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"Nursing students' experiences with concept cartoons as an active learning strategy for developing conceptual understanding in anatomy and physiology: A mixed-method study"

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ABSTRACT

Aim: The aim of this study was to explore bachelor-level nursing students' experiences with concept cartoons as an active learning strategy and formative assessment to develop conceptual understanding in anatomy and physiology (A&P).

Background: Many first-year nursing students struggle to understand central concepts in A&P. Concept cartoons–cartoon characters proposing scientifically acceptable statements and misconceptions combined with an illustration–might facilitate active learning in lectures, overcome misconceptions and promote deep learning. Voting on the most precise statement using a student response system gives formative information about the students' conceptual understanding.

Design: Parallel mixed methods design with an emphasis on a qualitative approach.

Methods: Nine concept cartoons were developed based on former students' written answers to exam items and applied in lectures at three universities/university colleges. Qualitative data of students' experiences were collected in three focus group interviews during November 2019, one focus group at each of the three universities/university colleges (n = 5, 8 and 8). A short questionnaire was also applied (n = 343) to all students at the three universities/university colleges. Qualitative data were analysed using qualitative content analyses, whereas frequency analysis and Chi-square statistics were applied for the quantitative data. The study was approved by the Norwegian Centre for Research Data, ref. 779586.

Results: Qualitative data analysis indicated that the use of concept cartoons addresses different learning styles and could promote deep learning and enhance the environment for learning. The concept cartoons were also seen as valuable for examination preparation. Regarding potential improvements, more information about concept cartoons, how they were developed and how they were supposed to be used would be beneficial, and the cartoons could be used in a more time-efficient manner during lectures. Quantitative data indicated that most of the students thought that concept cartoons were useful and inspiring in learning A&P, and they would recommend further use to increase their understanding of central concepts. There were no significant differences across sex, age, or entrance qualifications when it comes to the benefits of using concept cartoons in learning A&P.

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Compared to students born in Scandinavia, a larger proportion of students born outside Scandinavia found the use of concept cartoons inspiring for their learning in A&P.
Conclusions: The use of concept cartoons was appreciated by the students to develop a conceptual understanding in A&P. Most students recommended future use.
Registration number: *At point of submission put this on title page*
Tweetable abstract: Concept cartoons are appreciated as an active learning strategy and formative assessment in developing nursing students' conceptual understanding of anatomy and physiology.

1. Introduction

Bioscience knowledge, such as anatomy and physiology (A&P), is crucial for nursing competence. Such knowledge enables students to make systematic clinical assessments and adequate clinical decisions (Bakon et al., 2016; McVicar et al., 2015; Montayre et al., 2021; Regulation on national guidelines for nursing education, 2019). Knowledge about A&P is also needed for nursing students to learn about pathological processes and pharmacology. Hence, it is vital that nursing students comprehend the central concepts of A&P and can apply their knowledge in clinical practice.

Typically, A&P is taught as a distinct module early in a nursing programme (McVicar et al., 2015). The course has several learning outcomes that must be fulfilled in a short time. Hence, it involves a heavy study load and might be conceptually challenging. Many nursing students struggle with A&P and fail to understand the subject's central concepts (Bakon et al., 2016; Jensen et al., 2018; Johnston et al., 2015; McVicar et al., 2015). Students also report being anxious about everything they must learn and having doubts about whether they will master the subject and pass the exam (Bingen et al., 2020). The subject also faces the challenge of high failure rates. In Norway, approximately one-fifth of bachelor-level nursing students fail the national exam in anatomy, physiology, and biochemistry (Pedersen et al., 2018).

Traditional university lectures could be considered mostly passive for the students, where knowledge and the understanding of concepts and models are transferred from the lecturer to the students. However, several studies have found that nursing students appreciate various pedagogical styles and active learning in bioscience (Bakon et al., 2016; Bingen et al., 2020; Jensen et al., 2018; Johnston et al., 2015). Active learning requires that students engage cognitively and meaningfully in the material and learn through various activities, such as reflection, problem-solving or discussions with others (Bonwell and Eison, 1991; Freeman et al., 2014). When active learning principles such as reflection, interaction and engagement are emphasised, the learning could be more effective and positively affect students' performance (Bakon et al., 2016; Freeman et al., 2014). Previous studies have also pointed to positive experiences with e.g game-based learning (Castro et al., 2019), the use of virtual dissection table (Bianchi et al., 2020) and virtual reality (Thompson et al., 2020) in learning bioscience.

Nursing students have also emphasised the importance of dialogue with peers where they can give explanations of their understanding of the topic and receive feedback on their knowledge of A&P (Bingen et al., 2020). Peer-led discussions encourage students to learn from each other and could be appropriate for students to consolidate conceptual understanding (Boud, 2013, pp. 8). Zhang et al. (2017) found a significantly increased performance in students undertaking physics education when peer instruction was used compared with traditional teaching. Furthermore, female students tend to benefit even more from peer instruction than male students (Zhang et al., 2017), which should be considered in nursing education since it is dominated by female students.

The use of digital tools such as a student response system combined with peer instruction could constitute variations during lectures and promote active learning (Bingen et al., 2020; Efstathiou and Bailey, 2012). The use of a student response system might also support the identification of misconceptions of central topics (Bingen et al., 2020; Efstathiou and Bailey, 2012). Misconceptions could be a barrier to learning A&P and might influence scientific and clinical reasoning (Versteeg et al., 2019).

