



Nursing students' experiences with the use of a student response system when learning physiology

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Abstract

Digitisation has become a part of quality education and can help change the teacher's role from a lecturer to a supervisor, encourage a more student-centred approach, and increase the interactivity between the teacher and the students. However, it can be challenging to facilitate more interactive pedagogy in large classes. The aim of this study was to gain knowledge about nursing students' experience with the use of a student response system (SRS) in learning activities when learning physiology. This study was conducted at a university college in Norway, which offers Bachelor of Nursing degrees. In the Anatomy and Physiology course, a flipped classroom design, including the use of an SRS, was offered to nursing students. Data were collected in 2014 using focus group interviews with six students who were enrolled in the course and analysed using systematic text condensation. From this, four categories emerged describing the students' experiences with how the use of the SRS can support their learning: 1) creating a welcoming and stimulating learning environment, 2) encouraging participation in learning activities on campus, 3) facilitating collaboration on campus and 4) motivating students to study before and after on-campus meetings. The findings indicate that an SRS can be combined with different pedagogical strategies. Additionally, teachers should be aware of what kind of questions facilitate participation in polls versus those that are perceived as too challenging. New university college students studying within a flipped classroom design may struggle to prepare adequately before class meetings and need guidance from the teacher to handle both a new teaching approach and a new student role.

Keywords

Learning environment, Active learning, Higher education

Introduction

It is a time of upheaval in higher education in Norway, where the new White Paper on Quality in Higher Education (Ministry of Education and Research, 2017b), Norwegian Qualifications Framework (Ministry of Education and Research, 2014) and Digitisation Strategy for Universities and University Colleges (Ministry of Education and Research, 2017a) demand that universities enhance the focus on educational quality. Digitisation has become an important part of educational quality and can contribute to changing the teacher's role from the 'sage on the stage' to the 'guide on the side' (Van Dusen, 2000, p. 14). In this article, we examine how the use of digital tools can facilitate a more interactive pedagogical approach in large physiology lectures for nursing students.

Nursing students appear to find bioscience, particularly physiology, more difficult than their other subjects, and the high failure rate has been described as 'the human bioscience problem' (Rathner & Byrne, 2014). Many students regard bioscience as an intense subject with a heavy workload that contains unfamiliar concepts that are difficult to grasp, and teachers report challenges regarding class size and ineffective teaching modalities, as well as a lack of student concentration and motivation (Bakon, Craft, Christensen, & Wirihana, 2016). Scholars have argued for various forms of improved support or tutorial systems, in addition to traditional lectures, as a more effective way to teach physiology to nursing students (Craft, Hudson, Plenderleith, Wirihana, & Gordon, 2013; Davies, Murphy, & Jordan, 2000). In line with general pedagogical trends, the need for more active learning approaches has been voiced (Everly, 2013). The flipped classroom design (Bishop & Verleger, 2013) is an active approach to learning, where students watch lectures online at home and participate in activities on campus that require interactions with their peers and teacher. In addition, students complete exercises with a teacher who is available to assist them. In recent years, this approach has been used more often in nursing education (Betiavas, Bridgman, Kornhaber, & Cross, 2016; Njie-Carr et al., 2017).

It can be challenging to reach the students in large classes, and there is often passive, one-way communication with little interaction, where students are unwilling to speak up because they fear they will make mistakes in public and be embarrassed (Caldwell, 2007; Hornsby & Osman, 2014). A student response system (SRS) can enhance active learning and increase participation and engagement during lectures (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013; Lantz, 2010). An SRS allows students to respond anonymously to multiple-choice questions displayed on a screen. After students have voted on their choice of answers using remote devices, such as clickers, mobiles or tablets, the results are immediately collected, summarised and presented to the students in a visual format, often as a histogram (Kay & LeSage, 2009a). A meta-analytic review indicated that instruction using an SRS generally has a positive effect on learning (Chien, Chang, & Chang, 2016). The aim of this study was to gain knowledge about nursing students' experience with the use of an SRS in learning activities when learning physiology.

Background

Studies indicate that nursing students have positive experiences with the use of an SRS. They experienced it as fun to use, were satisfied and wanted to use it more often (Berry, 2009; Fernández-Alemán, García, Montesinos, & Jiménez, 2014; Meedzan & Fisher, 2009; Patterson, Kilpatrick, & Woebkenberg, 2010). Nursing students perceived an SRS as a positive addition to large classroom environments. The immediate feedback provided by the

SRS was seen as a helpful way to confirm and clarify their understanding of particular concepts. Moreover, the SRS contributed to maintaining concentration in lectures. Students appreciated the possibility to answer questions anonymously, and perceived that they interacted more with the other students when an SRS was used and, that discussions of voting results helped clarify their knowledge about the subject (Fifer, 2012; Meedzan & Fisher, 2009; Patterson et al., 2010; Porter & Tousman, 2010; Swart, 2015). Nursing students who used an SRS reported a greater level of motivation to answer questions correctly, were more comfortable in the classroom, and had a higher level of participation than a control group (Filer, 2010). Furthermore, nursing students reported an increased experience of active learning and engagement when an SRS was used (Hedén & Ahlstrom, 2016). However, the use of SRS may also lead to frustration, distraction and resistance. Students who are accustomed to being passive in lectures may be reluctant to use an SRS, as it could require more reasoning and collaboration. Furthermore, an SRS approach could lead to increased confusion in discussions, and students may experience that less content is addressed during lectures (Kay & LeSage, 2009a).

Few studies have focused specifically on nursing students' experiences using an SRS in bioscience. According to Al-Modhefer and Roe (2009), nursing students prefer to learn bioscience passively because they may find interactivity in lectures intimidating due to shyness and a lack of confidence in their abilities. This indicates that nursing students could benefit from using an SRS in lectures in bioscience. A few studies have investigated the use of SRS in teaching nursing students bioscience in large classes. When an SRS was used to facilitate interactions, students found it beneficial to discuss and clarify their misconceptions (Stein, Challman, & Brueckner, 2006), and to compare their knowledge of bioscience with their peers and to give the teacher feedback regarding their level of knowledge (Efstathiou & Bailey, 2012).

