Veterinary master's students reconnecting with foundational osteology through a guided, inductive learning activity.

Sophie Amalie Blirup-Plum

Department of Veterinary and Animal Sciences
University of Copenhagen

Introduction

"Veterinary Imaging" (SVEK13043U) is a mandatory course for students enrolled in the MSc Programme in Veterinary Medicine at the University of Copenhagen. The course includes a summary lecture, two practical exercises (group work), and a brief presentation session on the topics of topographic anatomy and osteology, which builds on knowledge introduced in the first year of the veterinary programme.

Currently, students show a lack of motivation and often leave the osteology exercises early, without making full use of the teacher's presence and support. In addition, some students appear to be unprepared for the presentation, which is based on the exercises. However, it is evident that the current format lacks sufficient framing, and the students are primarily responsible for managing their own learning during the whole exercise. A previous study has shown that incorporating core didactical principles, such as active learning through group work, can enhance student learning (Deslauriers et al., 2019). However, the success of any activity depends on student motivation and engagement, which must be actively supported by appropriate framing and instruction (Deslauriers et al., 2019, Prince and Felder, 2006). Therefore, the aim was to enhance student engagement and promote deeper learning through discussion and peer collaboration by replacing the purely independent format of the osteology exercise with a more interactive structure that includes a guided activity.

Methods

The course runs four times a year. Each time, the whole class is divided into two larger sets of students for the exercises (Fig. 1). Three separate sets were included (Fig. 1). One of these groups was designated as the control group and followed the original course structure.

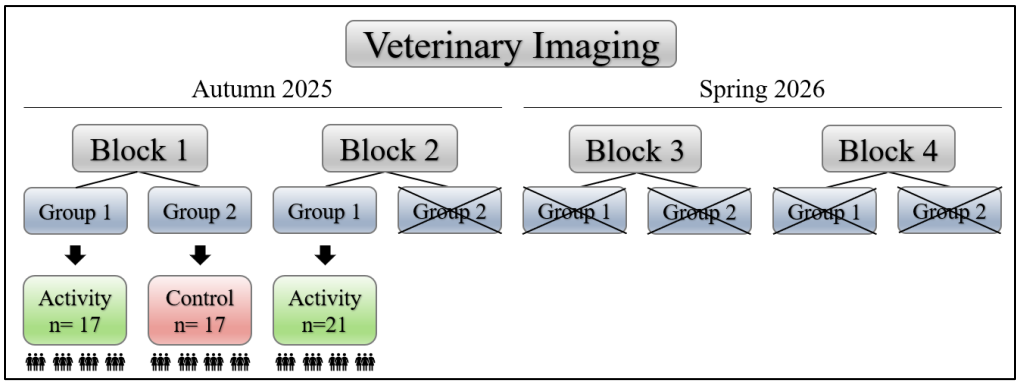

Fig. 1. Course structure and study design. Two groups of students from Block 1 and one from Block 2 were included in the present study. One of the groups from Block 1 was designated as the control group.

Overview of the original exercise and presentations

The original format of the osteology exercise was four hours of purely independent group work with reactive teacher support. The students were tasked with discussing and finalising "pocket checklists" for clinical radiography through the study of bone specimens and complete skeletons from cats, dogs and horses. A checklist was required for nine specific skeletal regions/joints and was expected to include:

1) Basic anatomical structures important for the radiographic evaluation and description of the normality/abnormality.
2) Normal (orthogonal) views.
3) The animal's position.
4) Anatomical, radiodense landmarks.
5) Palpable landmarks used for centering the radiographic image.
6) Main ossification centers.
7) One or two common lesions.

When students felt that they no longer needed teacher support or access to skeletons, they were allowed to leave the dissection hall and continue their group work elsewhere.

In a three-hour session with the whole class the following day, each group presented two-to-three checklists. Each presentation, lasting around five-to-ten minutes, involved a structured oral analysis of a radiograph from one of the included nine skeletal regions or joints, guided by the group's checklist. The presentation was followed by a brief peer-led Q&A session to reinforce learning and provide feedback.

