

Original research

Nursing students studying physiology within a flipped classroom, self-regulation and off-campus activities

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ABSTRACT

Nursing students experience physiology as a challenging subject to learn. A learner-centred approach could enhance their learning. This study explored nursing students' experiences of actively studying anatomy and physiology off-campus within a flipped classroom using various digital tools. The data from focus group interviews and students' reflective notes were analysed using a combination of systematic text condensation and activity systems analysis. In the students' activity system, three tensions were identified: tension between students' expectations and the teaching design, tension between a wish for more frequent attendance and being on their own and tension between the schedule and time needed. The use of digital tools could have facilitated learning and preparation for the course activities. However, students seemed to depend on social assistance, and they might not be ready to take full responsibility for studying adequately by themselves.

1. Introduction

Physiology is an important subject in the baccalaureate nursing programme to prepare nursing students for competent clinical practice. However, many nursing students face challenges in learning physiology and need to choose suitable learning strategies, as well as possess appropriate study skills (McVicar et al., 2014, 2015). Kirschner (2017, p.166) states that 'there is quite a difference between the way that someone prefers to learn, and that which actually leads to effective and efficient learning'. Students learn in different ways, and more active and learner-centred approaches have been highlighted to enhance students' learning outcomes (Freeman et al., 2014; Michael, 2006). One learner-centred approach to learning is the 'flipped classroom' (Bishop and Verleger, 2013). In a flipped classroom, students can view lectures online while at home and do exercises on campus when their teacher is available. The flipped classroom has recently been more frequently offered in nursing education. Studies (El-Banna et al., 2017; Missildine et al., 2013) indicate that, even though nursing students perform better within the flipped classroom, there are barriers to adapting this new approach.

In this paper, the aims are to gain knowledge of how nursing students describe learning and studying physiology off-campus and to propose a teaching design, which supports the students' studies

between the on-campus meetings. This study is part of a larger work exploring how nursing students experience learning physiology within a flipped classroom.

1.1. Background

Research suggests different reasons for why many nursing students experience challenges in learning bioscience. An integrated review by McVicar et al. (2015) suggests that this may be due to factors such as their age at entry, previous education and high school achievements in science. These factors may also influence the students' self-directed learning readiness (Slater and Cusick, 2017). At university college, it is expected that students manage to study independently and self-direct their learning, but evidence indicates that nursing students often lack the necessary skills to do so (Barker et al., 2016) and could need support (Felicilda-Reynaldo et al., 2017).

Research shows that nursing students seem to prefer didactic teaching methods in bioscience, finding interactivity in lectures discouraging because of a lack of self-confidence in their own abilities (Al-Modhefer and Roe, 2009). The most preferred learning styles seem to be learning by doing and hearing, while the least preferred are learning in a group, on their own and by reading (Johnston et al., 2015). Furthermore, students seem to prefer practical sessions over tutorials

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(Meehan-Andrews, 2009). However, it may be risky to adapt to the students' preferred learning styles, as they may not necessarily help them to perform better (Salvage-Jones et al., 2016).

Craft et al. (2017) suggest that lectures are an inadequate teaching strategy for bioscience, and active learning to engage students, such as team-based workshops, should be integrated. Furthermore, tutoring by the teacher may facilitate active participation and learning in online groups (Bingen, 2013). Including online resources such as online videos could support nursing students learning in bioscience (Johnston et al., 2018; Todorovic et al., 2016). In the flipped classroom, online lectures are integrated to facilitate students' off-campus preparations, and students may prefer to watch the videos rather than reading the textbook (McLaughlin et al., 2014). Furthermore, including the use of tools such as a student response system (SRS) in on-campus activities could encourage students to use online resources off-campus (McLaughlin et al., 2014).

Off-campus preparation is highly dependent on self-regulation strategies (Zimmerman and Labuhn, 2012). Research investigating students' self-regulation within the flipped classroom indicates that students' perceptions of the teaching design positively predict their use of self-regulating strategies (Sletten, 2017). Zimmerman and Martinez-Pons (1986) identified various categories of self-regulation strategies. High achievers use strategies such as 'seeking information', 'keeping records and monitoring', 'organising and transforming' and 'seeking social assistance'. Low achievers use more non-self-regulated strategies such as 'reactive', which indicates a lack of personal initiative and 'willpower' (Zimmerman and Martinez-Pons, 1986). Additionally, 'responsibility' can be added as a self-regulation strategy (Magno, 2010), as it reflects learners' liability for and conscientiousness of the learning task and learning experience.

To explore nursing students' use of self-regulated learning strategies, we have elaborated on the following research question: How do nursing students describe their experiences with off-campus activities when learning physiology within a flipped classroom?

2. Course design

The design of the anatomy and physiology course in this study is described in Fig. 1. Based on the findings from a pilot, one of the purposes of the new design was to encourage off-campus students to better prepare for the in-class activities. We continued to use the online lectures and the SRS and included digital tools, such as mYouTime (mobile application), Wordle and Adobe Connect (online conference room) in the design (see Fig. 1).

An introduction programme called 'Warm-up Week' was offered the week before the semester began (see Table 1). The programme focused on how to study within a flipped classroom, familiarisation with the digital tools and socialization of the class and the learning groups into which they were already divided.