However, a review of the literature suggests that the body of knowledge regarding nursing students' experience of SRS in physiology studies is scarce. Therefore, the research question was the following: How do nursing students experience the use of an SRS to support their learning of physiology?

Pedagogical perspectives

The role of feedback for learning in higher education has been increasingly emphasized (Evans, 2013; Shute, 2008). According to Hattie and Timperley (2007), feedback alone is not sufficient to bridge the gap between what a student understands and what is aimed to be understood. The feedback has to answer three questions: Where am I going? (Feed Up), How am I going? (Feed Back) and Where to next? (Feed Forward). To answer the first question, the learning goal related to a task must be clear so the students know when they have reached it successfully. The answers to the second question give information to the students about their performance, or what they have already done, while answers to the third question consist of comprehending information that gives the students a greater possibility to learn in the future by knowing what they can do better and how.

Students may need guidance from a teacher to both understand a new topic and to problem-solve within a new learning context. Wood, Bruner and Ross (1976) argue that the teacher, through scaffolding, can 'control' those elements of a task that are initially beyond the student's capacity. The students concentrate on and complete only those elements that are within their range of competence, and the teacher gradually withdraws as the students become more competent. The tasks should be engaging and keep the students involved, and the teacher should encourage the students if they experience frustration and struggle to

cope. The teacher has to adjust the tasks to the students' previous knowledge and to what they are going to learn, and the teacher must therefore expect misunderstandings that the students are likely to have in order to give them proper guidance.

Vygotsky (1978) describes the zone of proximal development as the distance between the actual developmental level, a level that can be achieved on your own without support, and the level of potential development, a level that can be attained through problem-solving with teacher guidance or in collaboration with a more capable peer. While formulating tasks or questions for the students, the teacher can adapt them to the students' assumed zone of proximal development. While working with the task, during peer instruction (PI) (Mazur, 1997), the students can collaborate and discuss their thoughts with their peers. Through this dialogue and interaction, what the peer already understands can be determined.

Design of the course

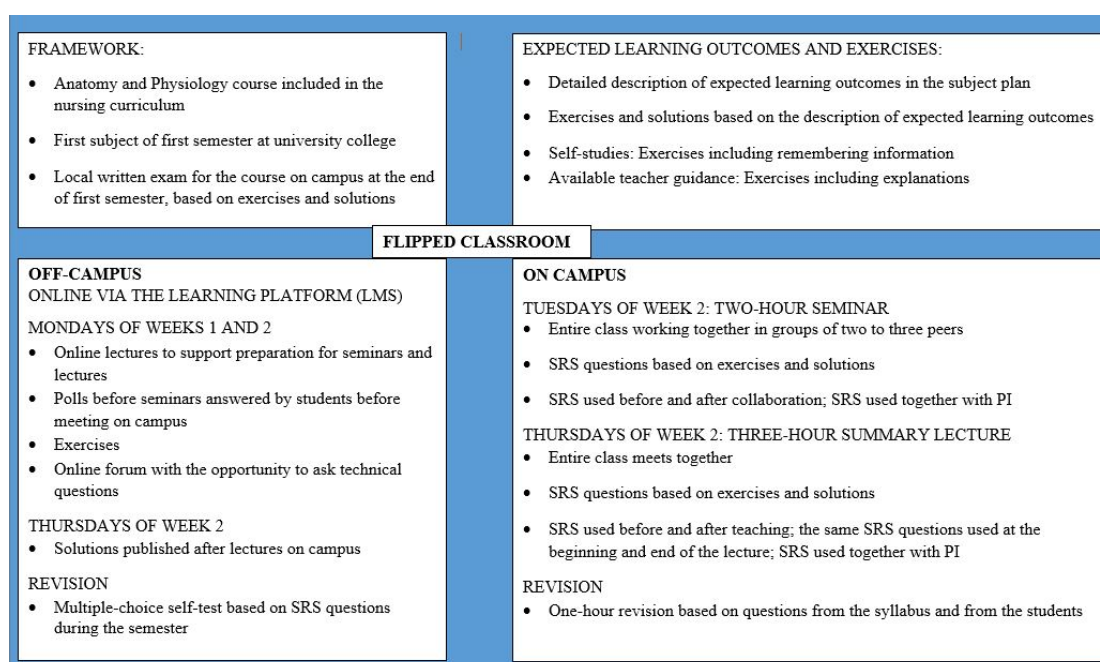


Figure 1 Design of the pilot study

The design of the Anatomy and Physiology course was based on a flipped classroom, and an SRS was used to facilitate collaboration and dialogue among peers and to adapt the teaching to the students' knowledge (Figure 1). This study was undertaken the first year that the flipped classroom design was offered, and it was the first year an SRS was used.

Two teachers taught the course. The syllabus was divided into five parts, and each part was taught over two weeks parallel to other themes under the subject of nursing. For each part, the programme was as follows: on Monday of weeks 1 and 2, there were four hours of online lectures by the teachers that the students could access via the learning management system (LMS); on Tuesday and Thursday of week 2, there were a two-hour seminar and a three-hour summary lecture on campus. Inside the LMS, the students had the opportunity to ask technical questions in an online forum, and they had access to exercises based on the description of expected learning outcomes. After the summary lectures on campus, solutions to the exercises of the corresponding part of the syllabus were published inside the LMS.