Misconceptions deal with beliefs that are not in line with current scientific views (Badenhorst et al., 2015; Taylor and Kowalski, 2004). They might be difficult to alleviate as new information is likely to either be ignored or distorted to fit the previous understanding of the concept (Taylor and Kowalski, 2004). When misconceptions conflict with new information and the student has a strong belief in alternative understanding, it could be more difficult for the student to understand the new information (Taylor and Kowalski, 2004). To overcome misconceptions lecturers must facilitate a conceptual change (Taylor and Kowalski, 2004), which implies a major restructuration of individuals thinking (Dole, 2000). According to a constructivist view of learning, knowledge is constructed by individuals through what Piaget calls assimilation and accommodation (Piaget, 1985). The accommodation process could be considered a central mechanism for conceptual change as it includes a change in existing knowledge structures. To facilitate conceptual change, it is important to explore students' prior knowledge and understanding (Taylor and Kowalski, 2004).

As well as identifying misconceptions, the use of student response systems could also form a formative assessment, which deals with feedback about the students' knowledge and understanding during the learning process (Black and Wiliam, 1998; Chin and Teou, 2009). Results from formative assessment can be used to modify the teaching and learning activities which might support the students to improve their knowledge and understanding (Black and Wiliam, 1998; Harlen, 2013; Pellegrino and Hilton, 2012; Sambell et al., 2013). Through formative assessment, the students might become aware of the gap between desired learning outcome and their current understanding, while the lecturer can use such information to fill this gap by adapting the information to students' knowledge and understanding (Black and Wiliam, 1998). A formative assessment might also enhance deep learning (Pellegrino and Hilton, 2012). Deep learning enables students to transfer their knowledge into other contexts (Pellegrino and Hilton, 2012). Such competence is highly relevant for A&P in nursing education as nurses need such knowledge to make clinical assessments.

Even though there has been increased attention to the benefits of different active learning strategies in bioscience in nursing education the recent years (Bianchi et al., 2020; Bingen et al., 2020; Castro et al., 2019, 2020; Moro et al., 2021; Saab et al., 2021; Thompson et al., 2020), there is still a lack of knowledge about how lecturers in higher education can facilitate and support nursing students' learning and conceptual understanding in biosciences.

The usage of concept cartoons (Keogh and Naylor, 1999) in combination with a student response system can be well suited to promote active learning and facilitate formative assessment as it allows lecturers to obtain feedback about students' conceptual understanding (Chin and Teou, 2009). It can also be used to address potential misconceptions.

1.1. Concept cartoons

The idea of concept cartoons as a learning tool originated in the early nineties and is based on a constructivist learning perspective and scientific epistemology in teaching practice (Keogh and Naylor, 1999). In concept cartoons, cartoon characters are proposing both scientifically

acceptable statements and common misconceptions (Chin and Teou, 2009). A concept cartoon illustrates a central topic that can stimulate reflection and argumentation. In form, concept cartoons are similar to multiple-choice questions, but the uniqueness of concept cartoons is that they are constructed to integrate written statements combined with visual stimuli such as illustrations. They also symbolize a discussion between the students on a central topic. The use of concept cartoons might support learning in science and can stimulate the students to a productive discussion, as well as clarification and restructuring of their understanding (Keogh and Naylor, 1999). Chin and Teou (2009) claim that concept cartoons have the potential to promote conceptual change as alternative conceptions and misconceptions are challenged and scientific ideas could be accepted through the discussions.

Concept cartoons can be used in combination with a student response system, which students can use to vote for the statement they think is the most precise. The use of concept cartoons combined with a student response system could uphold the principle of active learning through structured group discussions of the statements (Keogh and Naylor, 1999). The results from the voting might also constitute a form of formative assessment that the lecturer can use to adapt the lecture to the students' understanding. Traditionally, concept cartoons have been used in science and technology classes in primary and secondary schools (e.g. Chin and Teou, 2009; Kabapinar, 2005; Naylor and Keogh, 2013; Ören and Meriç, 2014). To our knowledge, concept cartoons have not yet been developed and used for learning in higher education, nor in nursing education.

1.2. Aim of the study

The aim of this study was to explore bachelor-level nursing students' experiences with concept cartoons as an active learning strategy and a formative assessment to develop conceptual understanding in anatomy and physiology.

2. Methods

2.1. Design

This study has a parallel mixed-method design, with an emphasis on a qualitative approach. The qualitative and quantitative data have been collected and analysed separately but are used in a complementary manner. The qualitative data sought to get an in-depth insight into nursing students' experiences with concept cartoons and quantitative data quantifies the proportion that benefited from using concept cartoons in learning A&P. The qualitative and quantitative results are integrated in the discussion. We have used the *Good Reporting of A Mixed Methods Study guideline* (O'Cathain et al., 2008) when writing this paper.

2.2. Settings

In Norway, there is a national curriculum for the A&P course in bachelor nursing education, and the Norwegian Agency for Quality Assurance in Education (NOKUT) facilitate a national exam in Norwegian for this course for first-year students on commission from the Norwegian Ministry of Education and Research. (In Norway nursing education is a bachelor-level programme, and we use the term 'nursing student' and 'bachelor-level nursing students' as synonyms in this paper). This exam is carried out at the end of the first semester of the nursing education and is a four-hour paper-and-pencil exam. The exam consists mostly of open-ended questions but also a few multiple-choice questions. Approximately 5000 nursing students complete this national exam each year. Failing the exam might lead to delayed progression which might have economic consequences for both the students and the universities. The students can present themselves for the exam three times. If they do not pass on the third attempt, they must end their education.

2.3. Development of concept cartoons

The concept cartoons were developed based on misconceptions evident in a random sample of former students' written answers to the national exams in A&P from 2017 and 2018. Regulation of hormone secretion by negative feedback is provided as an example of a concept cartoon (Fig. 1).

The development of concept cartoons followed five steps:

1. Selecting topics based on what students found challenging in the national exam. Exam items with high difficulty level were selected.
2. Reformulating the selected exam items to form a question that could be asked in a concept cartoon.
3. Qualitative analyses of students' responses to difficult exam items.
4. Formulating statements based on qualitative analyses. In addition, the course's learning outcomes were considered.
5. Drawing characters and illustrations.