The syllabus was divided into five parts. The programme for each part is described in Fig. 1. As a novel approach, the teachers offered a live broadcast, 'Morning Coffee', to guide the students' use of the online lectures. Via the learning management system (LMS), the students had access to online lectures, exercises with solutions and a forum where they could interact and receive responses from the teachers.

Prior to the on-campus seminars, the learning groups prepared by producing two group products (see Fig. 1). These products guided the seminars. At home, after the seminars, the students answered quizzes. The students also prepared at home for participation in on-campus SRS polls where they responded to questions by voting on different statements in class.

3. Method

Design-based research was used as the overall research design as it is a methodology for understanding how educational innovations work

in practice (Design-Based Research Collective, 2003). The implementation of the educational design is iterative and occurs over at least two cycles, and this study is from cycle number two.

Focus group interviews and reflective notes were used to explore the students' experiences with the course design. Focus groups are an appropriate way to learn more about how students perceive and experience an intervention, and students reflecting with other students can generate richer data than individual interviews (McKenney and Reeves, 2012). Reflective notes enable the students to individually describe their experience in a written form, allowing them more time to reflect (Dysthe et al., 2010).

3.1. Activity theory

Activity theory (AT) (Engeström, 2015) was used as an analytic tool to understand how nursing students experienced learning physiology within a flipped classroom. According to Engeström (2015), any learning activity can be understood as an activity system, a network consisting of the following elements: subject, object, tools, rules, community and division of labour. Using AT as an analytical tool provides insight into how changes, such as introducing new methods, have an impact on the different elements and how they mutually affect each other (Engeström, 2015). AT has been used in empirical studies as a framework for the analysis of learning mediated by digital tools (Yamagata-Lynch, 2010). In AT, contradictions are the driving force of change (Engeström, 2015). Description of the activity system is the basis for the identification of contradictions or tensions between interacting components. The *subject* is the individual or group whose viewpoint is adopted in the analysis. Tools mediate the object of the activity, and community refers to those who share the same object. Division of labour refers to the division of tasks and roles among the members of the community, whereas norms constrain and guide the activity and are the explicit and implicit regulations and guidelines. The object provides the determined direction of the activity.

3.2. Participants and setting

In 2015, 192 nursing students were enrolled in the course. The students were divided into four seminar groups, and, in each seminar group, there were four learning groups. The first and last author invited two learning groups based on purposeful selection, using the following criteria: learning groups from different seminar groups consisting of both male and female students and students who had and had not participated in the Warm-up Week. The two learning groups were invited via email and agreed to participate when presenting for the first interview. In learning group A, 12 of 13 students agreed to participate in the study, and in learning group B, 11 of 12 students agreed.

Four focus group interviews were conducted (see Table 2). During the interviews, an interview guide was used to initiate the dialogue and provide focus for the discussion (Stewart et al., 2007). The interview guides were informed by findings from the pilot. After preliminary analysis of the first focus groups' interviews and the reflective notes, additional questions were included in the second interview guide to be able to further elaborate and explore answers (see Table 2). The interviews lasted from 60 to 90 min and were all conducted by the same moderator (HMB). A secretary (BT) assisted during the first interviews. The focus group interviews were audiotaped and transcribed by an external transcriber. Between the two interviews, the participants individually sent two reflective notes to the first author (see Table 2). Themes guiding the reflective notes are described in Table 2. The reflective notes were anonymised before the analysis.

3.3. Analysis

The data were analysed using a combination of systematic text condensation (Malterud, 2012) and activity systems analysis

