Optimizing group work dynamics for student-activating learning

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Background

Cooperative learning (reviewed by Cohen 1994; Johnson and Johnson 2009) is an educational approach which has students working together in small groups to accomplish one or more collective tasks, and has been demonstrated to improve academic performance among STEM students at the university level (Springer et al. 1999; Theobald et al. 2020). While cooperative learning shifts the classroom focus from the teacher to the students, its efficacity is highly dependent upon the teacher assigning relevant tasks that can yield productive discourse as well as creating an environment where they can support, monitor, and assess students as they work in their groups (Cohen 1994; Dzemidzic Kristiansen et al. 2019). To do so, Kilgour et al. recommend that teachers be "well trained and experienced in managing small-groups and encouraging group harmony," "tutorials be well-structured," "students be given regular feedback on their learning performance", and "students be provided easy access to learning resources."

Group composition can also influence the learning environment, with a recent meta-analysis finding small groups (<5 members) to be more effective than larger groups (Swanson et al. 2019), perhaps due to individual members having increased accountability (Johnson and Johnson 2009). Many students express a desire to select their working partners due to expectations of comparable competencies and a fair division of labour, however collaboration can also potentially damage pre-existing relationships (Burdett 2003; University Teaching and Learning, Chapter 4.2). Conversely, heterogenous groups may encourage

acceptance of classroom diversity and foster interpersonal skills but requires that students display openness (Volet et al. 2009, University Teaching and Learning, Chapter 4.2). Regardless of group selection criteria, Webb observed that the "most able student in the group may take a teaching role even if he or she does not have high ability on an absolute scale," while Dzemidzic Kristiansen described a willingness to offer or seek help as core cooperative learning behaviours, indicating that this learning environment has the potential to create new experts. Moreover, a University of Colorado-Boulder study found that "peer discussion can be effective for understanding difficult concepts even when no one in the group initially knows the correct answer," suggesting that groups of variable composition have the potential to achieve deep learning (Smith et al. 2009).

Despite the benefits, it is important to consider that students' opinions on group work can be mixed. For a chemistry class at the University of Minnesota, in-class lecture hours were reduced and replaced with active learning hours with the authors observing no negative impact to student performance and improved "student perceptions of the learning environment" (Baepler et al. 2014). However, a study of engineering students at North Carolina State University in 2002 found that introverts initially perceived cooperative learning more negatively than extroverts (Felder et al. 2002). While this perception became more positive over time, consistent with continuous exposure to cooperative learning experiences (Dzemidzic Kristiansen et al. 2019), it is apparent that some students have individual characteristics, personality traits, or prior negative experiences that reduce their enthusiasm for cooperative learning (Kilgour et al. 2016; University Teaching and Learning, Chapter 4.2). In such instances, Kilgour et al. recommend that such students be identified and be provided additional support.

Rationale, Statement of Problem, and Aims

Student-activating learning (SAU) classes provide an ideal learning environment for students to work in groups to complete problem-solving exercises. However, in my past experience teaching SAU classes I have

noticed certain challenges which have the potential to impact overall class performance. These challenges include uneven levels of participation amongst all students, uneven levels of preparation before entering the class, and uneven levels of understanding of fundamental concepts until very late in the course. An even greater challenge, perhaps, was my observation that students rarely interacted with every other student in the class. Rather, most students were committed to working within their own "bubble" comprised of colleagues that they likely continued to socialize with outside of the classroom. This creates a problem whereby students working within a bubble interact less frequently with other students in the class, especially those who work individually, creating an environment with lower rates of student-peer transmission of information.

Therefore, the principle aim of this study was to increase the number of student-peer interactions by experimenting with pre-determined seating arrangements and pre-selected group composition in two of my classes, then compare the experience of students in those classes with other classes where these same students were responsible for their own group work interactions. I predicted that, not only would this help students engage more actively with the class material, but that I would also be achieving the following goals:

1. Increasing the level of student interactions within the classroom to the point where students felt comfortable providing/receiving assistance from their peers.
2. Building experts within the group.
3. Guiding students to reflect on how they experience working under different group structures.

Methods

The subject for this experiment was a Fall 2022 SAU class for Medical Genetics (course code: SMEB12006U), a first-year course for bachelor students of Medicine, and second-year course for bachelor students of Molecular Biomedicine, offered by the Department of Cellular and Molecular Medicine (ICMM) in the Faculty of Health and Medical

Sciences (SUND) at the University of Copenhagen. In this class I taught 30 students, each enrolled in the Molecular Biomedicine program (collaborative program between SUND and the Faculty of Science), for eight two-hour lessons during their third semester. The content of these lessons is designed to support material from the lectures by exploring case studies, and to prepare students for practical laboratory exercises and the final exam. The first five of these lessons were reserved for data collection (SAU1-5). In a typical lesson, students analyze case studies in groups, extract information from the text and figures, develop hypotheses, and address open questions. Students then submit this information to a shared Google or Padlet document that is taken up in plenum through dialogue and, when possible, having volunteers from the class draw their work on the white board to share with the class. Since this is the first time many of these students will have encountered a case study, it is important for me to provide clarity regarding their expected contributions and to moderate the discussion during plenum. In this way, I am keeping the learning environment "concrete, focused, and controlled" (University Teaching and Learning, Chapters 4.2 and 4.5.1).