To identify former students' misconceptions and alternative frameworks, former students' written answers to the national exam items were read and analysed qualitatively. As about 5000 nursing students complete the national exam each year, we had access to 10000 answer sheets. The answers to the open-ended questions formed the basis for the analyses. Permission to access exam answers was given by the Norwegian Agency for Quality Assurance in Education, and exam answers were randomly selected from nursing students across the country. For developing the concept cartoons, 50–107 answers to the selected exam items of the national exam were read depending on when saturation about typical misconceptions was reached. Two researchers read randomly selected answers separately. An inductive approach to the answers was used to identify central misconceptions. After identifying misconceptions and misunderstandings that appeared repeatedly, abstraction and interpretation of the student's comprehension of the concept were made. The findings of central misconceptions were discussed by the research team (a nurse educator, a physiologist, two science didactics and an IKT developer).

The misconceptions formed the basis for the statements in the concept cartoons. Four statements in Norwegian were constructed for each concept cartoon, in which one of the statements was considered as most precise. These statements were stated by four cartoon characters – Ane, Bano, Carl and Daniel (initials for response options A, B, C, D; Fig. 1). A graphic designer illustrated the concept cartoons. A total of nine concept cartoons were developed and applied in lectures (Table 1). The content of the concept cartoons has been translated from Norwegian into English for the purpose of this paper.

2.4. Application of concept cartoons in lectures

The concept cartoons were applied in lectures with students in their first semester of nursing education at three universities/university colleges in eastern Norway during the second half of 2019. The lecturers were encouraged to follow the Think-Pair-Share procedure (Lyman, 1981) when using the concept cartoons in lectures. The Think-Pair-Share procedure (Lyman, 1981) comprises three phases of learning: i) Think – students consider a given topic – a concept cartoon, for example – and reflect on their knowledge of the topic, ii) Pair – students discuss their understanding of the topic with a fellow student, and iii) Share – students share their ideas within a larger group or in the class. The procedure was also inspired by the 5E model (Bybee and Landes, 1990).

Before a specific topic was taught, the students were presented to a relevant concept cartoon. They used a student response system, either as a web-solution or as a mobile phone application, to vote individually on which of the four statements best answered the question. During the first poll, which intended to activate prior knowledge, the students had to think about the question and the statements. This could be linked to the

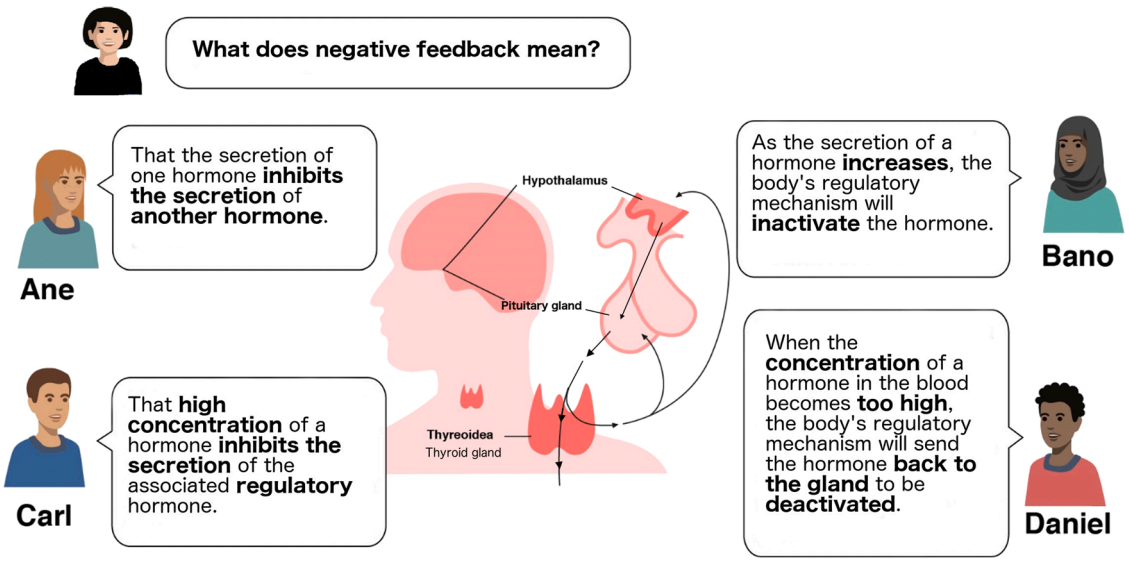

Fig. 1. Concept cartoon about negative feedback.

Think phase. A second vote was taken after the students had discussed the four statements in pairs for 2–3 min (cf. *Pair* and *Share*). After the second vote, the lecturer could ask the students to share their answers and arguments with the whole class (cf. *Share*). The lecturer could use the information from the voting and students' arguments to adapt the lecture to students' understanding. At the end of the learning sequence, the students were given the opportunity to improve their responses through a third poll.

2.5. Sampling and data collection

Qualitative and quantitative data were collected separately. Students' experiences with concept cartoons were explored using semi-structured focus group interviews and a short questionnaire, both in Norwegian. All nursing students at the three universities/university colleges were invited to participate in focus group interviews through an announcement on their digital learning platform. One focus group was established at each of the three universities/university colleges. Five students participated in focus group 1 (all females, age 19–26), while focus groups 2 and 3 had eight students each (two males and six females aged 19–40 in group 2, and one male and seven females aged 19–34 in group 3). Students with a first language other than Norwegian were included in all three focus groups (one, five and two, respectively). The interviews were conducted at the actual university/university college. The students were asked to provide feedback both on the content and the design of the concept cartoons. The focus group interviews were conducted by the first author who had not been involved in the teaching. The interviews were recorded using a secure data collection solution, Nettskjema-dictaphone (University of Oslo, 2021). Field notes were made directly after each interview. The interviews were conducted in November 2019 and lasted 45–54 min.