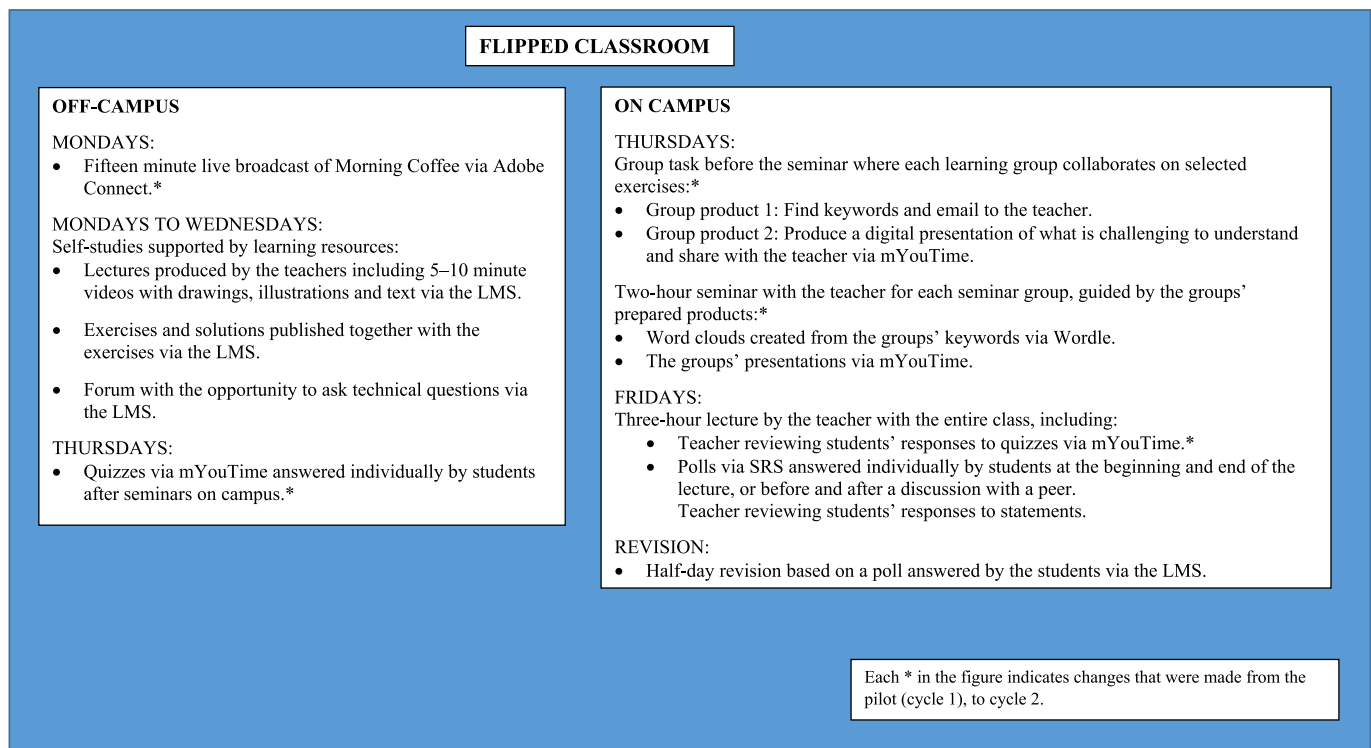


Fig. 1. Course design description.

Table 1

Description of the Warm-up Week introduction programme.

<p>OFF-CAMPUS: Via the LMS</p> <p>Day 1:</p> <ul style="list-style-type: none"> • Welcome and video presentations of the university college, the teachers etc. <p>Day 2:</p> <ul style="list-style-type: none"> • Videos with information about how to study within the flipped classroom and an opportunity to participate in a live meeting broadcast via Adobe Connect. <p>Day 3:</p> <ul style="list-style-type: none"> • Videos with information about the LMS, exercises to familiarize students with the LMS and an invitation to participate in an online forum with the entire class. <p>Day 4:</p> <ul style="list-style-type: none"> • Class divided into 16 learning groups. Videos with information about study techniques and group work about learning strategies. <p>Day 5:</p> <ul style="list-style-type: none"> • Videos with information about how to study for the courses during the first semester and a quiz via mYouTube answered individually by the students. <p>ON CAMPUS</p> <p>Day 1:</p> <ul style="list-style-type: none"> • During the students' first meeting on campus, each learning group completes the group work about learning strategies and emails keywords to the teacher. <p>Day 2:</p> <ul style="list-style-type: none"> • The entire class meets at a lecture about the flipped classroom and learning strategies. <ul style="list-style-type: none"> • Guided by students' answers to the quiz via mYouTube. • Discussions facilitating the use of the SRS and peer instruction. • Seminar in seminar groups. <ul style="list-style-type: none"> • Guided by word clouds created from the learning groups' keywords. • Learning groups using mYouTube for the presentation of their study scheme. • Discussions facilitated by the learning groups' presentations via mYouTube.
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(Yamagata-Lynch, 2010). During steps one to three of the analysis, the interviews and the reflective notes were analysed separately, considering the aim of the entire study. In the first step, the data material was read to get an impression of both the parts and the material as a whole. Keywords from the content were highlighted, notes were made and preliminary themes were identified. In the second step, meaning units related to the preliminary negotiated themes were identified and marked with a code. These codes were used to organize related meaning units into thematic code groups. In the third step, the meaning

units within each thematic code group were condensed and marked with codes to sort meaning units into subgroups. For further abstraction, the meaning units within the subgroups were condensed, a process which was repeated several times.

In the last step, activity systems analysis was used. For further abstraction, condensates from subgroups related to this paper's research question were chosen. The activity system was described (see Fig. 2) alternating with identification and interpretation of contradictions, a circular process repeated several times.

The data analysis was an iterative process where the first author analysed the data, while the last author formulated critical questions to expand understanding.

3.4. Ethics

The Norwegian Social Science Data Services approved the study. Information outlining the study and its aim and providing assurances that participation was voluntary and that anonymity and confidentiality would be safeguarded was given to the students in the two selected learning groups the week before they met on campus for the first time. Students' anonymity was ensured by removing their names and other identifying characteristics. Signed, informed consent was collected prior to participation in the study.

4. Findings

Three contradictions were identified from the data analysis: tension between students' expectations and the teaching design, tension between a wish for more frequent attendance and being on their own and tension between the schedule and time needed (see Table 3).

4.1. Tension between students' expectations and the teaching design

In the first interviews, the students' described how they had learned science in high school. Traditional blackboard teaching was the teaching strategy they all were used to. Memorisation was a frequently

Table 2
Data collection.