Case-based learning is considered well-suited to cooperative learning environments, particularly for students in health and medical sciences. Teachers and students report case-based learning to enhance satisfaction, motivation, engagement, learning, fostering collaboration, and connecting theory to clinical practice (Thistlethwaite er al. 2012; Ferreri et al. 2013; Yoo and Park 2015; Kilgour et al. 2016; Bi et al. 2019).

To satisfy the goals of my study, I decided to place my students in two different learning environments and compare these experiences. The control learning environment was used to establish a baseline and students were given the freedom to select their own group members (or work individually) as is normally expected. For the experimental learning environment, students worked with pre-selected group members and seating was assigned in at least one class. To compare experiences between these two different learning environments, I collected quantitative and qualitative data. Quantitative data was collected in the

form of an anonymous survey prepared with the SurveyXact tool (https://www.surveyxact.dk/). The complete survey, including response data, can be found in Appendix A. Qualitative data was collected in the form of in-class observations (e.g. frequency of student-peer and student-teacher interactions) and follow-up discussions with the students themselves.

Next, I needed to match the structure of my lessons with my plans for data collection:

- In SAU1 (control learning environment #1), I informed the students of my study and provided them a schedule, including the lessons with pre-selected groups. Students were given an opportunity to raise objections. After a short presentation of relevant theory, students were given pedigree analysis exercises to be performed in-class with group members of their own choosing (or individually if they preferred).
- In SAU2 (experimental learning environment #1), the class had a case study where they needed to construct a pedigree based on information from two families and clinical literature. Students worked in randomly pre-selected groups of three (or four).
- In SAU 3 (control learning environment #2), most of the class was dedicated to preparing students for an upcoming practical laboratory exercise. As part of this, students were given a karyotype notation exercise and were responsible for their own group work interactions.
- In SAU4 (experimental learning environment #2), the class worked on a case study related to population genetics. Students were assigned seating and worked in randomly pre-selected groups of three (or four). The composition of students in each group was different than that in SAU2. At the end of this class, students were provided the survey for the first time.
- In SAU5 (control learning environment #3), the class worked on a case study related to genetic linkage analysis. Students were responsible for their own group work interactions. This class was used to collect qualitative data only. Students were given the opportunity to complete the survey for the final time.

Results, Discussion, and Reflections

In the five SAU classes used for data collection, each of the 30 students attended at least two classes. While the lowest turnout for a class was 14 students, each of the other four classes were attended by between 22 and 29 students. Moreover, 14 students provided complete responses to the survey with notable findings presented in Figures 1-3 where I've attempted to correlate the data with the stated goals of this study: (i) increasing the level of student interactions within the classroom (Figure 1), (ii) building experts within the group (Figure 2), and (iii) understanding how students perceive different group structures (Figure 3).

Before delving into a comparison of work with chosen vs. pre-selected group members, it is important to understand how well my students knew one another, how they preferred to work, and how the physical classroom setting influenced their work. In Figure 1A we can see that nearly the entire class knew each other before starting this course, with the likely reason being these students are part of the Molecular Biomedicine program (the majority of Medical Genetics students are in the Medicine program) and have shared classes before this SAU. These students also had named a representative amongst themselves who represented their interests and facilitated communication between myself and the class, another measure to promote familiarity among the group. Thus, we should consider this pre-existing familiarity as a confounding factor in comparison to other student cohorts where the students would not have known each other so well. Nevertheless, it was encouraging to see that the students were inclined to work in teams (Figure 1B) as this is an effective format for exploring case studies in this SAU. However, while the students in my class knew each other and while they enjoyed working in teams, the physical seating arrangements in the classroom did not promote mobility and students were overwhelmingly engaging in "short-range" interactions over "long-range" interactions with their peers (Figure 1C). While, admittedly, it is easier for students to work with "whoever is next to me," as one student described, I also observed that students rarely moved from their seats once work on a case study or

exercise began. Taken together, these findings support my decision to alter the learning environment by placing students into pre-selected groups to encourage more "long-range" interactions.