Our SRS was a web-based voting system where students used mobiles, tablets or laptops to respond to questions determined by the teachers. The teachers formulated SRS questions based on exercises and solutions. Some questions were easy, while other questions were difficult to encourage the students to think (Figure 2). Before the seminars, the students responded to a poll inside the LMS. At the beginning of the seminar, the teacher presented the voting results and reviewed the responses. The SRS was then used to determine if the students had the basic knowledge needed to correctly complete the exercises. During each seminar, the students were arranged in groups with two to three peers and worked together on exercises under the guidance of the teacher. At the end of the seminar, the SRS was used to determine if the students had found the correct answers to the exercise questions. For one or two questions, the SRS was combined with PI (Mazur, 1997) as follows: 1) the teacher posed a question with response options; 2) students reflected on the question and response options; 3) students individually voted for the correct response option; 4) students discussed their thinking and answers with their peers; 5) students then again individually voted for the correct response option; and 6) the teacher reviewed responses and decided whether more explanation was needed.

The SRS was used twice during each summary lecture on campus as follows: 1) it assessed previous knowledge before teaching and after teaching; 2) it asked the same questions at the beginning and end of a lecture; or 3) it was combined with PI to assess whether the students had understood the main points which allowed the teacher to adapt teaching to fit the students' level of knowledge.

Example of an SRS question where the students voted once before the teacher's review of the responses, either before teaching or after teaching:

Which of these substances do we find in pancreatic juice?

- A. HCl
- B. HCO_3^-
- C. Amylase
- D. Pepsinogen
- E. Lipase
- F. Bile salts
- G. Protease
- H. Nuclease
- I. Mucin

Example of an SRS question where the students voted twice before the teacher's review of the responses, either at the beginning and end of the lecture or together with PI:

Which of these statements is true?

- A. Increased concentration of glucose in plasma stimulates increased secretion of insulin and glucagon.
- B. Increased concentration of amino acids in plasma stimulates increased secretion of insulin and glucagon.

Figure 2 SRS questions

Method

This study is the first part of a project that used design-based research (DBR) as its overall research design. DBR was chosen as it combines empirical educational research with the theory-driven design of learning environments. DBR is a methodology for understanding how, when and why educational innovations work in practice (Design-Based Research Collective, 2003). With DBR, learning is studied in context (Herrington, McKenney, Reeves, & Oliver, 2007) and data are collected in cycles. In this paper, results from the first cycle are presented. The focus group interview was a suitable data collection method to learn more about students' experiences, attitudes or viewpoints (Malterud, 2011) concerning the use of the SRS. The social interaction in a focus group where students reflect on their own experi-

ences with other students can generate richer data than individual in-depth interviews (Rabiee, 2004).

Ninety-two nursing students enrolled in the Anatomy and Physiology course at a university college were invited to participate in the study. Students were recruited by the convenience sampling method (Stewart, Rook, & Shamdasani, 2007). After receiving information orally in the classroom and written information inside the LMS, six students agreed to participate and were included in the study. All were females, 21–30 years of age. They all had participated in polls with the SRS using their own mobile, tablet or laptop, or they borrowed equipment from peers. Some participants had only a high school education, while others had studied at, for example, a university. None had previously studied health-related subjects. Some participants had experience with using an LMS, but none had experience studying within a flipped classroom.

The focus group interview was conducted in January 2014 and lasted 50 minutes. The last author served as the moderator with the first author acting as the secretary. At the outset of the interview, the aim of the study was reiterated, and the topics to be explored were described. Emphasis was placed on there being no right or wrong answers and that everyone's experiences and opinions were valuable. To initiate the dialogue and provide the focus for the discussion, an interview guide was used (Stewart et al., 2007). The interview guide was based on the results of a course evaluation and covered the following topics: learning activities in physiology, various forms of polls, communication with peers and the teachers using the SRS, participation by using the SRS, motivation and views on one's own knowledge. It also covered topics such as situations where the SRS was perceived as helpful for learning and how the teachers' handling of voting results could promote learning. The focus group interview was digitally recorded and transcribed verbatim.

The transcript was analysed using inductive systematic text condensation following the principles described by Malterud (2011, 2012), a method that emphasises informants' own descriptions and perspectives. In the first step, the transcript was read several times to get an impression of the individual perspectives of the participants and an understanding of the content of the transcript as a whole. The transcript was reread while keywords from the content were highlighted, notes were made and preliminary themes were identified. In the second step, the transcript was read line by line to identify and sort meaning units related to the negotiated preliminary themes. Identified meaning units were marked with a code used to organise related meaning units into code groups. In the third step, the meaning units of each code group were read, interpreted and sorted into subgroups. Meaning units belonging to a subgroup were marked with codes. For further abstraction, the meaning units in the subgroups were condensed (Table 1). The fourth step started with the condensates and quotations from each subgroup within a code group. Category headings of each thematic code group and subcategory headings of each subgroup were abstracted, and findings were examined against the empirical data. For each subgroup within a code group, the condensates and quotations were used to write an analytic text presenting the most salient content and meaning.

Table 1 Excerpts from the analysis

Category 1. Creating a welcoming and stimulating learning environment	
Subcategory b. The teacher's attitude and technical skills facilitate a relaxed atmosphere.	
Meaning units	Condensate
<i>E: The teacher handled the voting results funnily. When we got something wrong, the teacher was very relaxed. We laughed, and then she laughed. That was funny. There was nothing scary.</i>	Teacher's use of SRS is engaging and creates a positive atmosphere.
<i>F: I noticed also that 'Teacher 1' was perhaps more used to the technology than 'Teacher 2'. So, I felt much more confident during her lectures when the SRS was used, than during his, because of her approach, which I think worked very well then.</i>	Teacher's technical expertise gives students the experience of confidence.
<i>G: I felt very confident about saying something because everyone was in the same situation then. Because it was complicated for everyone. Our teacher understood that about us, and we understood it as well. So, there was nothing embarrassing in asking, 'Can you repeat that?' because it was a bit difficult. The teacher said it clearly and said it slowly and gave new examples and stuff. The teacher was humble and patient. We never got criticised.</i> <i>H: I felt that I was seen. The teacher was humble, helped me to cope and understand.</i>	Teacher's use of SRS facilitates the relationship between students and teacher. Teacher is positive although many answered incorrectly, showing empathy and patience.