	Time	Themes covered by the interview guides and reflection questions for this part of the study
The two first focus group interviews	Conducted in August 2015 on the students' second day at the university college.	Experience before studying physiology: <ul style="list-style-type: none"> ● Learning strategies they discussed during the Warm-up Week, which the teachers supposed would be helpful when learning physiology. ● Experience from studying science in high school and the learning strategies they had used.
The first reflective notes	Delivered in September 2015 via the LMS or email.	Experience while studying physiology: <ul style="list-style-type: none"> ● Which tools they chose to use and which tools were easy or challenging to use. ● Description of their preferred learning strategy and their reasons for choosing that strategy.
The second reflective notes	Delivered in October 2015 via the LMS or email.	Experience while studying physiology: <ul style="list-style-type: none"> ● How technology influenced which tools they chose to use, and which tools were easy or challenging to use. ● If the preferred learning strategy had changed, how technology influenced the choice of strategy and their reasons for changing or not changing the strategy.
The 2 s focus group interviews	Conducted in November 2015, two days after the exam.	Experience after studying physiology: <ul style="list-style-type: none"> ● Experience of becoming a university college student. ● Experiences in studying and learning physiology within the flipped classroom, and how the offered tools had influenced their preparations for participation in activities. ● Learning strategies that had been helpful when learning physiology, and how the offered tools had influenced their choices of learning strategies, both their own and the teachers' use of the tools.

used learning strategy when preparing for tests: 'I learned by heart and memorised what I didn't understand'. Students experienced the transfer from high school to university college as challenging. In the second interview, a student stated: 'I had used the same strategy for thirteen years, and then, suddenly, I had to do something completely different. That was overwhelming'.

The anatomy and physiology course was perceived as a 'bottleneck', a very demanding subject. Furthermore, students' responsibility was to remember to meet and be prepared for on-campus activities by viewing online lectures, reading the textbook and doing the exercises. However, this responsibility was new to them and difficult for them to handle: 'I

wanted a teacher in front of me to explain to me the fundamentals before reading the book'. Students missed a teacher writing keywords on a blackboard and using the keywords to repeat the content of the lecture at home. They found it challenging to find keywords and make notes by themselves: 'I had big problems when I read the book, I didn't understand what the main point was'.

Most students preferred viewing their teachers' online lectures rather than reading the textbook. They pointed out that the teachers had various lecture styles: 'Our first teacher had detailed and fine online lectures, but then another teacher just told what the topic was and what to read, nothing more'. In the reflective notes, students described that

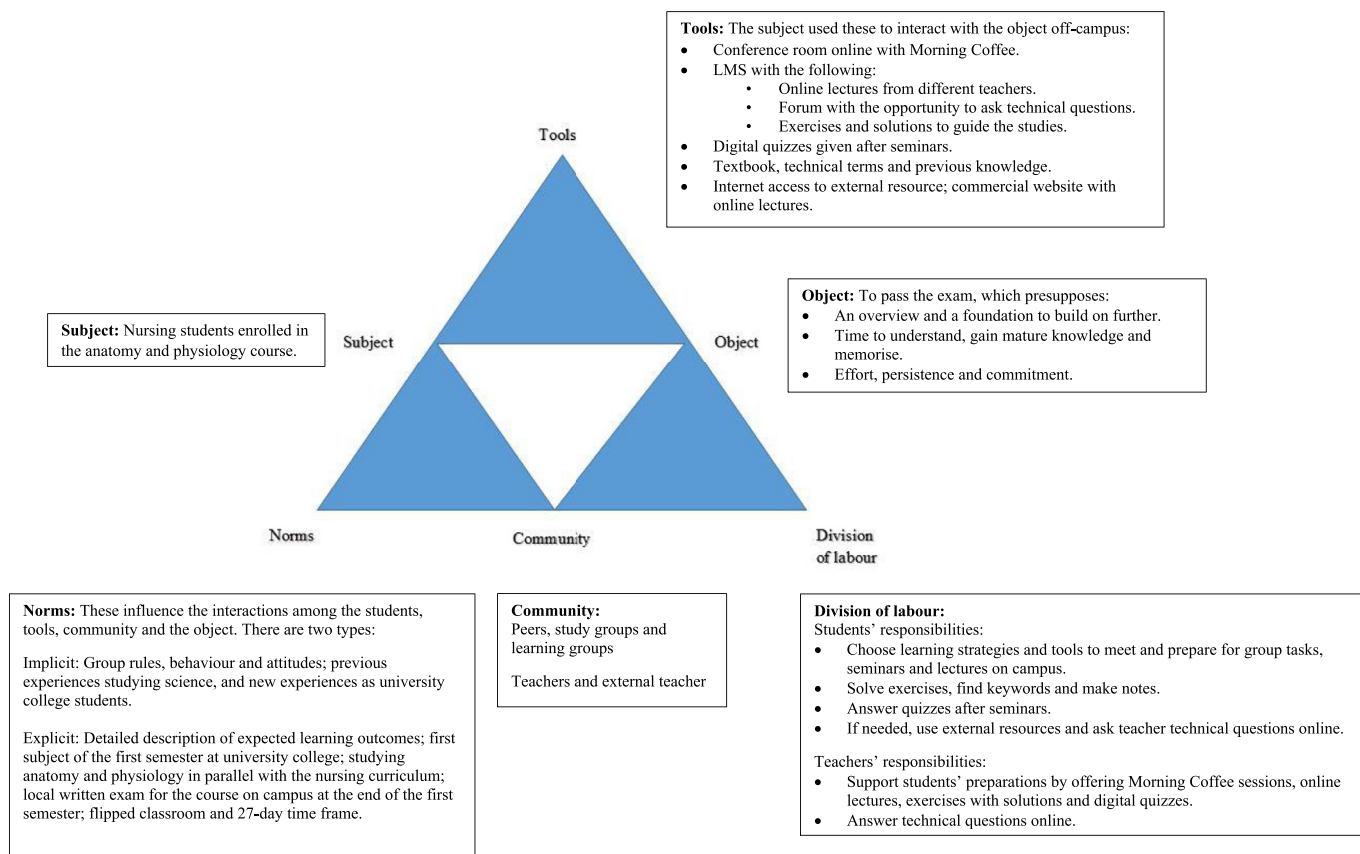


Fig. 2. Description of the activity system based on our findings.