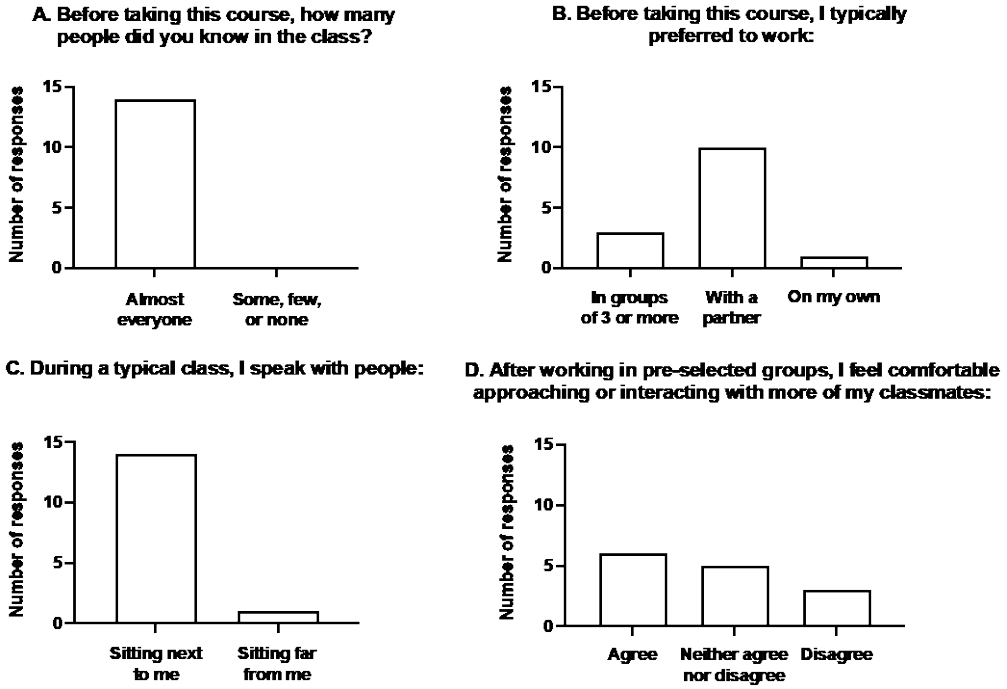


Fig 1. Pre-selected groups allow for increased frequency of in-class student-peer interactions. When students know one another and prefer working together, they still reserve most of their interactions for those seated most closely to them. But work in pre-selected groups increases the number of "long-range" interactions.

When students were provided the opportunity of working more frequently with students they would not normally interact with, they reported being more comfortable when approaching other classmates (Figure 1D). This suggests that pre-selected group work does not need to be used in every class, and that having even one class with pre-selected groups could provide a student-peer interaction benefit for future classes. Surprisingly, students also reported increased interactions with the teacher (see Appendix A, Question 11), although my personal observation was that I had less frequent interactions with students than in earlier SAU cohorts. Therefore, it is important for future comparisons to consider differences in student vs. teacher perceptions and to account for these differences with added objective measures.

After looking at the impact pre-selected group work had on student-peer interactions, I looked at how students functioned within the groups themselves. I wanted to create situations where students with lower levels of theoretical understanding could benefit from other group members with higher levels of understanding. At the same time, I wanted group members with higher levels of understanding to cultivate their expertise by helping others. Initially, I planned to create these settings by identifying and matching such students myself. To facilitate this process, I asked students to write their names on post-it notes in the first class so that I could memorize their names and get an initial perception about their relative levels of understanding. This was an optional request, although I received no objections, and in the past, I've found that knowing my students' names has had a positive impact on class rapport. Despite these measures, I was unable in the time required to identify enough students with higher or lower than average levels of theoretical understanding before I needed to divide students into pre-selected groups. Instead, students were assigned to each group randomly in SAU2, then again in SAU4, with the expectation that across these two classes, there would be enough groups containing unequal skillsets to compare against those sharing equal skillsets.

A contributing factor to students' different levels of understanding was the level of advanced preparation before entering class. While I did not expect students to read case studies before entering class (in fact it was important that they did not so that each group would have the same starting point), they still needed a fundamental grasp of key concepts before arriving for each lesson. Surprisingly, most students did not arrive prepared (Figure 2A), data that was partially confirmed by looking at my students' participation rates for quizzes provided to them before SAU1 (40%), SAU3 (10%), a practical exam (90%), and SAU4 (7%). When asked, one student commented "the SAU have been useful and I haven't felt the need to prepare because of that," perhaps suggesting that many students prefer to learn these concepts while in class or while interacting with their peers during group work.