Rigour

Investigator triangulation (Polit & Beck, 2017) was used to facilitate credibility and dependability. To facilitate reflexivity and transparency, the development of the interview guide, the data collection and the data analysis were discussed within the group of researchers. To assure validity, the moderator asked questions during the interview, such as 'Do you mean...?' or 'Have I understood you correctly?' to assess the validation of immediate interpretations (Kvale & Brinkmann, 2009, pp.151-153).

The first author performed the technical analysis of the data, but the group of researchers read the transcript and participated in an iterative and continuous discussion of the emerging results of each step of the analysis process. The group of researchers had diverse pedagogical and research experience, which enhanced different perspectives during the data analysis and the interpretation of the results. The analysis process was thorough and adhered to carefully to strengthen credibility. Examples of the process are shown in Table 1.

Ethical considerations

The Norwegian Social Science Data Service privacy policy was followed. All potential participants received verbal and written information about the study two weeks prior to the interview. The information underlined that participation was voluntary; participants could withdraw from the study at any time before the study results were published and were guaranteed anonymity. Those who volunteered to participate signed an informed consent form prior to the interview. The audio tape was deleted after transcription.

The interviewers considered the balance of power between themselves and the participants prior to the interview and planned ways to create a relaxed environment during the interview.

Results

Four categories emerged from the data analysis: 1) creating a welcoming and stimulating learning environment, 2) encouraging participation in learning activities on campus, 3) facilitating collaboration on campus and 4) motivating students to study before and after on-campus meetings. The categories and subcategories are elaborated in Table 2.

Table 2 Overview of categories and subcategories

Categories	Subcategories
1. Creating a welcoming and stimulating learning environment.	a. Anonymity facilitates confidence. b. The teacher's attitude and technical skills facilitate a relaxed atmosphere. c. An enjoyable atmosphere motivates students to concentrate.
2. Encouraging participation in learning activities on campus.	a. The teacher times the use of the SRS, and the questions are adapted to student knowledge and used as goals for the lecture. b. Challenging questions evoke commitment and reveal misunderstandings. c. The teacher's guidance aids and confirms student understanding.
3. Facilitating collaboration on campus.	a. Equally prepared peers at similar knowledge levels facilitate PI and collaboration. b. Easier questions can facilitate PI.
4. Motivating students to study before and after on-campus meetings.	a. More guidance and teaching can aid the management of the student's role. b. Adapted questions facilitate adequate challenges and the experience of coping. c. SRS questions for revision facilitate the experience of confirmation.

Creating a welcoming and stimulating learning environment

According to the participants, the SRS contributed to a welcoming learning environment. At the beginning of the course, several students had feelings of uncertainty and believed they were the only ones who struggled to learn physiology and possessed insufficient knowledge. The use of the SRS and anonymous polls enhanced their level of confidence by showing them that several others also had answered incorrectly and had insufficient knowledge. This is illustrated in the following comment by one of the students:

I didn't have to be afraid of choosing the wrong answers. The scores were on the screen, and you saw that many had chosen the wrong answers, which led to a lower threshold for asking questions in class. You didn't feel so stupid because you knew that the others were too.

Even though the participants were in a large class, they felt that they had a good relationship with the teacher when the SRS was used. According to their descriptions, the teacher was perceived as friendly and helpful, and the atmosphere was humorous, relaxed and never too serious. The participants also noted the importance of the teacher's technical skills in using the SRS to create a welcoming and relaxed environment. The teacher's behaviour was considered important to the students' learning process. Two participants expressed this:

G: It was very complicated for all. Our teacher understood that.... The teacher was humble and patient. We never got a scolding.

H: I felt that I was seen.

The students appreciated how the SRS encouraged concentration in a playful way. Having fun and the feeling of being in a competition were perceived as useful for their learning process. When the students knew they were to be assessed, they followed the teaching more

closely, and the use of the SRS created natural breaks in the lectures that provided variation and facilitated concentration.

Encouraging participation in learning activities on campus

The participants had various opinions as to when the SRS should be used, according to where they were in their learning process. Some thought that the SRS should not be used before they familiarised themselves with the topic, and they wanted lectures with new topics to be a bit more relaxed, since the use of the SRS could lead to stress. One participant stated, ‘Right after the lectures, I’m not sure that I’ve understood everything; I like to read it through on my own as well.’

Others thought it could be fun and motivating to use the SRS in lectures with new topics. One participant proposed that the teacher could use easier SRS questions, while another proposed the use of the same questions in the lectures and the summary lectures, so the students could see if there was any difference between the answers. Most preferred to use the SRS during summary lectures, since they would have read and been familiar with the course material and should have learned it. They stated that they preferred the same SRS questions at the beginning and end of teaching because this provided goals for the lecture and made what they had learned during the session obvious. One participant noted, ‘You feel that you really have a purpose with the lecture, which makes you pay attention because you know that you will be tested.’

The participants used the term ‘trick questions’ when they talked about the SRS questions with unfamiliar technical terms, or where one word made a whole statement false (Figure 2). One mentioned a question about the difference between the effect of adrenalin and aldosterone as an example of a trick question. They had different opinions whether trick questions were motivational for their participation in the polls or not. If they managed to understand them, they created feelings of fun and excitement that encouraged participation. On the other hand, when they failed to understand these questions, they became demotivated and confused. It was discouraging to meet after preparing and still not understand, as illustrated in this discussion among participants:

F: I found it rather cool with difficult questions because then one concentrated hard to try to understand.

C: You thought you were right and then there was an invisible error in the sentence. Then you lost the grip a bit, leaning back, maybe losing a bit of the eagerness because you had to analyse the sentence.

D: But it did motivate too, in a way.

The participants often struggled to understand the meaning of some of the statements and realized that they had to read them more carefully. The teacher helped them to focus and to read the SRS questions in a way that enabled them to capture the actual meaning, as one explained:

You did get it when the teacher said, ‘What is actually stated here?’ Then she walked through the question and the answers again. I thought, oh my God, I was totally off track, and then you got much better at reading between the lines.