Implementing the activity

The activity was integrated into the four-hour osteology exercise. The exercise began with setting the stage and establishing expectations by outlining the objectives of the activity, clarifying how the students were expected to participate and contribute, and providing an overview of the day's plan. Afterwards, the students were organised into four groups of five-to-six members and tasked with answering skeleton- or bone-related questions without prior preparation or the use of learning resources (Appendix A), aiming to activate their existing knowledge and identify knowledge gaps. Each student took a turn speaking for two-to-three minutes, sharing everything they knew or remembered about a specific bone or joint. Afterwards, their peers (comprising the remaining four or five group members) were to offer corrections and additions, engage in discussion, and deepen the collective understanding for another couple of minutes before moving on to the next student. The students were observed during the activity by me (the teacher), and the first activity group was also observed by my pedagogical supervisor. The last part of the exercise comprised of a two-hour collaborative study session, with reactive teacher support, during which the students could further deepen their understanding and address the established knowledge gaps.

Data collection

Most of the data gathered is based on teacher observations and the following were recorded:

1) Attendance: Do they still leave early?
2) How are their motivation and do they participate actively during the whole exercise?
3) Has the quality of student presentations in the plenum sessions improved?

In addition, students' perceptions of their learning and the course structure were gathered through a survey (Appendix B) administered at the end of the presentation session.

Results

For the activity groups, the students engaged with the new tasks attentively and sustained their focus throughout the exercise. The first two groups left the osteology exercise after an hour and a half. Three groups left after approximately two and a half hours, and the last three groups completed the exercise after four hours. The students seemed to identify the knowledge gaps quickly and one group encountered difficulties in progressing with the activity without learning resources, i.e. books, notes and computers. In comparison, the students from the control group used the first 10-15 minutes of the exercise to formulate a structured plan. Once a plan had been established, they also engaged attentively with the exercise. However, two groups were slightly more prone to engage in small talk. The first group finished after one hour and 45 minutes, another group left after three hours, and the last two groups completed the exercise after four hours.

At the presentations, the students from the activity groups seemed slightly more prepared than the students from the control group, i.e. they relied less on their notes. However, no substantial difference was observed.

Student questionnaire

Of the 55 students who participated in the exercises, 44 completed the questionnaire. Of these, 34 had been assigned to the new activity and 10 followed the original format.

The results from the student questionnaire are demonstrated in Figures 2, 3 and 4. Students from the activity group were generally more satisfied with the outcome of the anatomy exercise compared to students from the control group (Fig. 2). In addition, the students from the activity group experienced a higher degree of coherence between the lecture, exercises and presentations, and felt better prepared for the clinical teaching and exercises compared to students from the control group (Fig. 3). In the activity group, 18% of students reported that the activity had little or no impact on their ability to prioritise time during the remainder of the osteology exercise (Fig 4). For the control group, 30% did not feel they prioritised their time appropriately (Fig 4).