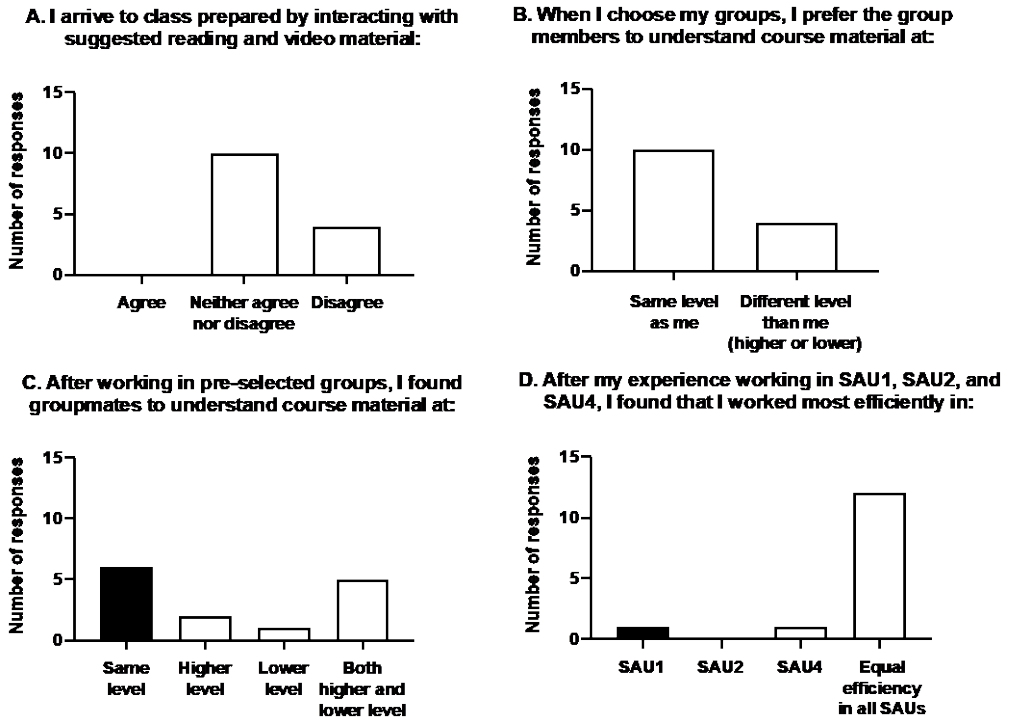


Fig 2. Students work just as efficiently in pre-selected groups as they do when they are responsible for their own group work interactions. Pre-selected groups had students with mixed levels of theoretical comprehension and low advanced preparation, contrasting with students' initial preconceptions about desirable qualities in an ideal partner. Despite this difference, students still performed efficiently under the mixed setting. [Note: SAU3 was excluded from the question in panel D as this lesson had less time allocated for group work.]

To better interpret the experiences of my students, I wanted to compare their perception of an ideal working partner with their real-world experiences. When asked who they prefer to work with, 71% of students replied that they prefer working with a partner who understands course material at the same level as them (Figure 2B). Yet, while only 43% of students found themselves with partners at the same level in the pre-selected groups (Figure 2C), 86% of students reported working just as well in the pre-selected group lessons as the lesson where they selected their own groups (Figure 2D). Therefore, students had a positive view of their working efficiency even when placed in groups with other students who understood course material at higher and lower levels. These results are consistent with my in-class observations where I've found nearly all

groups to achieve similar and correct major conclusions for every case study we had covered. Indeed, the only lesson where I observed major issues with comprehension was in SAU1. Moreover, 100% of students reported a willingness to help peers struggling with challenging material and 29% of students would refer them to another classmate if they thought it could help (in comparison to 14% of students who would leave their peer to figure out a solution on their own), suggesting that this cohort of students has the capacity to build themselves as experts within the group (see Appendix A, Question 9).

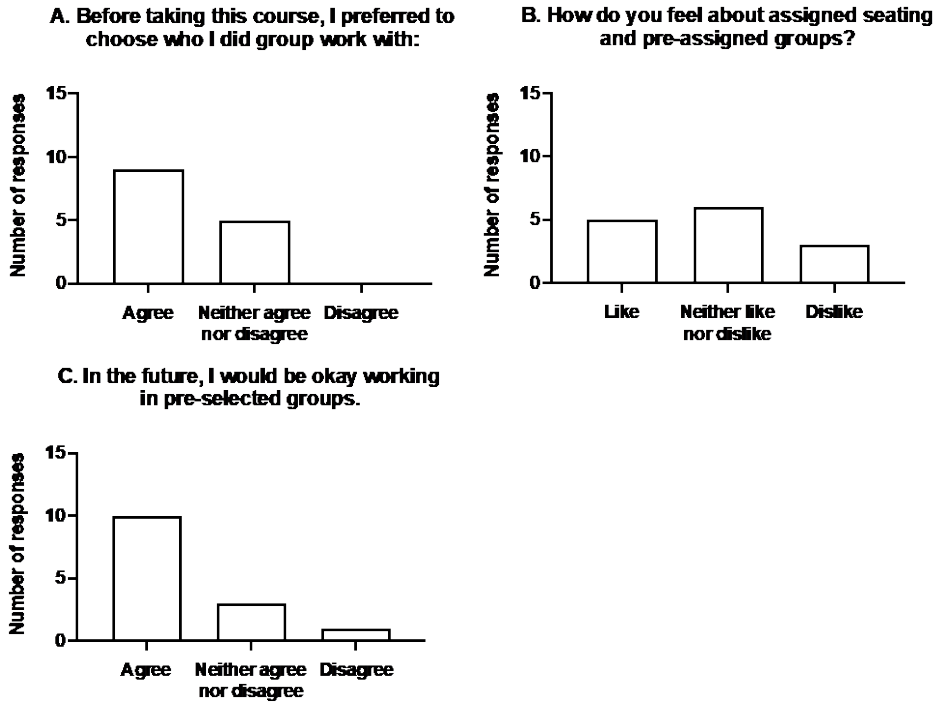


Fig 3. While students prefer to choose their working partners and seating arrangements, they are also willing to continue working in pre-selected groups in the future.