Participants were sometimes unsure whether they had understood the topic and the SRS questions or not, but they felt that they had received feedback on their knowledge from the voting results. Their understanding was confirmed when they voted correctly on the

answers to the questions. The teacher's review of the correct and incorrect answers of the poll was of great importance, since the students got explanations and a conclusion, which motivated and facilitated learning. As one said:

I thought it was excellent that they went through the questions very carefully. They explained what the small trick question was, so that one could understand what was right and what was wrong. You weren't left with unresolved questions.

The participants followed the teacher's review even more thoroughly when they had misunderstood. However, they stressed the importance of the teacher adapting the review process to the voting results.

Facilitating collaboration on campus

During seminars, the students collaborated on exercises, and the SRS was used alone and together with PI. The success of the collaboration depended on the students being equally prepared. When they collaborated with peers that were on a similar level, they found it easier to carry out the collaboration and to participate in the polls than when they collaborated with unprepared peers. Likewise, in the summary lectures, the students had dialogue with peers during PI, and differences in the levels of knowledge and preparation among the students could lead to confusion and stress. One participant described this situation:

It depended on who sat next to you. If it was a person who wasn't prepared and didn't understand, then it became very difficult, and we got more confused. If both were prepared, it went well. Then it was great fun. It was stressful to sit next to a person who really got it. You get the feeling you're behind.

The difficulty of the SRS questions affected participation and engagement during PI. The SRS questions that were perceived as too difficult seemed to be a barrier to dialogue among peers instead of encouraging a joint effort of figuring out the correct answer. As one stated:

It's a bit easier to start to discuss a topic with others if it's easier questions. Then, you get a conversation out of it, and you might get into the difficult stuff. If it's straight on to the difficult (ones), then what should we talk about? We haven't understood anything.

Participants felt that they had contributed by bringing knowledge into these dialogues and had benefitted from the process of sharing and interacting. One explained, 'You have a lot to offer to others when you feel that you understand it, then you can teach others, and then you learn even more yourself.' They trusted their peers, knowing what they talked about would remain confidential.

Motivating for studies before and after on-campus meetings

The participants believed that learning tools, such as lectures, forums and exercises inside the LMS, in addition to the textbook, helped them prepare for participating in seminars and summary lectures, activities where the SRS was used. They all stated that they studied on a regular basis throughout the course and made efforts to meet well-prepared for activities on campus. However, a common experience was the feeling of anxiety and exhaustion because of insufficient time to study. Some thought that more teaching on campus could have made them more prepared in less time. Additionally, they noted, more guidance from the teacher on campus on how to study could have saved time during preparations. The need for more time was linked to the process of adapting to the new role as university college students. The

expectation of a large amount of self-study and being responsible for allocating study time were perceived as difficult and unfamiliar to them. As one described it, 'I guess it was that we didn't know what was ahead of us. If I had known, I might have started (to study) already the first week at the university college.'

The participants had different experiences and opinions about the SRS's role as a motivator to study between the meetings on campus. This is illustrated in the following student dialogue:

C: Maybe you had not understood it, and then you understood that you should read more. So it motivated in a way... Experience of coping motivates, and it doesn't have to be like: when I am right, then I stop reading.

H: I think that easier questions lead me to think, 'Yes, I get this,' and then I don't need to read.

Both the experiences of failing and coping by answering correctly on the polls could be used as motivation. However, a continued lack of coping could be experienced as challenging. This was described by one participant:

If you never experience coping, then you'll not read more either. If all the time you don't get it, you'll become stressed and you'll have to have good self-discipline. If you don't have that, you might lose your grip.

The students were given access to all the SRS questions as self-tests inside the LMS. This was used as a repetitive exercise before the exam, and it gave them an opportunity to get feedback on their knowledge. One participant said, 'Yes, now I've understood a bit. Because one had time to think on one's own as well, and it is quite nice with that kind of confirmation.'

Discussion

Our research question concerned how nursing students experience the use of SRS to support their learning of physiology. In this section, we discuss how the use of the SRS can contribute to a welcoming and stimulating learning environment, encourage participation in learning activities and facilitate collaboration on campus. Furthermore, we discuss how the use of the SRS may motivate students to study off-campus and to understand the importance of studying before meeting in class in order to experience coping.

A welcoming and stimulating learning environment

In line with previous studies (Berry, 2009; Filer, 2010; Patterson et al., 2010), the participants believed that the use of the SRS promoted feelings of engagement and confidence. They felt that the teacher promoted a good student-teacher relationship by using the SRS to influence the emotional atmosphere of the learning environment. A welcoming environment was facilitated by integrating the SRS as a fun and competitive way to learn. However, the SRS was not used for testing with grades and that may have decreased the motivation to use it, which was also found by Berry (2009). A teaching approach with a suitable amount of seriousness and awareness, in addition to the teacher's technical prowess, appeared to be important in promoting an environment where the participants felt confident.

The participants emphasised their reluctance to show other students that they had an insufficient knowledge of physiology. This is in line with research showing that nursing stu-

dents worry about their level of knowledge, even when they answered correctly using the SRS (Efsthathiou & Bailey, 2012). Being able to answer anonymously and see that others also lacked knowledge enhanced the participants' confidence. Anonymity allowed them to more actively participate in learning without recrimination; this reduced feelings of embarrassment and anxiety (De Gagne, 2011; Kay & LeSage, 2009a).