As there was a risk that the most interested and positive-oriented students volunteered for the focus group interviews, a short questionnaire was distributed to all the first-year nursing students at the three universities/university colleges via their learning platform during December 2019. Of 1079 students, 343 responded to the questionnaire, yielding a response rate of 32%. The students were asked if they had experienced the use of concept cartoons useful for their learning, if the use of concept cartoons was inspiring for their learning, if they recommended the use of concept cartoons to increase their understanding of central concepts, and if they had received sufficient information about the use of concept cartoons. The following response options were offered: strongly disagree, disagree, agree, and strongly agree. In addition, data on demographic variables such as sex, age, entrance qualification to higher education and country of birth were collected. The participants in focus group interviews were also invited to respond to the questionnaire. Hence, there was a nested relationship between the participants in these two parts of the study.

2.6. Analysis

The qualitative data were analysed using manifest inductive content analysis (Elo and Kyngäs, 2008). The analysis process consisted of three phases: preparation, organising and reporting. In the preparation phase, the unit of analysis was selected based on the aim of this study. Interpreting the data in its entirety was achieved by listening to the interviews and reading the written transcript repeatedly. The organising phase started with open coding by writing headings and collecting them into a coding sheet. These sheet headings were grouped by gathering similar content into subcategories, and similar subcategories were grouped into higher-order generic categories. Additionally, an abstraction into a main category was done. In the reporting phase, an overview of the abstraction process and the generation of categories was performed.

For quantitative data frequency analyses were performed. In addition, chi-square tests with continuity correction were conducted to explore whether experiences with concept cartoons differ across sex, age, entrance qualification and country of birth (Scandinavian country or other). To explore whether the youngest students, those who come directly from upper secondary school, are more or less satisfied with the use of concept cartoons than those who are older, age was dichotomized into 18–21 and 22 or older. To be admitted to higher education in Norway, students need to have general university and college admissions certification, which could be achieved either by *Specialization in general studies* or *Vocational education and training*, which was used for categorization of entrance qualification. Statistical analyses were performed using SPSS 26. Statistical significance was set at 5%.

2.7. Ethical considerations

Students' participation was based on informed consent. They received information that their participation was voluntary, and that participation would not have any impact on their follow-up as students. The students were also informed that they could withdraw from the project at any time and that withdrawing would not elicit negative consequences. This study was approved by the Norwegian Centre for

Table 1
Overview of students' central misconceptions and content in the developed concept cartoons.

Topic	Central misconceptions	Questions in concept cartoons	Response alternatives in concept cartoons
Aerobic and anaerobic metabolism	Students are confused about the difference between aerobic and anaerobic metabolism, and where in the cell the aerobic and anaerobic processes occur. They are also confused about whether the difference concerns access to O_2 or ATP. Students are also unsure whether ATP is the product of or a prerequisite for the processes.	What is the difference between aerobic and anaerobic metabolism?	A) The only difference is that the processes take place in different places in the cell. B) The difference is that aerobic metabolism does not require energy. C) Aerobic metabolism produces twice as much ATP as anaerobe. D) Only aerobic metabolism is dependent on O_2.
Definition of pulse	Students tend to confuse the difference between heartbeat and arterial pulse. Some think pulse is the same as blood pressure.	What is pulse?	A) is how hard the heart beats B) is how fast the heart beats C) is the same as blood pressure D) is a pressure wave that spreads along the arteries
Normal values of pulse	Students confuse normal heart rate values, respiratory rate values and blood pressure values. Some stated only a single value, without understanding that values within a given range can be normal.	What are normal values for resting pulse in adults?	A) I think it is between 12 and 15 beats per minute B) I think it is 65 beats per minute C) I think it is between 50 and 80 beats per minute D) I think it is 120 above 75 beats per minute
Crossing of nerve pathways	In the exam, students wrote that the crossing of the nerve paths takes place in the spinal cord, which is somewhat imprecise.	Motor nerve signals go from the cerebral cortex to skeletal muscles. Why can a stroke in the left hemisphere cause paralysis in the right side of the body?	A) Because the nerve pathways cross in the spinal cord B) Because the nerve pathways cross in the brainstem C) Because the nerve pathways cross in the hypophysis D) Because the nerve pathways cross in the hypothalamus
Localisation of smooth musculature and how it is innervated	Several students had difficulty locating the different types of muscles. Several wrote that smooth muscles are found in organs without specifying further. Although most students knew that smooth muscles are not will-controlled, many did not mention the autonomic nervous system in their answers.	Where do we have smooth musculature, and how is it affected by the nervous system?	A) Smooth musculature is found in the musculoskeletal system, and it is regulated by the autonomic nervous system. B) Smooth musculature is found in internal organs and in blood vessels, and it is regulated by the somatic motor nervous system. C) Smooth musculature is found in internal organs and in blood vessels, and it is regulated by the autonomic nervous system. D) Smooth musculature is found in the musculoskeletal system, and it is regulated by the somatic motor nervous system.
How organs are affected by sympathetic nerve stimulation	This topic was developed based on the same task as the previous one.	How is the body affected by the sympathetic nervous system?	A) Heart rate increases B) Peristalsis in the intestine increases C) Blood pressure is lowered D) The pupils become smaller
Alveolar capillary gas exchange	Some students wrote that the gas exchange occurs due to differences in pressure or differences in the amount of O_2 and CO_2, without mentioning the prerequisites for diffusion (such as differences in concentration). Some students had a misconception that there is more O_2 in the cells than in the arteries and that O_2 will diffuse from the cells and into the bloodstream. Other students gave an unclear description of where the gas exchange takes place.	How does the gas exchange between alveoli and pulmonary capillaries occur?	A) diffusion from high to low concentration. CO_2, therefore, diffuses from the alveoli to the pulmonary capillaries. B) diffusion from low to high concentration. CO_2 therefore diffuses from the alveoli to the pulmonary capillaries. C) diffusion from high to low concentration. O_2, therefore, diffuses from the alveoli to the pulmonary capillaries. D) diffusion from low to high concentration. O_2, therefore, diffuses from the alveoli to the pulmonary capillaries.
Negative feedback	Several students were unsure of which hormones and which organs are involved in the process. Several students also wrote that negative feedback means that the hormone that is secreted is neutralised or deactivated.	What does negative feedback mean?	A) The secretion of one hormone inhibits the secretion of another hormone. B) As the secretion of a hormone increases, the body's regulatory mechanism will deactivate the hormone. C) High concentration of a hormone inhibits the secretion of the associated regulatory hormone. D) The concentration of a hormone in the blood becomes too high, the body's regulatory mechanism sends the hormone back to the gland to be deactivated.