Table 3
Description of the contradictions.

Contradictions	Tools	Norms	Division of labour
Tension between students' expectations and the teaching design.	Online lectures supporting textbook reading versus external resources covering the textbook and highlighting relevant exam parts.	Willingness to adapt versus resistance to changing one's learning strategies.	Students' responsibility to prepare for activities before meetings on campus versus teacher's responsibility to prepare during the meetings.
Tension between a wish for more frequent attendance and being on their own.	When studying by themselves; resources that provide goals and guidance versus resources that provide answers to exam questions.	Attitudes towards use of digital tools; gives flexibility versus are unable to replace physical contact and should not be used outside the classroom	Students' responsibility to determine how to proceed versus teacher telling them what to do.
Tension between the schedule and time needed.	Resources supporting progression and saving time versus time-consuming and tiresome activities.	Know priorities within the time frame and keep up versus giving up and falling behind.	Students' responsibility to follow the schedule versus teacher's responsibility to keep the schedule for the students by lecturing.

adapting to the different teachers' teaching strategies was exhausting. They wanted more uniform online lectures, and several decided to use a commercial online course consisting of videos with PowerPoint presentations and the voice of an external teacher. Students felt that this external resource covered the entire syllabus in the textbook and that the external teacher highlighted the parts of the syllabus that were relevant to them passing the exam.

Students experienced a disconnection between their strategies and the offered teaching and felt that they could not learn physiology as they had previously learned science. Some continued to miss their teacher from high school, while others adapted, changed strategies and adopted new learning strategies along with learning physiology: 'As a new university college student, it was hard to meet prepared, but I realised that I had to learn it'. Additionally, some students experienced that the use of SRS on campus motivated them to meet better prepared in order to benefit from participating in such activities.

In their reflective notes, students described how they studied physiology by alternating among learning resources, and they noted that they used technology to access internal and external resources and to make notes. The intention was to get an overview and build a foundation layer-by-layer, contextually and repetitively. In the interviews, they elaborated that their previous knowledge was poor and that physiology was a subject that needed maturity, as explained by this student: 'Once you understood one thing, you understood the rest of it'. Another student stated: 'I never understood science. I was frustrated the first weeks. The week before the exam, after I had been through everything, I understood the connections, and I could see how much I actually had learned'.

4.2. Tension between a wish for more frequent attendance and being on their own

In high school, the participants were used to daily physical attendance at school. As university college students, several of them expressed that they missed a physically present teacher and the social interaction with peers on campus. They pointed out the importance of physical contact by reflecting upon their choice of profession and claimed that 'nursing is about human contact'. During the off-campus study days, students experienced loneliness. Even though some found it less lonely to hear the teacher's voice online, students stated that 'technology cannot replace face-to-face contact'. One supervisor divided one of the learning groups into study groups. Students who participated in these study groups met regularly, and a student described how they cooperated: 'We saw online lectures together and explained prepared topics to each other; it didn't have to be so lonely'. In their reflective notes, few students mentioned contacting the teachers in the online forum or meeting with the teachers live online during the Morning Coffee session. In the second interview, they explained that they did not remember to use these tools: 'It depended on priorities, it took extra time and, if you already were behind, you forgot it'.

In the first interviews, students were sceptical about studying by

themselves at home prior to on-campus meetings. This required self-discipline, and in the second interview, a student stated: 'I didn't want to read several hours. I became lazy when I knew I could do it when I wanted to. When you had to meet physically at school, you had to get up in the morning'. Others appreciated the flexibility online lectures gave them, with the opportunity to choose where and when to study, and they appreciated that they could retake the digital quizzes several times. However, students thought that the digital tools should be used with a teacher present to encourage a commitment to participate and have the opportunity to get explanations immediately, not having to wait until the next day.

The course had only one test: a final exam at the end of the course; hence, the students' responsibility was to determine how to proceed by themselves: 'The teacher should make it clear that the students had to read in the process. It is obvious, but, if you weren't used to it, you may not do it'. They had to decide to do work weekly on the expected learning outcomes and not wait until the last few weeks before the exam. As one student said: 'In high school, you had chapter tests that made it easier. Before a test, you learned by heart. You don't do that before a lecture'.

The students described that exercises with solutions provided goals and guidance, which emphasised what they had to learn to pass the exam. Some students wanted more on-campus lectures with a teacher who wrote what they needed to learn on a blackboard, as illustrated by one student: 'I learn considerably more with a teacher in front of me than by reading on my own'. Students appreciated that the external teacher in the commercial resource told them what the exam questions probably would be and how to answer those questions according to the grade they wanted.