Due to the observed differences between students' preconceptions and actual experiences working in different group structures, I wanted to understand how the students themselves perceived this exercise. While students evidently value these SAU classes (93% reported improved understanding; see Appendix A, Question 13), it is also true that group pre-selection challenges their autonomy, with 64% preferring to choose their own partners (Figure 3A). Moreover, a sizable minority (21%)

dislike being told where to sit and who to work with (Figure 3B), with one student commenting: “I work with very different people already. I don't feel I gained anything by preselected groups and assigning is too much like being in a school room. I don't like the hassle of being told where to sit. It is not a problem for me, but I prefer not.” For my part, I did my best to respect the students holding this perspective by being very transparent about why I was having them work in pre-selected groups and being explicit about which lessons would be impacted, and it is my opinion that the students valued this open communication. What is also clear was that 71% of students were willing to continue working in pre-selected groups in the future, with only one student disagreeing (Figure 3C). This number is higher than I expected and is perhaps inflated by most of the students already knowing each other, however it is encouraging to see that so many students held positive opinions about this exercise.

Conclusions and Future Perspectives

Students who know each other work efficiently in groups even when their working partners are selected at random and when groups are comprised of students who understand course material at mixed levels. Increased diversity in group composition also leads to more student-peer interactions, and while most students accept placement into pre-selected groups, one fifth of this cohort did not and their position must be accommodated if this structure is to be repeated.

A major pitfall of this study is that the students knew each other before taking this course. When questioned further, students revealed that this class of 30 has remained mostly intact for three semesters (1.5 years), that the size of their program cohort is 70 students, and that all students from the program have joined a group on social media to strengthen how they network outside the classroom. Moreover, these students have at least one other class where the teacher has placed them in pre-selected groups. Therefore, it is very likely that these factors influenced the outcome of my experiment such that positive student experiences are over-represented in my dataset.

In the future, I plan to incorporate pre-selected group work into a small percentage of my lessons while adding the following conditions to my methodology: (i) applying group pre-selection to classes where students do not already know each other; (ii) creating pre-selected groups by combining well-performing and under-performing students (this would need to be done in a course's later stages); and (iii) teaching students in a spatial environment that permits greater mobility and allows students to visually see one another throughout the lesson, which has been shown to influence student satisfaction and in-class perceptions in previous studies (Yang et al. 2013, Han et al. 2018). Under this third condition, I want to see if pre-selected group work retains the capacity to improve student-peer interactions when compared to low mobility environments.

Discussion of project with teaching colleagues

This report was shared with my departmental supervisor and two colleagues at the Department of Cellular and Molecular Medicine (ICMM), where it was positively received without the need for major changes. Two minor changes were recommended and incorporated into the final version (one technical, another to better clarify my interpretation of Figure 1C). The remainder of the discussion focused primarily on the challenge of investigating group work for a class with pre-established social interactions. The consensus was that future studies need to compare this setting to those where students do not initially know each other. Finally, it was recommended that future group work studies be supplemented with student perspectives or experiences regarding individual work.

References

Wells, A. (2009). *Metacognitive therapy for anxiety and depression in psychology*. Guilford Press.

Baepler P, et al. (2014). It's not about seat time: Blending, flipping, and efficiency in active learning classrooms. *Computers & Education*. **78**: 227-236.

Bi M, et al. (2019). Comparison of case-based learning and traditional method in teaching postgraduate students of medical oncology. *Medical Teacher*. **41**: 1124-1128.

Burdett, J. (2003). Making Groups Work: University Students' Perceptions. *International Education Journal*. **4**: 177-191.

Cohen, EG. (1994). Restructuring the Classroom: Conditions for Productive Small Groups. *Review of Educational Research*. **64**: 1-35.

Dzemidzic Kristiansen S and Burner T. (2019). Face-to-face promotive interaction leading to successful cooperative learning: A review study. *Cogent Education*. **6**: 1674067.

Felder RM, et al. (2002). The effects of personality type on engineering student performance and attitudes. *Journal of Engineering Education*. **91**: 3-17.

Ferreri SP, et al. (2013). Instructional Design and Assessment: Redesign of a Large Lecture Course Into a Small-Group Learning Course. *American Journal of Pharmaceutical Education*. **77**: Article 13.

Han H, et al. (2018). Physical classroom environment and student satisfaction with courses. *Assessment and Evaluation in Higher Education*. **43**: 110-125.

Johnson DW and Johnson RT. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher*. **38**: 365-379.

Kilgour et al. (2016). A Rapid Review of the Factors Affecting Healthcare Students' Satisfaction with Small-Group, Active Learning Methods. *Teaching and Learning in Medicine*. **28**: 15-25.

Smith MK, et al. 2009. Why peer discussion improves student performance on in-class concept questions. *Science*. **323**: 122-124.

Springer et al. 1999. Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis. *Review of Educational Research*. **69**: 21-51.

Swanson E, et al. 2019. The effect of team-based learning on content knowledge: A meta-analysis. *Active Learning in Higher Education*. **20**: 39-50.

Theobald EJ, et al. 2020. Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *PNAS*. **117**: 6476–6483.

