lecture is reduced, which can prevent cognitive overload.

Most of the respondents benefited from the drawing pads outside of organized teaching, and for many of them, the pads also contributed to their use of drawing when working with the subject outside of class. However, we did not find statistical correlations between the students' opinions on the drawing lessons and their use of drawing outside of class. The size of the data material and the small spread in the students' responses may be contributing factors to this, making it difficult to obtain statistical significance. However, students' different learning styles may also be a reason [29]. It is possible that whether students chose drawing as a learning method when working on their own, depends more on their learning style than the use of drawing during lectures.

When it comes to VR, the majority of the respondents totally or partially agreed that the use of this learning method provided great learning outcomes and better understanding. Our results also indicate that the students' previous experience of using VR did not seem to have a large impact on their ability to use the anatomy program or on their perceived benefit of using VR. There are two possible conclusions that we can see here: 1. Using VR equipment combined with the 3D Organon applications is sufficiently intuitive to make it equally easy to use for both individuals already

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familiar with the technology, and those completely new to it. 2. The short instructions on the use of the software-relevant buttons that we gave at the beginning of the VR session played a significant role for first-time users in familiarizing them with the technology. An additional comparative study could provide insights into whether the implementation of a deliberately designed introduction plays a role in bridging the gap between first-time users and experienced individuals.

Although students' prior experience of using VR did not seem to be of great importance, they were a bit divided regarding their opinion on the use of the program itself and about finding the anatomical structures on the 3D models. We also found that the perceived learning outcomes and understanding of the subject matter correlated to how easy the students perceived finding the anatomical structures. As mentioned earlier, for the VR exercise, we chose anatomical structures in the limbs to link this exercise to the preceding drawing lesson and the subsequent demonstration on the operating table the same day. This also meant that the students were to find nerves in the limbs. As several of the respondents commented, nerves are small and can be difficult to grasp in VR. In retrospect, we see that although many students experienced great learning outcomes despite little experience with VR, we could have omitted some of the nerves, and only focused on the nerves most vulnerable to pressure injury during operation. Many students also expressed that they would have preferred to explore organs in the thorax and abdomen during the VR exercise. As these organs are larger, they and easier to find in the anatomy program. The results of this study encourages us to repeat this teaching program for new OR students. When we are going to repeat the teaching program, we will listen to the students' advice concerning this. This time, the drawing lessons regarding organs in the thorax and abdomen were performed later in the teaching program.

Cybersickness is one effect of VR that we did not look at in our research. It is a term that describes visually induced experience similar to motion sickness, which can include different symptoms such as nausea, disorientation, headache, and eye strain [24]. In a study among 201 nursing students, 65 % experienced discomfort symptoms during their first use of VR application [20].

We can roughly divide the cybersickness-inducing factors into hardware- and software-based, where the first originates from the technical qualities and capabilities of the VR devices, and the latter is related to the qualities of the used VR content. Kolasinski's report provides a comprehensive review of the hardware-based factors that include flicker, low framerate, time lag, etc. [26]. But we considered these factors irrelevant since the use of improved modern VR hardware (such as Pico Neo 3 VR sets) allows us to avoid most of the hardware-based cybersickness issues.

The software-based factors were comprehensively discussed in the study by Oh and Son. They concluded that passive camera movement was the dominant factor influencing cybersickness incidents [25]. Since, for our study, we used the 3D Organon software that has no passive camera movement but allows the user full control over the camera, we considered the software-based factors insignificant. The same study also confirmed the previously observed link between the duration of a VR experience and cybersickness – the longer the experience is, the more likely a user is to feel cybersickness symptoms [25]. So, to further reduce the possibility of VR-related discomfort, we shared one VR set among two or three students. The assignment instructions encouraged each student to use it for around 20 minutes, thereby reducing the duration of VR exposure.

However, in the process we observed a few of the students taking more frequent breaks from VR or occasionally skipping their turns, which indicated that they might have still felt some level of discomfort and could have higher individual sickness susceptibility. This suggests that further research is necessary to evaluate the effect of individual cybersickness-inducing factors on the effects of using VR applications with no passive camera movement for teaching anatomy.

5. Study Limitations

One limitation is the study size, as only 29 students attended the OR Nursing Master Study program. However, the response rate was high (96.4 %), indicating that the answers are representative of the opinions of the student group as a whole.

Another limitation is that for the purpose of this study, validated questionnaires are not available. Instead, we used a self-made questionnaire designed especially for this learning program.

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A limitation in the performing of the statistical analysis is that the respondents provided rather similar answers to several of the check-off questions in the questionnaire. This made it more difficult to calculate statistical correlations between the different statements that the students had to consider.

Finally, having a control group not using VR would have been the best for comparing the effect on the learning outcomes of using VR to not using it. This would be an interesting question for future research, including randomizing students to two classes with different teaching methods (a randomized controlled trial).

6. Conclusions

The combination of drawing and VR technology may be of benefit to OR Nursing students when learning anatomy by both increasing student activity and learning outcomes. The students in this study highly appreciated both the anatomy lectures with drawing guided by the teacher and the VR sessions where they were to find various anatomical structures on 3D models. Most of the students reported that drawing during lectures made them work more actively and increased their learning outcomes. Most students also perceived that the VR sessions were helpful to get a better understanding of the subject matter and of the location of anatomical structures. Lack of previous experience with VR did not seem to have a great impact on students' perceived benefit of using VR when studying anatomy. This indicates that the threshold for applying VR for this purpose is rather low. We plan in future studies to investigate the combination of learning by drawing and by VR for larger groups, possibly also for other kinds of health education studies.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org. Statistical data.

Author Contributions: Conceptualization: LK, GD**;** Formal analysis: GEE, LK**;** Investigation: LK, GD**;** Methodology: LK, AR, GD, GEE**;**Project administration: LK**;** Resources: AR, LK, GD**;** Supervision: LK**;** Visualization: GEE, LK**;** Writing – original draft: LK, AR, GD, GEE**;** Writing -review and editing: LK, GD, AR, GEE

Funding: This research received no external funding.

Institutional Review Board Statement: The study did not require ethical approval. The Norwegian Agency for Shared Services in Education and Research (SIKT) considered that if the submitted questionnaires did not contain information that could identify individuals, the project was not notifiable. This type of information did not appear in the submitted questionnaires. E-mail correspondence (in Norwegian) with The Norwegian Agency for Shared Services in Education and Research (SIKT) can be provided.

Informed Consent Statement: An Informed consent statement was not required as the questionnaires were designed to be anonymous. Written information was provided on the questionnaires that participation in the evaluation was voluntary and that names should not be written on the evaluation form. Participants were also informed in writing that the results of the evaluation could be used in oral or written presentations, such as lectures, reports, or articles.

Data Availability Statement: Dataset available on request from the authors

Public Involvement Statement: No public involvement in any aspect of this research.

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Use of Artificial Intelligence: The following has been used for translation and to check spelling: DeepL Translate: The Wolds most accurate translator; Grammarly: Free AI Writing Assistance; Søk Microsoft Translator – oversett fra Norsk Bokmål til Engelsk (bing.com); Translator provided via copilot on the website of Western Norway University of Applied Sciences (HVL)

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