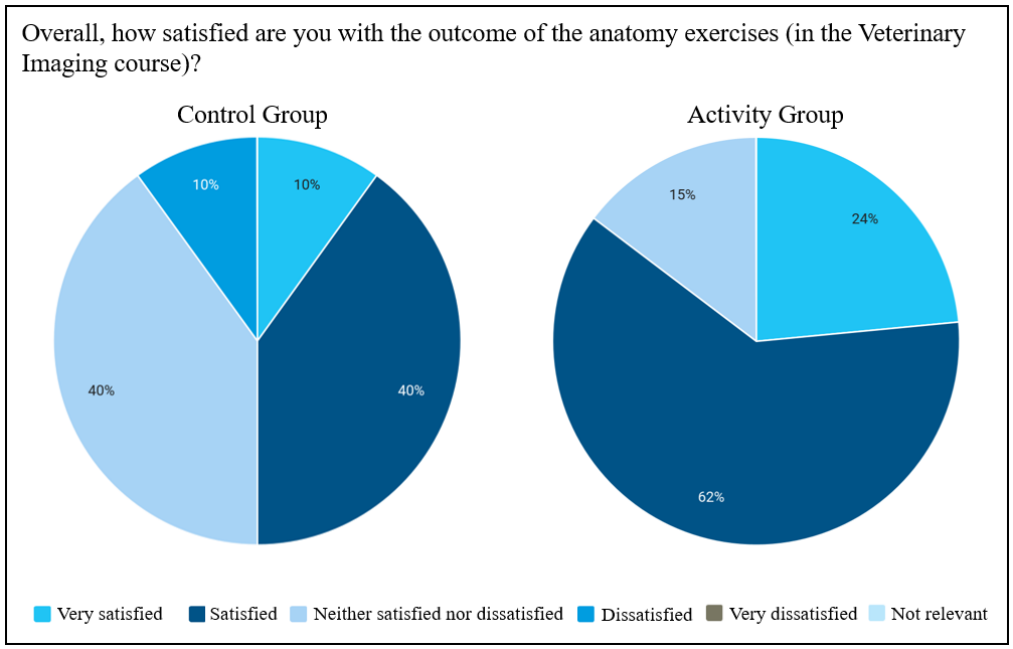

Fig. 2. Distribution of student responses from the questionnaire assessing the overall satisfaction with the anatomy exercises. The control group (n=10) followed the original exercise format whereas the activity group (n = 34) followed the revised format, which included the new osteology activity.

The key points gathered from the free-text responses were as follows:

1) Two control-group students requested more structure and/or a guided demonstration of the materials.
2) Three activity-group students wanted more guided instruction.

3) Two control-group students appreciated the independent format with the teacher available.
4) Three students from the control-group and 15 from the activity-group valued having bones and skeletons available for practice and repetition.
5) Four activity-group students felt there was too much time allocated, while one student wanted more time for the osteology exercise.

The full free-text responses are not included as the small cohort size makes anonymisation challenging. However, the complete dataset from the questionnaire is available from the author upon reasonable request.