Thistlethwaite JE, et al. 2012. The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. *Medical Teacher*. **34**: e421-e444.

University Teaching and Learning. 2015. Eds: Rienecker, Jørgensen, Dolin, and Ingerslev. Samsfundslitteratur, Frederiksberg C, Denmark.

Volet et al. 2009. High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction*. **19**: 128-143.

Webb NM. 1989. Peer interaction and learning in small groups. *International Journal of Educational Research*. **13**: 21-39.

Yang Z, et al. 2013. A study on student perceptions of higher education classrooms: Impact of classroom attributes on student satisfaction and performance. *Building and Environment*. **70**: 171-188.

Yoo MS and Park HR. 2015. Effects of case-based learning on communication skills, problem-solving ability, and learning motivation in nursing students. *Nursing and Health Sciences*. **17**: 166-172.

Appendix

Appendix A: Complete Survey

Survey Title: Group Work Dynamics in Medical Genetics SAU hold Mb2 (E2022)

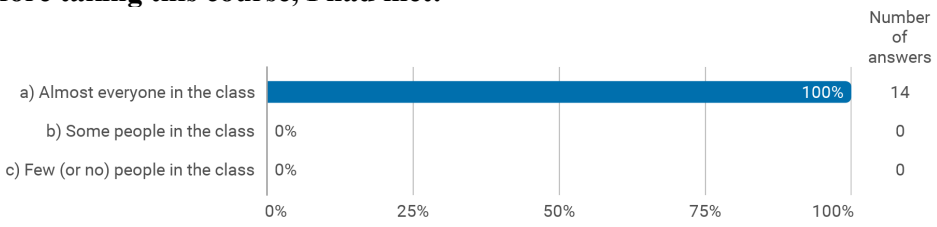
I would like to gain more insight into the student experience regarding group work at the University of Copenhagen. My goal in researching this is to optimize and improve the way students approach case studies in the Medical Genetics SAU and for students to improve peer-to-peer interactions while working in class.

To help me with this, I request that you answer the following questions as honestly as possible according to your experience. Please use our class as a reference when answering these questions.

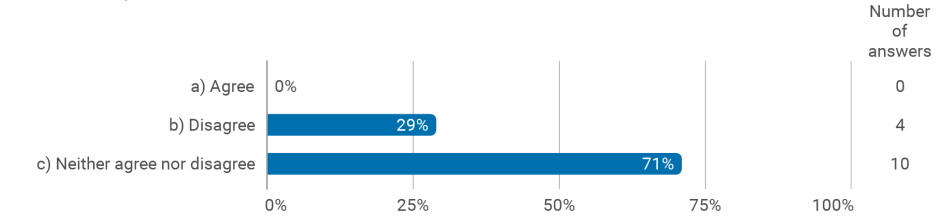
All of the collected answers will be treated anonymously. However, I will dedicate time to follow up on the results of the survey through a class discussion.
Thank you in advance!

Closing date: 23 December 2022

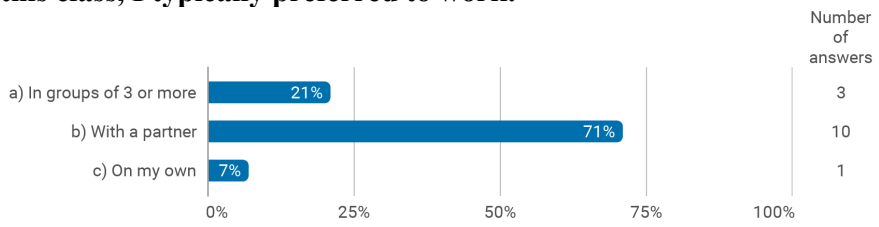
1. Before taking this course, I had met:



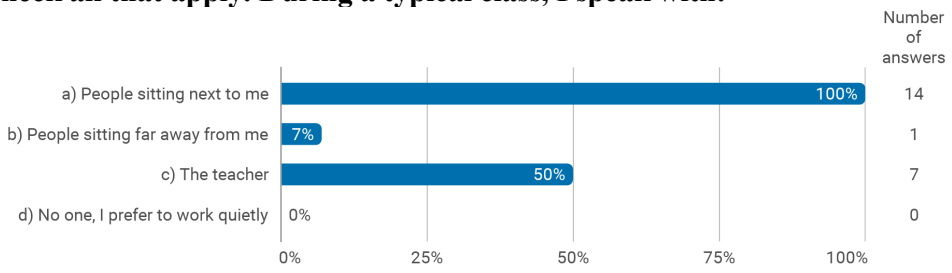
2. I arrive to class prepared (e.g. I read the SAU page, do the quizzes, watch the videos, etc.)