Questions and guidance encouraging and facilitating participation and collaboration

It was surprising that the participants used the term 'trick question' regarding questions that contained some incorrect information. When developing questions, the intention was not to trick the students, but to offer questions with different levels of difficulty to enhance reasoning during dialogues with peers and before the teachers' review. SRS questions that are vague with respect to possible answers are recommended to help students process, reason and resolve misconceptions, and the questions should be sufficiently challenging to encourage students to engage in dialogue with peers (Kay & LeSage, 2009b). The participants had to understand the SRS questions to participate in the polls and to discuss them with peers. Our findings showed that trick questions could be a source of frustration. Trick questions may also be considered questions that emphasise a careful reading of the text. At the beginning of the course, the teacher guided the participants' reading of the SRS questions, which can be seen as a form of scaffolding (Wood et al., 1976), and over time, they became more able to do this on their own.

The participants expressed that trick questions could motivate and engage learning, but also discourage it, especially if they met prepared but still did not understand. Therefore, the use of trick questions should be carefully considered when designing SRS sessions. In our study, questions were formulated based on expectations of what the students understood after preparation at home and what was possible to obtain during PI or with teacher guidance, which is a method inspired by Vygotsky's (1978) zone of proximal development. However, the participants met in class with different levels of preparedness and knowledge. Therefore, sufficient time for the students to reason and discuss the SRS questions and for the teacher to review them seems important to facilitate learning. To avoid superficial teaching, our use of SRS questions was limited to two questions per lecture. Moreover, close attention to how things worked in the previous session could improve the next SRS session. Knowing that nursing students struggle with physiology and lack confidence in this subject, teachers should be aware of the feelings SRS questions may evoke and have a balance between easy and difficult questions.

The participants emphasised that the timing of the use of SRS questions with different degrees of difficulty should be adapted to their learning process and knowledge, and it could be stressful if it was used when they were learning new topics, or if they met without having sufficient knowledge. In their opinion, the most appropriate strategy was to use the same SRS questions at the beginning and end of teaching. They stated that these questions should focus on the essential content of the lecture and the goals related to it. Their description resembles what Hattie and Timperley (2007, p. 86) call feed up: the SRS questions indicated what the learning goal was. Additionally, voting on the same questions at different times gave them an opportunity to see how much they had learned. Through the polls and the teacher's review of the correct and incorrect answers, students could receive both feedback on their performance and feed forward (Hattie & Timperley, 2007) when getting information on what they had understood and misunderstood. The students' worry about their level of knowledge and expressing the need for confirmation of what that they had under-

stood might be related to nursing students' lack of confidence in their abilities when studying bioscience (Al-Modhefer & Roe, 2009). The participants positively responded to the teacher's adaptation of explanations according to the voting results, so they were not being left with any unanswered questions. Thus, even if the majority answer correctly, the teachers should explain and review all the polls to give all students an opportunity to receive explanations of what they misinterpreted or did not understand. According to Krumsvik (2013), students can use feedback received through the polls to improve their understanding of the teacher's explanations.

The participants experienced challenges during discussions when peers had very different knowledge levels, which limited the gain from PI. Especially for seminars, they described that some of their peers came inadequately prepared. Equally prepared peers were the best conversation partners; they could discuss which answers to the SRS questions they thought were correct or incorrect. The way the participants described the perfect peer resembles what Vygotsky (1978) calls a 'capable other'. A capable peer seems to be one who studies before meetings on campus and reveals a similar level of knowledge during the discussions; such peers can confirm each other's knowledge and work towards understanding together without feeling 'unsure and stupid'. In line with another study (Nielsen, Hansen-Nygård, & Stav, 2012), we found that students were more likely to become passive and withdraw from the discussion if they were uncertain about the SRS question and sat next to peers they did not know well.

The need to understand the importance of studying before meeting in class and to experience coping

The participants perceived it as challenging to prepare for on-campus activities within a schedule that they thought allotted insufficient time. The teachers offered tools to support the students' self-studies. Even though the participants perceived these tools as helpful, in order to save time, they wanted more guidance from the teacher on whether they were on the right track. This finding may be related to nursing students' need for augmented guidance when learning bioscience (Davies et al., 2000). The participants' experiences of exhaustion and need for more guidance seem to express a need for more scaffolding within a new teaching approach, especially as they were new university college students. An introductory course could make the transition to higher education easier, and the teacher's scaffolding could support nursing students (Bingen, 2013). According to Salamonson et al. (2016), nursing students with a high ability to cope with stressful situations may have a more self-regulated approach to learning, which could affect adaptation and transition in higher education.

The participants emphasised the importance of adequate challenges. They described the experience of coping as important in order to be motivated to read more after participating in polls. However, they also stated that questions that were too easy could lead them to think they did not need to read more. Therefore, there needs to be a balance between easy and difficult SRS questions, to motivate students to read and study more. When the goal or the task is appropriately challenging, it is possible for the teacher to provide feedback to the students. At the end of the course, the SRS questions were offered as self-tests inside the LMS, and the participants felt that this gave them more time to read and think. In this way, the students' need for confirmation was facilitated, and they got an opportunity to correctly answer the SRS questions they had previously answered incorrectly in class.

One limitation of this study may be that the nursing students were from one university college. Other limitations may be the small sample size, that the sample consisted of only

females aged 30 years or younger, and that only one focus group was interviewed. There may be variations and distinctions in the experiences of students who use an SRS that we were not able to identify due to these limitations, and other students may experience the use of an SRS differently. The data generated by focus groups are affected by the group dynamics (Rabiee, 2004.) In our focus group, all the participants were active and shared their experiences.

The first author's dual role as course manager and secretary during the focus group interview could have influenced the data collection. The participants might have been reluctant to speak about negative experiences from the lectures due to a differential in power. However, they shared both positive and negative experiences. The first author's roles might also have influenced the data analysis, but to balance this limitation, a group of researchers participated in the analysis.

Conclusions

In summary, we found that the participants felt that the use of the SRS contributed to increased student-teacher and student-student interactivity in a subject where many nursing students struggle. In addition to the opportunity to answer anonymously, the teacher's friendly attitude, technical prowess and use of the SRS in an enjoyable way contributed to a welcoming and stimulating learning environment. To facilitate participation in learning activities and receiving feedback, the students preferred the use of the same SRS questions at the start and the end of the lecture. They also emphasised the importance of the teacher's guidance and ability to adapt explanations to meet individual student needs. In order to facilitate the experience of academic challenges and coping with them, there should be a balance between easy and difficult SRS questions. In addition, it seems that successful participation in on-campus activities requires adequate preparation at home, and that new university college students studying within a flipped classroom design may need more guidance from the teacher to handle both a new teaching approach and a new student role.