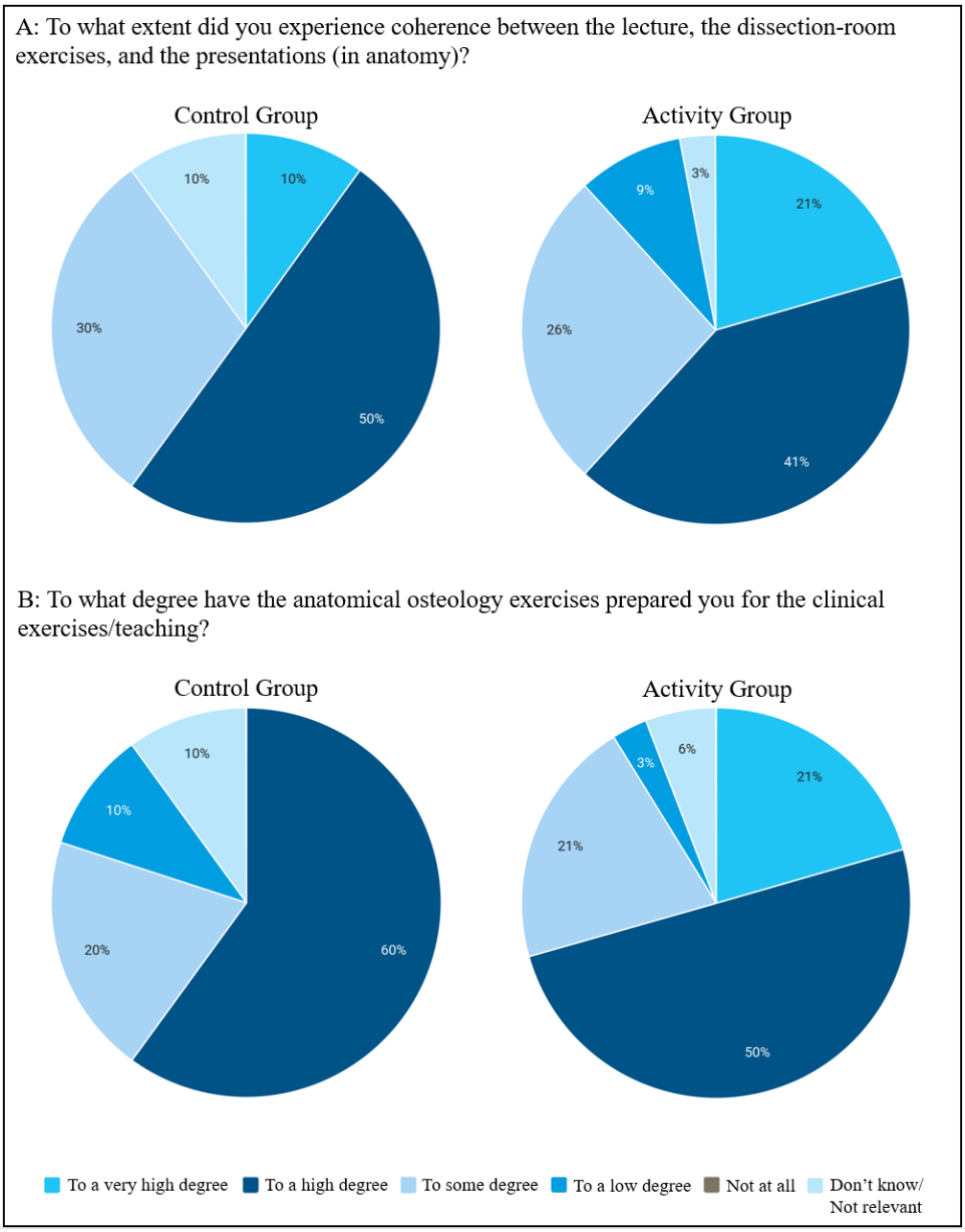

Fig. 3. A+B: Distribution of student responses from the questionnaire. The control group (n=10) followed the original exercise format whereas the activity group (n = 34) followed the revised format, which included the new osteology activity.