4.3. Tension between the schedule and time needed

At the beginning of the semester, students thought it would be possible to learn physiology just by reasoning it out, but after studying this subject, they realised that it was more complicated: 'Questions in physiology had set answers that weren't possible to reason out'. During the semester, they found that the schedule was insufficient when they had to deal with the syllabus in physiology and that they needed more time to understand and memorise. Students were concerned about spending unnecessary time studying and wanted to prioritize what to learn and to use strategies, which saved time. They had to be persistent, but that could be challenging, as one student described: 'You gave up when you didn't keep up'. Students found it time-consuming to familiarize themselves with new topics on their own: 'I felt forced to learn on my own ... at home, you needed to use half an hour to look up the answer yourself'.

The students' responsibility was to follow the schedule, but they experienced time pressure. Students who expressed that they did not keep up thought the teacher should help them adhere to the schedule by lecturing on campus. They wanted fewer self-studies: 'More lectures with a teacher who told us what we were going to learn'.

The students wanted tools, which could help them study effectively and support their progress, and exercises with solutions to show them where to concentrate their efforts. Learning resources covering all they needed to know to answer exercises and to pass the exam were seen as time-efficient. The online lectures were experienced as insufficient because they also had to read the textbook: 'I had to work double when I had to supplement the online lectures with reading, and it took too much time'. Even though students described the usefulness of the external resource, they preferred on-campus lectures. It was easier to learn when they were together with a teacher, and that saved time: 'It was frustrating that it took so much time to learn something I knew I would have learned much faster if I had a teacher who told me'. Even though students struggled with self-studies, several of them emphasised that the new approach took time and was hard, but that it had been worth the effort.

5. Discussion

The aim of this paper was to explore how nursing students describe their experiences with the off-campus activities for learning physiology within a flipped classroom design. In this section, we will discuss the findings and the identified contradictions or tensions under the following subheadings: traditional students—a new teaching approach, attempts to self-regulate, the tools and social interaction and the need for an adapted teaching design.

5.1. Traditional students—a new teaching approach

Our findings showed tension between students' expectations and the teaching design. In line with other studies (El-Banna et al., 2017; Missildine et al., 2013), many of our students seemed to prefer traditional lectures and resisted doing the work required to adapt their learning style to the flipped classroom. Their resistance to adapt may be rooted in a lack of belief in the new strategies, but also an uncertainty that they could perform an effective self-regulation response. There could be a good reason to oppose a student's preferred form of learning, as it is may not necessarily be the best way to learn (Kirchner, 2017). However, it is important not to neglect the role of motivation in learning. According to Mega et al. (2014), learning depends on the interplay of self-regulated learning and motivation, and motivation seems to have the greatest effect on academic achievement. A teaching design that diverges from the preferred form of learning may evoke negative emotions and, hence, demotivate students.

According to our students, attempts to self-regulate often required extra time and effort, which they did not always feel were available. Our students felt frustrated because they expected a more traditional format where the teacher taught them what they needed to learn in class. This may be related to the fact that most of our students were new university students, who may be less ready to self-direct their own learning (Barker et al., 2016). This may also be related to nursing students' preference for authority (Boström and Hallin, 2013) and dependency on instructors for learning physiology (Al-Modhefer and Roe, 2009).

5.2. Attempts to self-regulate

Our students seemed to perceive 'passing the exam' as their main goal. However, several students described the efforts they made off-campus to improve their understanding and grasp of the subject. Some students sought social assistance off-campus by participation in their study group. Students described learning physiology as a building process and used multiple repetition as a means to remember things and develop an overview. They felt that this brought maturity and increased understanding, which is in line with previous research highlighting the importance of repetition (Johnston et al., 2015). Even though most students took notes and used them for reviewing, which is a self-

regulation strategy (Zimmerman and Martinez-Pons, 1986), some felt it was difficult to rely on them to capture the essence of the subject. Several preferred reviewing notes and keywords made by the teacher. The fact that several students decided to seek instruction from an external commercial website teaching physiology for nursing students is worth noting. This could be seen as a self-regulated activity to seek the resources they needed. The use of this resource could also be understood as related to students' need for an authority (Boström and Hallin, 2013) and to pursuing their main goal of 'passing the exam', as the teacher on the external website provided reassurance that they would pass the exam by following his advice.

Those of our students who appreciated the flipped classroom method and adapted to it in order to enhance their learning seemed to have used what is called a self-oriented feedback loop (Zimmerman and Labuhn, 2012). They responded by changing strategies when they realised that they could not use the same strategies they had used to study science in high school. Salamonson et al. (2016) showed that adaptation to higher education could be affected by nursing students' ability to perform self-regulated learning, and students with high ability to handle stressful situations seemed to have a more self-regulated approach to learning.

5.3. The tools and social interaction

Different tools were included in the course design to facilitate students' off-campus studies (see Figs. 1 and 2). However, our findings implied that many students did not use these tools as intended and struggled with their off-campus work. Few students took advantage of the Morning Coffee and the online forum, where they could seek assistance from the teacher, and the off-campus digital quizzes, which were resources that presupposed active participation. Students appreciated resources, such as the exercises with solutions, and some students felt motivated to use the resources to prepare for the teachers' use of the SRS on campus.