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References

- Al-Modhefer, A. K., & Roe, S. (2009). Nursing students' attitudes to biomedical science lectures. *Nursing Standard*, 24(14), 42–48. DOI: <https://doi.org/10.7748/ns2009.12.24.14.42.c7435>
- Bakon, S., Craft, J., Christensen, M., & Wirihana, L. (2016). Can active learning principles be applied to the bioscience assessments of nursing students? A review of the literature. *Nurse Education Today*, 37, 123–127. DOI: <https://doi.org/10.1016/j.nedt.2015.11.030>
- Berry, J. (2009). Technology support in nursing education: Clickers in the classroom. *Nursing Education Perspectives*, 30(5), 295–298.
- Betihavas, V., Bridgman, H., Kornhaber, R., & Cross, M. (2016). The evidence for 'flipping out': A systematic review of the flipped classroom in nursing education. *Nurse Education Today*, 38, 15–21. DOI: <https://doi.org/10.1016/j.nedt.2015.12.010>
- Bingen, H. M. (2013). Trygt læringsmiljø på nett for å lære gjennom skriftlige dialoger i diskusjonsfora. In T. Fosslund, E. Gjerdrum, & K. R. Ramberg (Eds.), *Ulike forståelser av kvalitet i norsk, fleksibel høyere utdanning – eksempler fra teknologi og læring på og utenfor campus* (pp. 235–249). Tromsø: Norgesuniversitetet.
- Bishop, J., & Verleger, M. (2013). *The flipped classroom: A survey of the research*. Paper presented at the 120th ASEE Conference & Exposition, Atlanta. Retrieved from: <https://peer.asee.org/the-flipped-classroom-a-survey-of-the-research>

- Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, 62(2013), 102–110. DOI: <https://doi.org/10.1016/j.compedu.2012.10.019>
- Caldwell, J. (2007). Clickers in the large classroom: Current research and best-practice tips. *Life Sciences Education*, 6(1), 9–20. DOI: <https://doi.org/10.1187/cbe.06-12-0205>
- Chien, Y. T., Chang, Y. H., & Chang, C. Y. (2016). Do we click in the right way? A meta-analytic review of clicker-integrated instruction. *Educational Research Review*, 17, 1–18. DOI: <http://dx.doi.org/10.1016/j.edurev.2015.10.003>
- Craft, J., Hudson, P., Plenderleith, M., Wirihana, L., & Gordon, C. (2013). Commencing nursing students' perceptions and anxiety of bioscience. *Nurse Education Today*, 33(11), 1399–1405. DOI: <https://doi.org/10.1016/j.nedt.2012.10.020>
- Davies, S., Murphy, F., & Jordan, S. (2000). Bioscience in the pre-registration curriculum: Finding the right teaching strategy. *Nurse Education Today*, 20(2), 123–135. DOI: <https://doi.org/10.1054/nedt.1999.0375>
- De Gagne, J. C. (2011). The impact of clickers in nursing education: A review of literature. *Nurse Education Today*, 31(8), 34–40. DOI: <https://doi.org/10.1016/j.nedt.2010.12.007>
- Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, 32(1), 5–8.
- Efstathiou, N., & Bailey, C. (2012). Promoting active learning using audience response system in large bioscience classes. *Nurse Education Today*, 32(1), 91–95. <https://doi.org/10.1016/j.nedt.2011.01.017>
- Evans, C. (2013). Making sense of assessment feedback in higher education. *Review of Educational Research*, 83(1), 70–120. DOI: <https://doi.org/10.3102/0034654312474350>
- Everly, M. C. (2013). Are students' impressions of improved learning through active learning methods reflected by improved test scores? *Nurse Education Today*, 33(2), 148–151. DOI: <https://doi.org/10.1016/j.nedt.2011.10.023>
- Fernández-Alemán, J. L., García, A. B. S., Montesinos, M. J. L., & Jiménez, J. J. L. (2014). Examining the benefits of learning based on an audience response system when confronting emergency situations. *CIN: Computers, Informatics, Nursing*, 32(5), 207–213. DOI: <https://doi.org/10.1097/CIN.0000000000000053>
- Fifer, P. (2012). Student perception of clicker usage in nursing education. *Teaching and Learning in Nursing*, 7(1), 6–9. DOI: <https://doi.org/10.1016/j.teln.2011.07.005>
- Filer, D. (2010). Everyone's answering: Using technology to increase classroom participation. *Nursing Education Perspectives*, 31(4), 247–250.
- Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81–112. DOI: <https://doi.org/10.3102/003465430298487>
- Hedén, L., & Ahlstrom, L. (2016). Individual response technology to promote active learning within the caring sciences: An experimental research study. *Nurse Education Today*, 36, 202–206. DOI: <https://doi.org/10.1016/j.nedt.2015.10.010>
- Herrington, J., McKenney, S., Reeves, T., & Oliver, R. (2007). *Design-based research and doctoral students: Guidelines for preparing a dissertation proposal*. Paper presented at the Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007, Vancouver, Canada. Retrieved from: <http://www.editlib.org/p/25967/>
- Hornsby, D. J., & Osman, R. (2014). Massification in higher education: Large classes and student learning. *Higher Education*, 67(6), 711–719.
- Kay, R. H., & LeSage, A. (2009a). Examining the benefits and challenges of using audience response systems: A review of the literature. *Computers & Education*, 53(3), 819–827. DOI: <https://doi.org/10.1016/j.compedu.2009.05.001>
- Kay, R. H., & LeSage, A. (2009b). A strategic assessment of audience response systems used in higher education. *Australian Journal of Educational Technology*, 25(2), 235–249.
- Krumsvik, R. J. (2013). Formativ e-vurdering og læringsutbytte i høyere utdanning – fra intensjon til realitet. In T. Fosslund, E. Gjerdrum, & K. R. Ramberg (Eds.), *Ulike forståelser av kvalitet i norsk, fleksibel høyere utdanning – eksempler fra teknologi og læring på og utenfor campus* (pp. 207–218). Tromsø: Norgesuniversitetet.