(*continued on next page*)

Research Data, ref. 779586.

3. Results

Results from the qualitative arm of the study are presented first, followed by quantitative findings.

3.1. Experiences with concept cartoons - findings from focus group interviews with students

The qualitative data material consisted of two units, one about the students' experiences with concept cartoons in lectures and another about the design of the concept cartoons. These units were analysed separately.

Two main categories were generated from the unit about students' experience with concept cartoons in lectures: *Learning by means of concept cartoons meets various learning styles* and *Potential for improvement*. The former was generated from the three generic categories and eleven subcategories, and the latter from two generic categories and four subcategories (Fig. 2a). In the unit about design, the generic category *Content and layout* was generated from four generic categories and nine subcategories (Fig. 2b).

3.1.1. Learning by means of Concept Cartoons meets Various Learning Styles

The use of concept cartoons in lectures could be considered to meet the student's different learning styles. Some students reported that they learn by listening, others by reflecting upon the topic and their own progress, and others by discussing the subject with fellow students.

Deep Learning. This generic category concerns the benefits of using concept cartoons in teaching and learning A&P, and that concept cartoons can give a deeper understanding of central topics. The category consists of five subcategories: i) thinking and reflection, ii) remembering, iii) several perspectives, iv) deeper understanding, and v) learning of scientific terms. The participants expressed that the concept cartoons made them reflect on their learning and their comprehension of the topic. They gained a deeper understanding of the concept and gained new perspectives on key topics. Using concept cartoons also helped participants remember the main topics and learn scientific terms. Together this might bring deep learning.

One participant expressed his/her experience in this way:

[…]'you sit and think about it a bit, and then you remember it much better later […]'.

Another pointed out:

[…]'it kind of gives the opportunity to stop and reflect on what you have learned […]'.

Environment for Learning. Using concept cartoons facilitates an environment for learning. The participants emphasised the value of discussing issues with fellow students and the significance of this for their own learning. Furthermore, the use of concept cartoons in combination with a student response system in lectures gave variety and allowed active learning in a passive setting. The participants also asserted that concept cartoons made learning fun.

This can be supported by the statement from one of the participants:

[…]'you use slightly different senses than what one usually does during a lecture. I try to use as many different learning tools as possible. I do not benefit much from just reading and writing notes […] Variation is quite comfortable because it can be quite static and monotonous during lectures at times. […]it spices up a bit then'.

Another stated:

[…]'you can discuss and have a dialogue with those who sit next to you […] I have benefited greatly from it at least. Opportunities to discuss the material […]'.

The setting for using concept cartoons was also discussed. Some participants claimed that it would be beneficial to use concept cartoons in seminars instead of lectures since there is more room for discussion in

Table 1 (*continued*)

Topic	Central misconceptions	Questions in concept cartoons	Response alternatives in concept cartoons
Digestion of proteins	Some students wrote about either protease or pepsin. Some do not know where the different enzymes are secreted, or which enzymes contribute to the digestion of the various nutrients. Some students mentioned other digestive enzymes such as amylase and lipase. Another misconception is that proteins are decomposed into triglycerides. Some students wrote bipeptides instead of dipeptides.		A) Proteins are decomposed into peptides by the enzyme pepsin in the ventricle and further in the duodenum by secretion of protease from the pancreas. B) Proteins are decomposed into peptides by the enzyme pepsin in the ventricle and further in the duodenum by secretion of lipase from the pancreas. C) Proteins are decomposed into bipeptides by the enzyme trypsin in the ventricle and further in the duodenum by secretion of protease from the pancreas. D) Proteins are decomposed into bipeptides by the enzyme amylase in the ventricle and further in the duodenum by secretion of trypsin from the pancreas.