Most of our students preferred the commercial online course rather than the teachers' online lectures. This was unexpected since the teachers' online lectures were highly appreciated by the students in the pilot. The videos were short and covered a single concept as recommended (Johnston et al., 2018; Todorovic et al., 2016) in contrast to the commercial videos. In line with other studies, many students stated that they found it difficult to read the textbook and figure out things by themselves (Johnston et al., 2015) and preferred to watch videos (McLaughlin et al., 2014).

Our students seemed not to use the support offered by the various off-campus learning tools or activities because of lack of time. They perceived the time for the entire course as insufficient and tools offered off-campus as too time-consuming. Furthermore, some students claimed that nursing is about human contact, and technology could not replace physical, face-to-face contact. This is in line with previous research (Koch et al., 2010). In particular, the students who did not join an off-campus study group experienced loneliness. A sense of belonging seems to be important to facilitate participation in off-campus activities (Bingen, 2013).

5.4. The need for an adapted teaching design

As described in Table 3, three contradictions or tensions were identified in the students' activity system. Even though there was resistance to the flipped classroom, we still believe this approach could support the students' learning of physiology, and we will continue to offer it with some adjustments. Our students experienced a situation where they had to learn physiology along with adapting to a new teaching approach and a new student role. This seemed to be too much for them to handle by themselves and required persistence. In the next design, more gradual implementation of the flipped classroom prior to the anatomy and physiology course could contribute to preparing the

students to study by themselves and choose appropriate learning strategies. Additionally, this could allow students to adapt to being university college students and help them to study more effectively and save time.

There was tension between the students' wish for more frequent on-campus attendance and studying by themselves. In the next design, students could be encouraged to establish study groups. By participating in study groups, students may experience less loneliness, and they could help each other structure their studies.

Some students missed having chapter tests but appreciated answering quizzes, and chapter test quizzes inside the LMS could be included in the design. Our students found the external lectures helpful for their studies, and professional online resources could be included and possibly replace some of the teachers' online lectures.

5.5. Limitations and strengths

The study is based on a single Norwegian university college. We have enhanced transferability by describing the design of the flipped classroom, data collection and analysis, and providing the findings reflected in the statements of the students. However, it is the reader's responsibility to decide whether the results are transferable (Graneheim and Lundman, 2004). An advantage when investigating one's own workplace is that the researchers are familiar with the educational practice, but there are also challenges because of this (Mercer, 2007). The moderator was linked to the participants as the course administrator and as one of the teachers. The students' previous experiences with the moderator may have influenced the data. Throughout the research process, we reflected upon our own roles to be aware of how this could affect the study. Students were informed that their grade would not be affected by what they shared, and the students spoke openly, displaying both satisfaction and dissatisfaction. During the interviews, the moderator asked questions to assess the validity of immediate interpretations. However, no further participants' validation of the interpretation of the interviews was done. Methodological triangulation was used in the study aims to enhance the validity of the study (Denzin and Lincoln, 2011).

6. Conclusions

When facilitating a new learning approach such as the flipped classroom, teachers need to be aware of the challenges involved. Many nursing students seem to depend on physical, social interaction with the teacher and may not be ready to assume the responsibility of studying adequately off-campus. More time should be allocated to allow the students to adapt to being university college students and self-regulation strategies should be taught prior to the course.

Conflicts of interest statement

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.nepr.2019.01.004>.