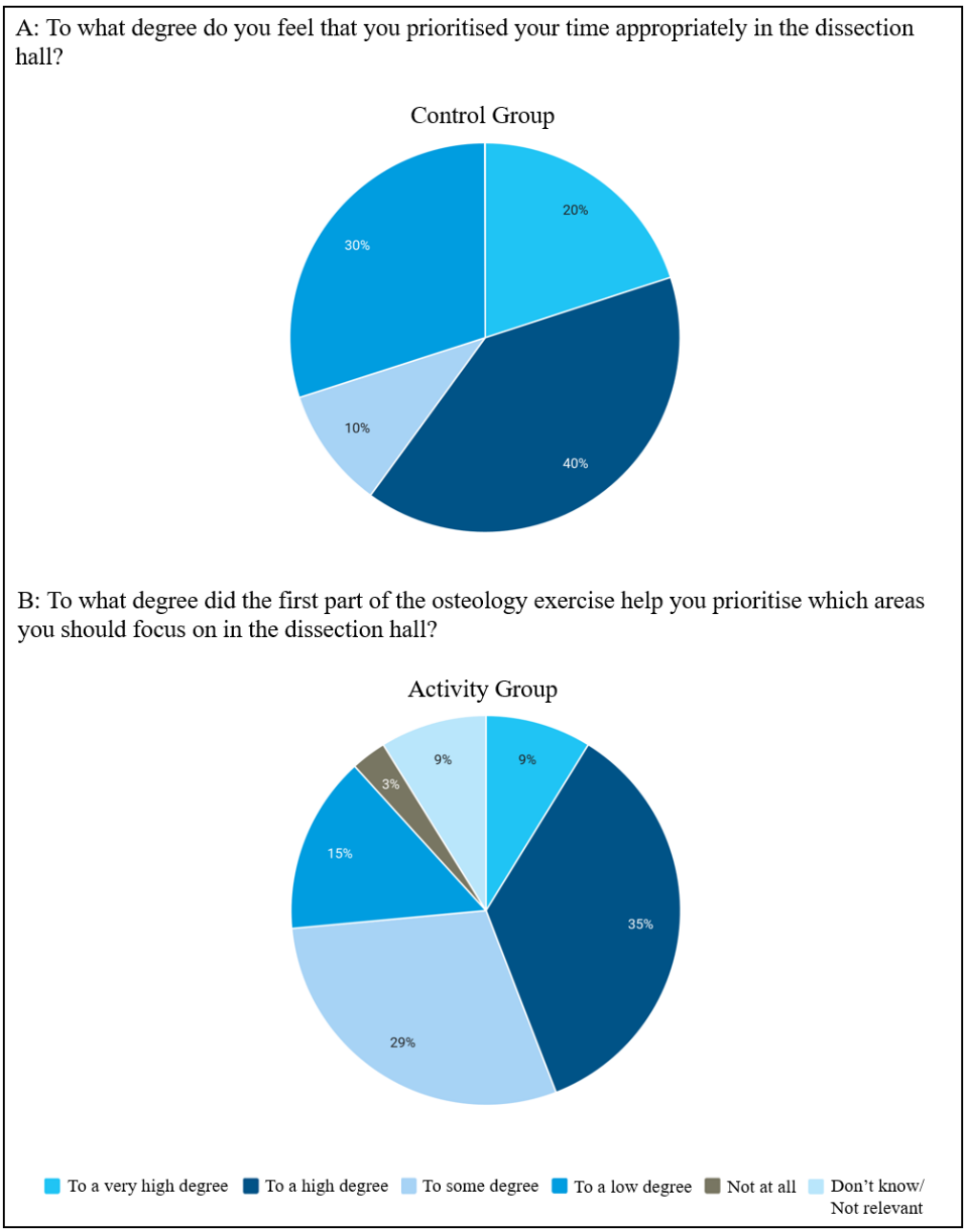

Fig. 4. A+B: Distribution of student responses from the questionnaire. A) The question was only distributed to the control group (n=10), which followed the original exercise format. B) The question was only distributed to the activity group (n=34), which followed the revised format that included the new osteology activity.

Discussion

According to the theory, increased engagement of the students through activities should enhance their learning and help maintain attention (Deslauriers L. et al., 2019, Rienecker L. et al, 2015). However, students' perceptions of their own learning have been shown to anticorrelate with their actual learning outcomes, with students often demonstrating greater resistance to active learning methods (Deslauriers et al. 2019). Nevertheless, all students in the present study participated attentively and maintained focus throughout the activity. In addition, questionnaire responses showed that students in the activity group were generally more positive, as 86 % reported being satisfied or very satisfied with the overall outcome of the exercises, compared with 50 % of control-group students. The questionnaire further revealed that 71% of students in the activity group experienced that the exercises prepared them for clinical teaching to a high or very high degree, compared with 60% of students in the control group who reported being prepared to a high degree. This is in accordance with another study, where students generally liked and valued active learning environments (Andrews et al. 2022). However, it is important to remember that the group sizes varied, and the total cohort was relatively small, which may influence the results.

In order to enhance learning and help student activate prior knowledge, it is important to offer a context that aligns with their future professional practice, while encouraging them to expand and apply their knowledge (Schmidt, 1983, Rienecker, 2015). In addition, the success of an activity is dependent upon student motivation and engagement, which require active support through clear framing and teacher guidance. The enhanced framing of the exercise combined with the new activity fostered more immediate and attentive student engagement. The slight increase in performance even though students continue to leave early may be attributed to greater efficiency in the group work.

Many students are resistant to teaching methods that make them more responsible for their own learning, and lack of teacher support can lead to poor evaluations and inferior learning outcomes (Prince and Felder, 2006). This is also reflected in the findings of the present study, in which students in the control group felt less prepared and were slightly

less satisfied with the overall outcome of the exercises, compared to the activity group, where the learning was more teacher controlled.

In conclusion, the new activity contributed positively to the course's learning objectives by enhancing students' engagement and perception of their own learning. In addition, it employs a more inductive approach, guiding students to examine a specific set of bones and integrate their findings into the broader framework of radiographic principles and topography. Based on observed outcomes and discussions with other teachers familiar with the course, the activity will be implemented as a permanent element.

References

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Appendices

Appendix A – Instructional handout for the activity.

Imaging Anatomy – Skeleton: Øvelsesvejledning

Del 1

Hver gruppe får tildelt en kasse, med knogler fra enten hund og/eller kat samt forben/fod fra hest.

1) Udvælg en/et specifik skeletal region/led (se nedenstående liste) og få den/det samlet af de løse knogler i fællesskab (i nogle tilfælde er knoglerne allerede delvist sammensat med snore).
2) Én studerende fra gruppen skal nu bruge **ca. 2 minutter** på at angive så mange landemærker og palperbare strukturer på de involverede knogler ud fra hukommelsen.
3) De resterende gruppemedlemmer kommer med input og tilføjelser **(2-3 minutter).**
4) Rotér og fortsæt således at en ny studerende starter ud med en af de resterende regioner/led (gentag punkt 1-3).

Forsæt indtil I har været alle skeletale regioner/led igennem.

Formålet at aktivere jeres eksisterende viden og identificere "videnshuller".