ATP= adenosine triphosphate

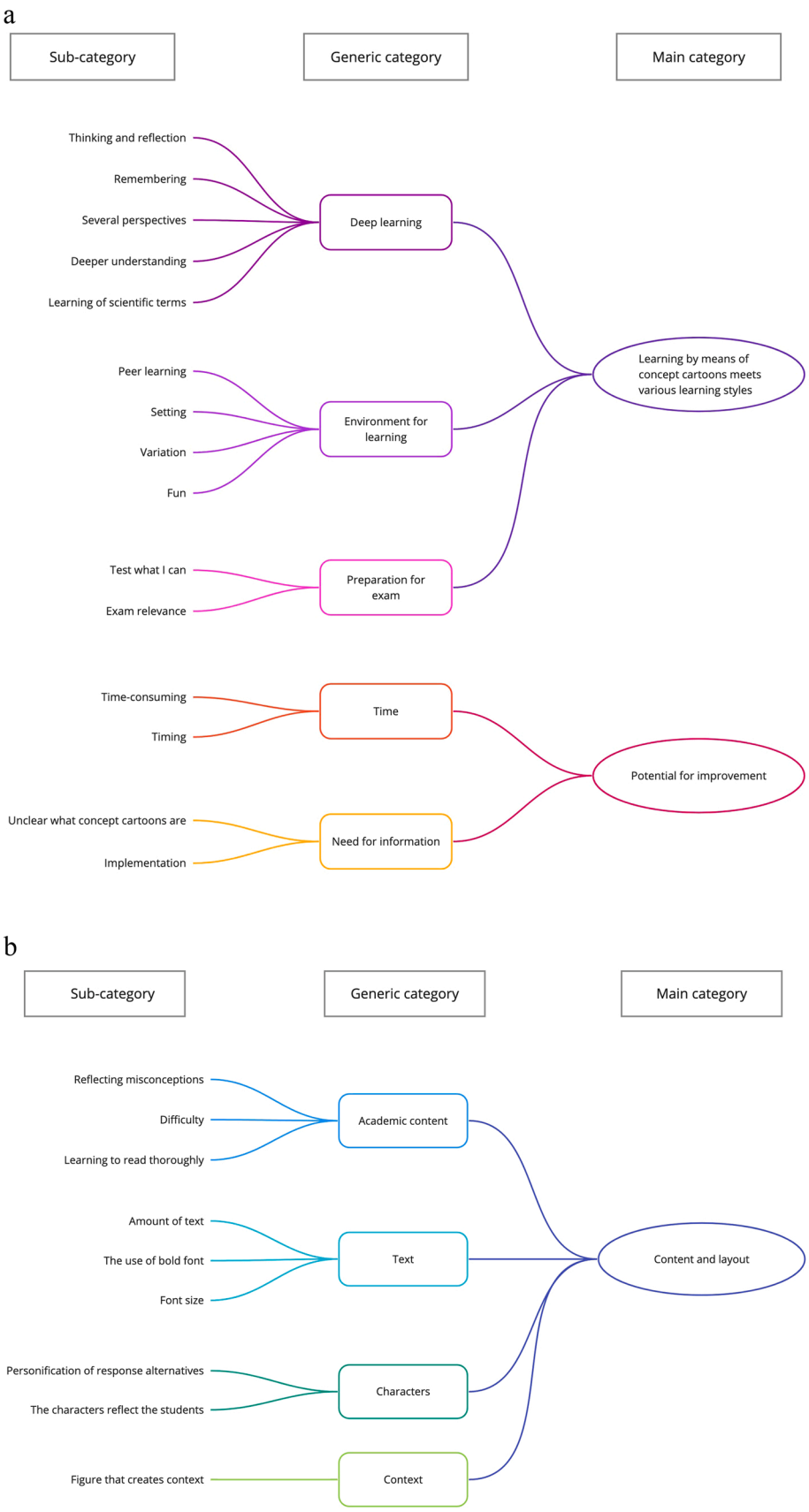

Fig. 2. Fig. 2**a** Subcategories and categories for students' experiences with concept cartoons in lectures, Fig. 2**b** Subcategories and categories for the design of the concept cartoons.

such a setting. Others claimed that concept cartoons added valuable variety in lectures.

Preparation for the Exam. The participants reported that the concept cartoons provide good preparation for the exam. As the statements were developed based on written answers from previous students, this provided information on how they should express themselves when describing central concepts. The participants highlighted the importance of carefully reading the statements to discover the differences between them, and they asserted that reading task instructions thoroughly had a transfer value to the exam.

[…]'it gives you something, what to think about at the exam then. It is easy to get burned. You must read thoroughly the exam task, I think, so I don't answer incorrectly…]'.

The fact that the statements were linked to learning outcomes and the statements were taken from previous students' answers to the exam meant that they were perceived as particularly exam relevant. Using concept cartoons, the students also reflected upon what they had learned and to what extent they had reached the learning outcomes.

3.1.2. Potential for Improvement

Need for Information. A need for more information for students and lecturers alike was revealed. The students lacked prior information about concept cartoons, how they had been developed, how they would be used in lectures and the intention of using them. The participants reported varying implementation abilities among lecturers – for example, some were unfamiliar with the student response system, and some did not report the correct answer at the end of the lecture. Not knowing the answer could take the focus away from the next topic, since students were left to ponder the appropriate response.

Time. The use of concept cartoons could be time-consuming. The participants expressed that waiting for fellow students to pick up their phones and log on to the student response system was an unnecessary use of time. Others mentioned that they wanted more time to discuss the different statements. Noise in the lecture hall from fellow students impacted concentration, and as a result, the students needed more time to read and think of the various statements.

One of the participants expressed it in this way:

[…] 'I generally think that when there is a lot of noise around, as there often is, then I can't concentrate on being able to read it myself. Then I have to read it through several times, and then it usually takes a little longer[…]'.

The participants also mentioned the timing for the use of concept cartoons. If they had known in advance when the concept cartoons should be used, they could have their mobile phones ready. The participants stated that it would save time if concept cartoons were used at the beginning of a lecture or immediately after a break, as it would then be possible to read the instructions in advance.

3.1.3. Content and Layout

Comments on the design of the concept cartoons covered both content and layout. Academic content, text, cartoon characters and context-creating figures were discussed.

Academic Content. It was highly appreciated that the statements had been developed based on the misconceptions and everyday experiences of former students and that they were linked to the learning outcomes.

One participant said:

'if previous students have struggled with this on the exam, then it is good that it is brought up in the cartoons [….]'.