References

- Al-Modhefer, A.-K., Roe, S., 2009. Nursing students' attitudes to biomedical science lectures. *Nurs. Stand.* 24, 42–48.
- Barker, C., King, N., Snowden, M., Ousey, K., 2016. Study time within pre-registration nurse education: a critical review of the literature. *Nurse Educ. Today* 41, 17–23.
- Bingen, H.M., 2013. Trygt læringsmiljø på nett for å lære gjennom skriftlige dialoger i diskusjonsfora. In: Fosslund, T., Gjerdrum, E., Ramberg, K.R. (Eds.), *Ulike Forståelser Av Kvalitet I Norsk, Fleksibel Høyere Utdanning*. Norgesuniversitetet, Tromsø, pp. 235–249.
- Bishop, J., Verleger, M., 2013. The flipped classroom: a survey of the research. In: 120th ASEE Conference & Exposition, Atlanta.
- Boström, L., Hallin, K., 2013. Learning style differences between nursing and teaching students in Sweden: a comparative study. *Int. J. High. Educ.* 2, 22–34.
- Craft, J., Christensen, M., Bakon, S., Wirihana, L., 2017. Advancing student nurse knowledge of the biomedical sciences: a mixed methods study. *Nurse Educ. Today* 48, 114–119.
- Denzin, N.K., Lincoln, Y.S., 2011. *Handbook of Qualitative Research*, fourth ed. SAGE Publications, Los Angeles.
- Design-Based Research Collective, 2003. Design-based research: an emerging paradigm for educational inquiry. *Educ. Res.* 32, 5–8.
- Dysthe, O., Hertzberg, F., Hoel, T.L., 2010. *Skrive for Å Lære: Skrivning I Høyere Utdanning*, second ed. Abstrakt, Oslo.
- El-Banna, M.M., Whitlow, M., McNelis, A., 2017. Flipping around the classroom: accelerated Bachelor of Science in nursing students' satisfaction and achievement. *Nurse Educ. Today* 56, 41–46.
- Engeström, Y., 2015. *Learning by Expanding: an Activity-Theoretical Approach to Developmental Research*, second ed. Cambridge University Press, New York.
- Felicilda-Reynaldo, R.F.D., Cruz, J.P., Bigley, L., Adams, K., 2017. Baccalaureate student nurses', study habits prior to admission to nursing program: a descriptive qualitative study. *Nurse Educ. Today* 53, 61–66.
- Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafo, N., Jordt, H., Wenderoth, M.P., 2014. Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci. Unit. States Am.* 111, 8410–8415.
- Graneheim, U.H., Lundman, B., 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ. Today* 24, 105–112.
- Johnston, A.N., Hamill, J., Barton, M.J., Baldwin, S., Percival, J., Williams-Pritchard, G., Salvage-Jones, J., Todorovic, M., 2015. Student learning styles in anatomy and physiology courses: meeting the needs of nursing students. *Nurse Educ. Pract.* 15, 415–420.
- Johnston, A.N.B., Barton, M.J., Williams-Pritchard, G.A., Todorovic, M., 2018. YouTube for millennial nursing students; using internet technology to support student engagement with bioscience. *Nurse Educ. Pract.* 31, 151–155.
- Kirschner, P.A., 2017. Stop propagating the learning styles myth. *Comput. Educ.* 106, 166–171.
- Koch, J., Andrew, S., Salamonson, Y., Everett, B., Davidson, P.M., 2010. Nursing students' perception of a web-based intervention to support learning. *Nurse Educ. Today* 30, 584–590.
- Magno, C., 2010. Assessing academic self-regulated learning among Filipino college students: the factor structure and item fit. *Int. J. Educ. Psychol. Assess.* 5, 61–76.
- Malterud, K., 2012. Systematic text condensation: a strategy for qualitative analysis. *Scand. J. Soc. Med.* 40, 795–805.
- McKenney, S.E., Reeves, T.C., 2012. *Conducting Educational Design Research*. Routledge, London.
- McLaughlin, E.J., Roth, T.M., Glatt, M.D., Gharkholonarehe, A.N., Davidson, M.C., Griffin, A.L., Esserman, J.D., Mumper, J.R., 2014. The flipped classroom: a course redesign to foster learning and engagement in a health professions school. *Acad. Med.* 89, 236–243.
- McVicar, A., Andrew, S., Kemble, R., 2014. Biosciences within the pre-registration (pre-requisite) curriculum: an integrative literature review of curriculum interventions 1990–2012. *Nurse Educ. Today* 34, 560–568.
- McVicar, A., Andrew, S., Kemble, R., 2015. The 'bioscience problem' for nursing students: an integrative review of published evaluations of Year 1 bioscience, and proposed directions for curriculum development. *Nurse Educ. Today* 35, 500–509.
- Meehan-Andrews, T.A., 2009. Teaching mode efficiency and learning preferences of first year nursing students. *Nurse Educ. Today* 29 (1), 24–32.
- Mega, C., Ronconi, L., De Beni, R., 2014. What makes a good student? How emotions, self-regulated learning, and motivation contribute to academic achievement. *J. Educ. Psychol.* 106, 121–131.
- Mercer, J., 2007. The challenges of insider research in educational institutions: wielding a double-edged sword and resolving delicate dilemmas. *Oxf. Rev. Educ.* 33, 1–17.
- Michael, J., 2006. Where's the evidence that active learning works? *Adv. Physiol. Educ.* 30, 159–167.
- Missildine, K., Fountain, R., Summers, L., Gosselin, K., 2013. Flipping the classroom to improve student performance and satisfaction. *J. Nurs. Educ.* 52, 597–599.
- 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 Educ. Pract.* 17, 208–213.
- Salvage-Jones, J., Hamill, J., Todorovic, M., Barton, M.J., Johnston, A.N.B., 2016. Developing and evaluating effective bioscience learning activities for nursing students. *Nurse Educ. Pract.* 19, 63–69.
- Slater, C.E., Cusick, A., 2017. Factors related to self-directed learning readiness of

- students in health professional programs: a scoping review. *Nurse Educ. Today* 52, 28–33.
- Sletten, S.R., 2017. Investigating flipped learning: student self-regulated learning, perceptions, and achievement in an introductory biology course. *J. Sci. Educ. Technol.* 26, 347–358.
- Stewart, D.W., Rook, D.W., Shamdasani, P.N., 2007. *Focus Groups: Theory and Practice*, second ed. SAGE, California.
- Todorovic, M., Johnston, A.N.B., Fenwick, C., Williams-Pritchard, G., Barton, M.J., 2016. Enriching biosciences in undergraduate nursing programs: establishment and assessment of online video resources. *IJISM* 24 (4), 44–53.
- Yamagata-Lynch, L.C., 2010. *Activity Systems Analysis Methods*. Springer, New York.
- Zimmerman, B.J., Labuhn, A.S., 2012. Self-regulation of learning: process approaches to personal development. In: Harris, K.R., Graham, S., Urdan, T., McCormick, C.B., Sinatra, G.M., Sweller, J. (Eds.), *APA Educational Psychology Handbook*. American Psychological Association, Washington, pp. 399–425.
- Zimmerman, B.J., Martinez-Pons, M., 1986. Development of a structured interview for assessing student use of self-regulated learning strategies. *Am. Educ. Res. J.* 23, 614–628.