- Kvale, S., & Brinkmann, S. (2009). *Interviews: Learning the craft of qualitative research interviewing* (2nd ed.). Los Angeles: Sage.
- Lantz, M. E. (2010). The use of 'clickers' in the classroom: Teaching innovation or merely an amusing novelty? *Computers in Human Behavior*, 26(4), 556–561. DOI: <https://doi.org/10.1016/j.chb.2010.02.014>
- Malterud, K. (2011). *Kvalitative metoder i medisinsk forskning: En innføring* (3rd ed.). Oslo: Universitetsforlaget.
- Malterud, K. (2012). Systematic text condensation: A strategy for qualitative analysis. *Scandinavian Journal of Social Medicine*, 40(8), 795–805. DOI: <https://doi.org/10.1177/1403494812465030>
- Mazur, E. (1997). *Peer instruction: A user's manual*. New Jersey: Prentice Hall.
- Meedzan, N., & Fisher, K. L. (2009). Clickers in nursing education: An active learning tool in the classroom. *Online Journal of Nursing Informatics*, 13(2), 1–19.
- Ministry of Education and Research. (2014). *Nasjonalt kvalifikasjonsrammeverk for livslang læring [The Norwegian qualifications framework for lifelong learning]*. Oslo: Kunnskapsdepartementet/NOKUT. Retrieved from: http://www.nokut.no/Documents/NOKUT/Artikkelbibliotek/Norsk_utdanning/NKR/Nasjonalt_kvalifikasjonsrammeverk_for_livslang_l%C3%A6ring_NKR_NN.pdf
- Ministry of Education and Research. (2017a). *Digitaliseringsstrategi for universitets-og høyskolesektoren*. Oslo: Kunnskapsdepartementet. Retrieved from: https://www.regjeringen.no/globalassets/departementene/kd/dokumenter/digitaliseringsstrategi-for-universitets--og-hoyskolesektoren-2017-2021_ny.pdf
- Ministry of Education and Research. (2017b). *St. mld. nr. 16 (2016–2017). Kultur for kvalitet i høyereutdanning [Quality culture in higher education]*. Oslo: Kunnskapsdepartementet. DOI: <https://www.regjeringen.no/no/dokumenter/meld.-st.-16-20162017/id2536007/>
- Nielsen, K. L., Hansen-Nygård, G., & Stav, J. B. (2012). Investigating peer instruction: How the initial voting session affects students' experiences of group discussion. *International Scholarly Research Notices*, 2012, 1–8. DOI: <https://doi.org/10.5402/2012/290157>
- Njie-Carr, V. P. S., Ludeman, E., Lee, M. C., Dordunoo, D., Trocky, N. M., & Jenkins, L. S. (2017). An integrative review of flipped classroom teaching models in nursing education. *Journal of Professional Nursing*, 33(2), 133–144. DOI: <http://doi.org/10.1016/j.profnurs.2016.07.001>
- Patterson, B., Kilpatrick, J., & Woebkenberg, E. (2010). Evidence for teaching practice: The impact of clickers in a large classroom environment. *Nurse Education Today*, 30(7), 603–607. Retrieved from: <https://doi.org/10.1016/j.nedt.2009.12.008>
- Polit, D. F., & Beck, C. T. (2017). Designing and conducting qualitative studies to generate evidence for nursing. In D. F. Polit & C. T. Beck (Eds.), *Nursing research: Generating and assessing evidence for nursing practice* (10th ed.). Philadelphia: Wolters Kluwer.
- Porter, A. G., & Tousman, S. (2010). Evaluating the effect of interactive audience response systems on the perceived learning experience of nursing students. *Journal of Nursing Education*, 49(9), 523–527. DOI: <https://doi.org/10.3928/01484834-20100524-10>
- Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society*, 63(4), 655–660.
- Rathner, J. A., & Byrne, G. (2014). The use of team-based, guided inquiry learning to overcome educational disadvantages in learning human physiology: A structural equation model. *Advances in Physiology Education*, 38(3), 221–228. DOI: <https://doi.org/10.1152/advan.00131.2013>
- Salamonson, Y., Ramjan, L. M., van den Nieuwenhuizen, S., Metcalfe, L., Chang, S., & Everett, B. (2016). Sense of coherence, self-regulated learning and academic performance in first year nursing students: A cluster analysis approach. *Nurse Education in Practice*, 17, 208–213. DOI: <https://doi.org/10.1016/j.nepr.2016.01.001>
- Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, 78(1), 153–189.
- Stein, P. S., Challman, S. D., & Brueckner, J. K. (2006). Using audience response technology for pretest reviews in an undergraduate nursing course. *Journal of Nursing Education*, 45(11), 469–473.
- Stewart, D. W., Rook, D. W., & Shamdasani, P. N. (2007). *Focus groups: Theory and practice* (2nd ed. Vol. 20). Thousand Oaks: SAGE.
- Swart, R. (2015). *Examining critical thinking development in undergraduate nursing students utilizing online and face-to-face technology-enhanced learning environments*. University of Calgary. Retrieved from: http://theses.ucalgary.ca/bitstream/11023/2322/4/ucalgary_2015_swart_ruth.pdf

- Van Dusen, G. C. (2000). *Digital dilemma: Issues of access, cost, and quality in media-enhanced and distance education* (Vol. 27, no. 5). San Francisco: Jossey-Bass.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* Cambridge: Harvard University Press.
- Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, 17(2), 89–100.