It was also appreciated that the concept cartoons had varying difficulty and that some had more text than others.

Text. Most participants thought the amount of text was appropriate and that the font size was satisfactory. Others stated that some of the statements were too lengthy. Where the statements included long text, it was appreciated that differences in the statements were marked in bold.

Characters. A personification of the response options A, B, C and D was appreciated. The students could identify with the characters and appreciated the sex balance and the inclusion of different ethnicities.

One of the participants stated:

'I feel included[….]'.

Context. The participants appreciated a coloured illustration in the centre of the concept cartoon that defined the context. They declared that an animation could be disruptive and could take the attention away from the content.

Table 2
Students' experiences with concept cartoons in lectures, n = 343.

Item	Strongly disagree %	Disagree %	Agree %	Strongly agree %	Missing# %
The use of concept cartoons was useful for my learning.	5	12	56	21	5
The use of concept cartoons was inspiring for my learning.	6	20	49	20	6
I recommend the use of concept cartoons to increase understanding of central concepts.	5	14	47	28	6
I received sufficient information about the use of concept cartoons	6	16	50	22	7

#Missing responses due to not attending the lecture when concept cartoons were applied

3.2. Results from the Questionnaire

The quantitative data material indicated that most students were very pleased with the use of concept cartoons (Table 2).

The results indicate that the majority of the students thought the use of concept cartoons was useful (77%) and inspiring (69%) for their learning. Almost three-quarters recommended future use of concept cartoons to increase the understanding of central concepts. About the same amount reported that they had received sufficient information about the use of concept cartoons in lectures. There were no significant differences across sex, age, or entrance qualification when it comes to the students' experiences (Table 3). A significantly larger proportion of students born in another country than Scandinavian reported that the use of concept cartoons was inspiring for their learning compared to those who are born in a Scandinavian country.

4. Discussion

This study aimed to explore bachelor-level nursing students' experiences with concept cartoons to develop a conceptual understanding in A&P. The students experienced that the use of concept cartoons could meet different learning styles. The use of concept cartoons was highly appreciated, and the students recommended further use. However, some improvements were suggested.

To our knowledge, this is the first study where concept cartoons are developed based on former students' misconceptions that appeared from written exam answers. Hence, the misconceptions raised in the concept cartoon statements could be deemed evidence-based. This fact was highly appreciated by the students. They declared that learning from previous students' misconceptions was highly valuable. The students also learned that it is crucial to read the exam task thoroughly and be aware of how to express oneself more precisely in writing. Consequently, the use of concept cartoons was appreciated as a means of preparing for

Table 3
Differences in experiences with concept cartoons across sex, age, entrance qualifications, and country of birth.

	The use of concept cartoons was useful for my learning.				The use of concept cartoons was inspiring for my learning.				I recommend the use of concept cartoons to increase understanding of central concepts.				I received sufficient information about the use of concept cartoons.			
	agree n (%)	disagree n (%)	Chi sq[a]	p-value	agree n (%)	disagree n (%)	Chi sq[a]	p-value	agree n (%)	disagree n (%)	Chi sq[a]	p-value	agree n (%)	disagree n (%)	Chi sq[a]	p-value
Sex																
Male	40 (73)	15 (27)	2.462	0.117	37 (69)	17 (32)	0.448	0.503	41 (73)	15 (27)	1.653	0.199	42 (78)	12 (22)	< 0.001	1.000
Female	223 (83)	46 (17)			197 (74)	69 (26)			216 (82)	48 (18)			206 (78)	59 (22)		
Age																
18–21	142 (84)	27 (16)	1.509	0.219	124 (74)	43 (26)	0.122	0.727	139 (83)	29 (17)	0.746	0.388	131 (78)	37 (22)	< 0.001	1.000
≥ 22	121 (78)	34 (22)			110 (72)	43 (28)			119 (78)	33 (22)			118 (78)	33 (22)		
Entrance Qualifi-cation																
Gen.stud	199 (81)	47 (19)	< 0.001	1.000	172 (71)	71 (29)	1.734	0.188	195 (80)	48 (20)	< 0.001	1.000	188 (78)	54 (22)	< 0.001	1.000
VET	57 (81)	13 (19)			55 (80)	14 (20)			56 (80)	14 (20)			54 (77)	16 (23)		
Country of birth																
Scand.	218 (80)	55 (20)	1.338	0.247	190 (70)	80 (30)	5.513	0.019 *	215 (80)	55 (20)	0.271	0.603	209 (77)	61 (23)	0.023	0.880
Other	44 (88)	6 (12)			43 (88)	6 (12)			42 (84)	8 (16)			39 (80)	10 (20)		

Gen.stud = Specialization in general studies; Scand. = Scandinavia; VET = vocational education and training
[a] Chi-square (Chi sq) test with Yates' Correction for Continuity; *Statistically significant at 5% level

the exam.

The use of concept cartoons was considered a valuable break in lectures and encouraged reflection and activity. This is in line with the experiences of Strande and Madsen (2018) when teacher students used concept cartoons in science class with students in secondary school. Hence, concept cartoons might meet different learning styles, such as thinking and reflection, collaboration, dialogue and sharing knowledge with others. Other studies focusing on nursing students learning A&P have concluded that various learning styles and active learning are appreciated (Bakon et al., 2016; Bingen et al., 2020; Efstathiou and Bailey, 2012; Johnston et al., 2015). The positive experience with concept cartoons was also confirmed by the quantitative data. Particularly students born outside Scandinavia found the use of concept cartoons inspiring. However, the proportion of students representing this group was relatively small, and consequently, we cannot draw any generalisations. This association should be further explored in future studies.