Del 2

Den anden del af øvelserne består af en samarbejdsbaseret studiesession med adgang til diverse knogler, relevant litteratur og faglig vejledning fra underviser. Her arbejders der videre med de forberedte tjeklister *(skriftlig opgave)* med henblik på at styrke den overordnede forståelse og målrettet adressere de videnshuller, der blev identificeret i den forudgående aktivitet **(ca. 2 timer).**

Side **1** af **2**

Skeletale regioner/led der skal laves tjeklister til:

1. Skulderled (ca, fe).
2. Albueled (ca, fe, eq).
3. Carpus (ca, fe, eq).
4. Hoftled (ca, fe).
5. Knæled (ca, fe, eq).
6. Tarsus (ca, fe, eq).
7. "Fod" (manus/pedis; ca, fe, eq).
8. Kranie – inkl. tænder (ca, fe, eq).
9. Rygsøjle (ca, fe).

Den gode tjekliste indeholder:

1) Navn på regionen /ledet.
2) De mest basale/almindelig anvendte projektioner (standard views inkl. orthogonale views).
3) Dyrets lejring ved diverse projektioner.
4) Palperbare strukturer anvendt til at fokusere strålen.
5) Røntgentætte landemærker der kan anvendes til at orientere sig på et røntgenbillede (lateral/medial /cranial (dorsal) / caudal (palmar)).
6) Evt. andre røntgentætte strukturer (bløddele, sener etc.) der er klinisk relevante.
7) Ossifikationcentre og hvornår de lukker (dyrets alder; husk at angive i tal, som du kan forholde dig til fx måneder fremfor dage).
8) Mest almindelig(e) radiologisk stillede diagnoser (1-2 stk).

Appendix B – Student questionnaire.

Velkommen til spørgeskemaet om anatomiundervisning i kurset "Veterinary Imaging".

Formålet med dette spørgeskema er at indsamle dine oplevelser og vurderinger af undervisningen i anatomi, herunder øvelser i skelettet.
Dine svar vil hjælpe os med at forstå, hvad der fungerer godt, og hvor der er mulighed for forbedringer, så vi kan gøre undervisningen endnu mere lærerig og relevant for fremtidige studerende.

Spørgeskemaet er anonymt, og det tager ca. 5–10 minutter at besvare.

Hvor tilfreds er du samlet set med udbyttet af øvelserne i anatomi (i kurset veterinary imaging)?

(5) m Meget tilfreds	(4) m Tilfreds	(3) m Hverken tilfreds eller utilfreds	(2) m Utilfreds	(1) m Meget utilfreds	(6) m Ikke relevant

I hvilken grad oplever du, at der er en sammenhæng mellem forelæsningen, øvelserne i dissektionssalen og præsentationerne (for anatomi)?

(5) m I meget høj grad	(4) m I høj grad	(3) m I nogen grad	(1) m I mindre grad	(6) m Slet ikke	(7) m Ved ikke / Ikke relevant

I hvilken grad har anatomiøvelserne i skelettet gjort dig klar til at gennemføre den kliniske undervisning?

(5) m I meget høj grad	(4) m I høj grad	(3) m I nogen grad	(2) m I mindre grad	(1) m Slet ikke	(6) m Ved ikke / Ikke relevant

Hvilke datoer havde du øvelserne?

(1) m 8. og 9. september + 17. og 18. november (v. Amalie)	(2) m 6. og 7. oktober (v. Merle)

I hvilken grad hjalp første del af skeletøvelserne dig med at prioritere, hvilke områder du skulle fokusere på i dissektionssalen? (Spørgsmål stilles hvis svar til forrige spørgsmål er 8. og 9. september + 17. og 18. november (v. Amalie))

(5) m I meget høj grad (4) m I høj grad (3) m I nogen grad (1) m I mindre grad (6) m Slet ikke (7) m Ved ikke / Ikke relevant

I hvilken grad synes du, at du prioriterede din tid hensigtsmæssigt i dissektionssalen? (Spørgsmål stilles hvis svar til forrige spørgsmål er 6. og 7. oktober (v. Merle))

(5) m I meget høj grad (4) m I høj grad (3) m I nogen grad (1) m I mindre grad (6) m Slet ikke (7) m Ved ikke / Ikke relevant

Hvad fungerede særligt godt ved skeletøvelserne ?

_____
_____
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Hvordan kunne skeletøvelserne forbedres?

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Andet du vil tilføje?

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Mange tak for din besvarelse.
Dine svar er vigtige for at gøre undervisningen bedre!