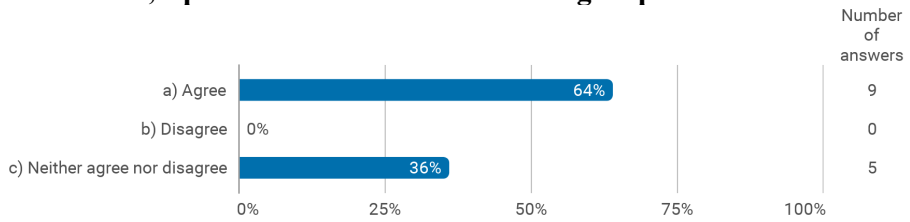
3. Before this class, I typically preferred to work:



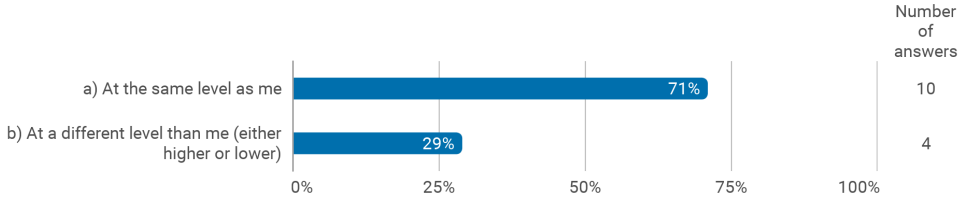
4. Check all that apply. During a typical class, I speak with:



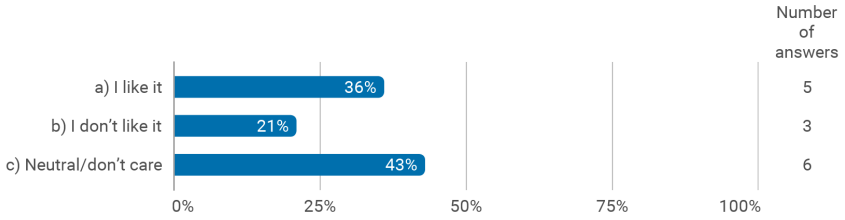
5. Before this class, I preferred to choose who I did group work with:



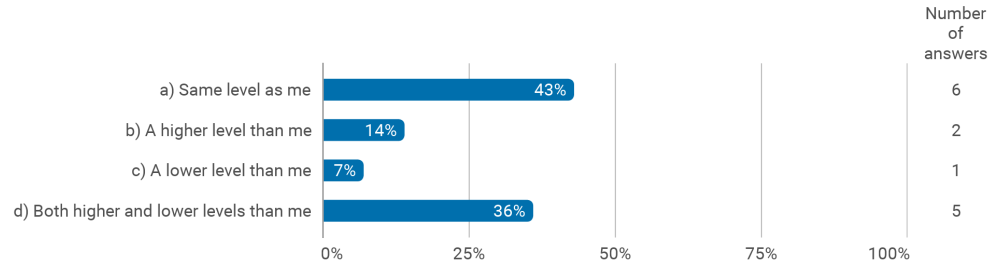
6. When I choose my own groups, I prefer my groupmates to understand the course material:



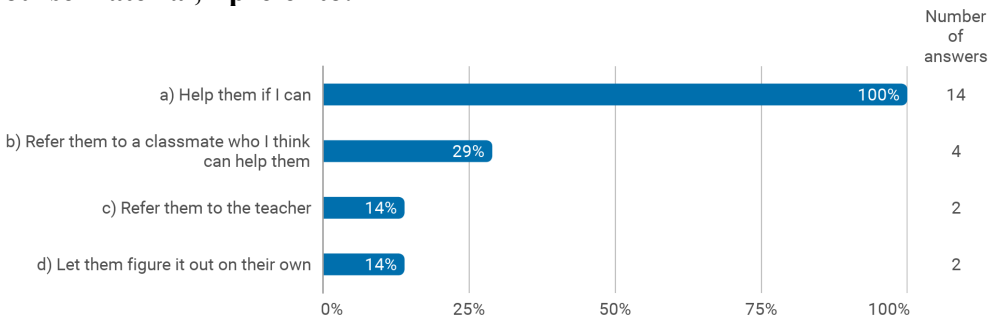
7. How do you feel about assigned seating and pre-assigned groups:



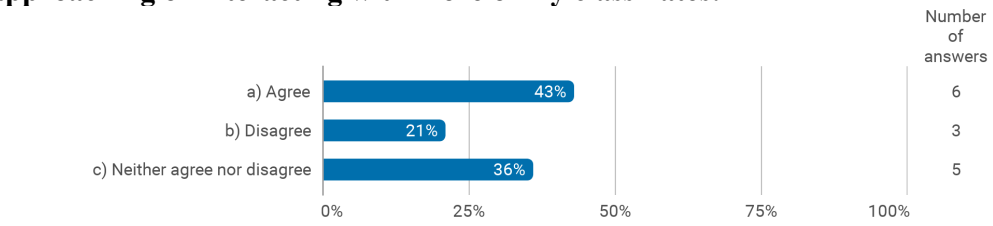
8. When working in pre-selected groups, I found that my groupmates understood the course material at the:



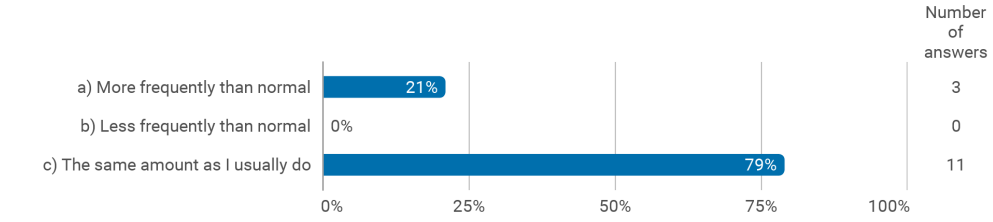
Check all that apply. When I see someone experiencing challenges with the course material, I prefer to:



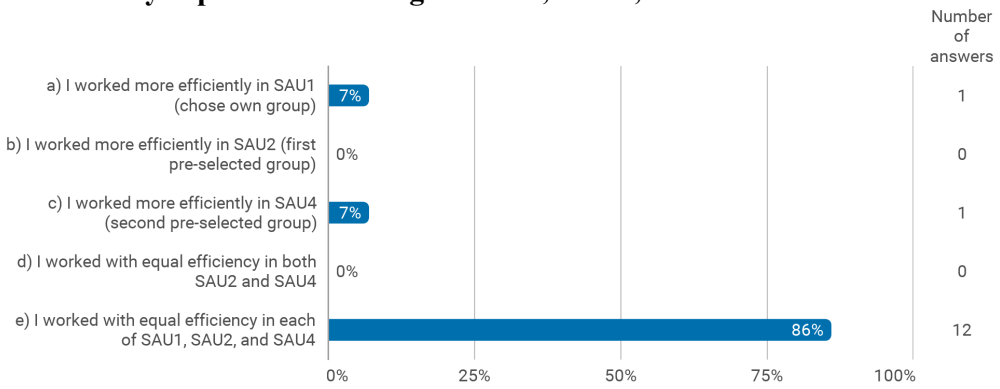
10. After working in pre-selected groups, I feel more comfortable approaching or interacting with more of my classmates:



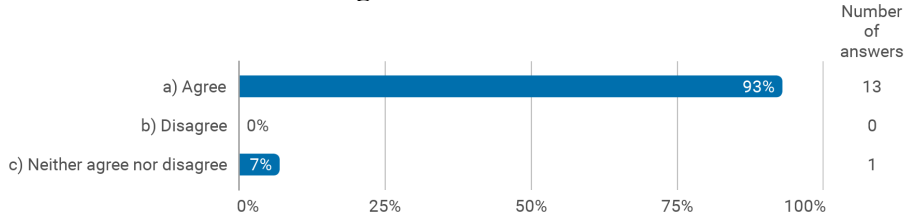
11. After working in pre-selected groups, I found that I communicated with the teacher:



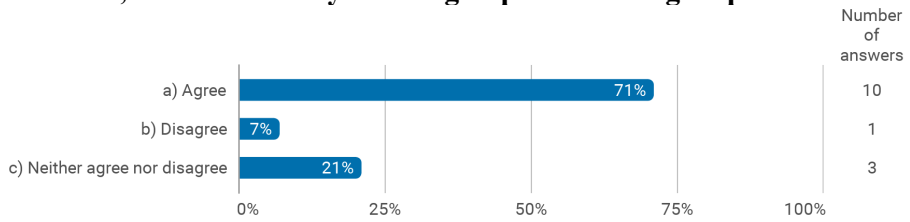
12. After my experience working in SAU1, SAU2, and SAU4 - I found that:



13. At this point in the course, I feel that when I leave at the end of each SAU class, I have a better understanding of the course material:



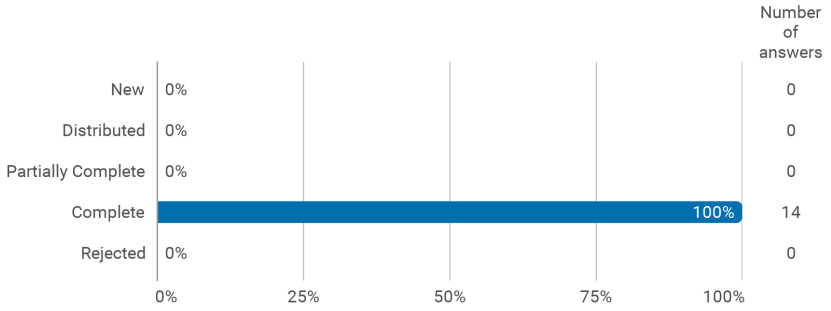
14. In the future, I would be okay working in pre-selected groups.



15. If you have any additional comments you would like to add, please write them here.

Sometimes we go through things a little fast
In terms of preparation in class. We have just finished a large course, with no free week after, which really has the ability to demotivate students in terms of doing work at home. That being said then the SAU have been useful and I haven't felt the need to prepare because of that
I feel like, I at least, work with very different people already, since it is just whoever is next to me. I don't fell like I gained anything by preselected groups and the assigning of groups is a little to much like being in a School room. And I don't like the hassel og moving or being told where to sit. It is not a problem for me persay , but I prefer not.

Overall Status:



(Complete responses from 14 out of 30 total students)