The use of concept cartoons combines learning as an individual process and learning in a social context. The use of concept cartoons involves individual cognitive processes, as the students are intended to reflect on their understanding of central concepts. This notion aligns with *Think* in Lyman's (1981) Think-Pair-Share procedure. When concept cartoons are presented to the students their prior knowledge is engaged, and they may become aware of their understanding of the concept. This might facilitate the transformation of misconceptions and increase the students' knowledge to a larger extent than only receiving additional information (Versteeg et al., 2020, 2019). This is in line with Kabapinar (2005) who found that the use of concept cartoons was effective in remedying children's misconceptions in science. Pairing up with fellow students and sharing mutual understandings might reflect a social constructivist learning perspective (Vygotsky, 1986). Vygotsky (1986) emphasised that learning takes place in interaction with others and that language is important in this context. By sharing and explaining their understanding of the statements, the students can articulate their newfound knowledge. In this way, they can become more aware of their knowledge and understanding while simultaneously learning from their fellow students.

The participants expressed that the use of concept cartoons led to reflection and a deeper understanding, which could be related to deep learning. This is supported by Ören and Meriç (2014) who found that the use of concept cartoons in learning science and technology leads to deep learning. However, their study involved 7th-grade students. In contrast to surface learning, deep learning might bring a deeper understanding of central concepts and enable knowledge to be transferred and used in new situations (Pellegrino and Hilton, 2012), which is valuable when transferring knowledge in A&P into nursing practice. Benner et al. (2009) called for a change in the way A&P is taught in nursing. Traditionally, students are presented with the material, which they are expected to learn by heart. However, this can be considered a pedagogical strategy that does not convey to students how the knowledge can be used in clinical practice (Benner et al., 2009). The use of concept cartoons in lectures could make it easier for students to relate the concepts in A&P to nursing practice and maintain a deep learning perspective.

Our findings indicate that the participants had mostly positive experiences with concept cartoons in lectures. However, there is room for improvement. A quarter disagreed that concept cartoons were inspiring. The reason for this is unknown and should be further explored. However, in the focus group interviews, some participants expressed that it was somewhat time-consuming. Only a few hours of lectures are given on each topic within this subject. Hence, it is possible that some students prefer that the lectures are teacher-led. Moreover, students have different learning styles, which also was evident from the focus group interviews. Some students prefer activities and variety, whereas others might prefer listening and taking notes.

As the use of concept cartoons in lectures was perceived to be somewhat time-consuming students and lecturers need to be more

prepared to save time. Knowing when concept cartoons are going to be used would enable students to have their mobile phones ready for voting. The student response system could also have been downloaded as an application at the beginning of the course. The interviews revealed that not all students did know what concept cartoons were, how they had been developed or the reasons for using them in the lectures and asked for more information about concept cartoons. Hence, more information should be given at the beginning of the course, and the information should be given both orally and written. However, from the quantitative part of the study, most students were satisfied with the information they had received. The lecturers should also be given more information about the purpose of using concept cartoons and the importance of correcting misconceptions so that they do not linger with the students in their clinical work.

As the students experienced benefiting from the use of concept cartoons it might be worth developing more concept cartoons within the subject of A&P, but also within other subjects in nursing education. The use of concept cartoons could be one strategy to promote active learning and address central misconceptions. However, the effect on conceptual change should be further explored. The lecturers' experiences in using concept cartoons as an active learning strategy and as a formative assessment should also be further explored.

Strengths and limitations

A strength of this study is that a mixed method approach was applied and that results from the quantitative data somewhat support the findings from the focus group interviews which might strengthen the validity and reliability of the study. Another strength is that the study is based on three focus group interviews from three different universities/university colleges. For the quantitative part, we received responses from about a third of the students, which according to sample size calculation could be deemed as sufficient for drawing generalisations for the students at the current universities/university colleges. However, the qualitative and quantitative data were handled in parallel. The two approaches might have given deeper information if the questionnaire items had captured issues that were raised in the focus group interviews (or vice versa). There were also limited variables available for quantitative analyses. In future studies, it would be beneficial to explore the association of experiences with concept cartoons with other variables, such as learning strategies, motivation, admission grades, performance in the exam etc.

Overall, the students reported benefitting from using concept cartoons. However, there is a risk of response bias, that participants in focus group interviews might not dare to make negative comments, or they might want to be polite. However, the researcher that conducted the interviews was not involved in the teaching of the students and was unknown to them. Moreover, room for improvement was revealed in the interview, such as the use of concept cartoons was considered somewhat time-consuming. When conducting the quantitative part, control groups could have been used to further explore the gain of using concept cartoons.

Another limitation is that one researcher coded the data. However, the coding was discussed among the researchers. As all students at the three universities/university colleges were invited, there is a risk that the most interested have chosen to participate. The participants could also have been invited to read the transcribed material and the findings.

5. Conclusions

The students experienced that the use of concept cartoons meets different learning styles and could promote deep learning. The use was highly appreciated by the students, and most students recommended further use of concept cartoons in learning A&P. However, possible improvements were revealed. Future research should focus on the effect of concept cartoons on knowledge in A&P and whether the use impacts examination marks. More concept cartoons could also be developed to address other central misconceptions in biosciences or in other subjects, such as basic nursing, to promote critical thinking skills and ethical reflections.

CRediT authorship contribution statement

Hanne Søberg Finbråten: Conceptualization and design, Analyses, Writing - original draft, Writing - review & editing. **Heidi Kristine Grønlien:** Conceptualization and design, Analyses, Writing - review & editing. **Kjell Sverre Pettersen:** Conceptualization and design, Funding, Writing - review & editing. **Camilla Foss:** Visualization and formatting figures, Writing - review & editing. **Øystein Guttersrud:** Conceptualization and design, Funding, Writing - review & editing.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Availability of data and material

Data are available upon reasonable request.

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