STUDENT PERSPECTIVES ON ONLINE HYBRID LEARNING IN AN UNDERGRADUATE ROBOTICS COURSE

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ABSTRACT

Many institutions in higher education worldwide are transforming classes into online courses, or into hybrid courses with students participating both physically in the classroom and digitally through video conferencing software. The latter is a growing trend for multi-campus institutions offering the same courses to multiple campuses. Hybrid courses with synchronous learning activities requires a careful balance when designing student-active learning methods between focusing on the students physically present in the classroom, and the students participating online. In this paper, a set of online hybrid student-active learning activities were implemented for a third year robotics course, and we present student perspectives on online hybrid learning collected from surveying students on what learning tools were perceived as useful for their learning. The results show that students generally appreciate how digital tools can activate students in online hybrid learning, and are especially positive to short lecturing videos, online interactive quizzes, and anonymous digital whiteboards for questions and comments. However, results also show that students do not rate online hybrid learning as equally good when compared to face-to-face lectures, and are ambivalent on whether they achieve the learning outcomes equally well through an online hybrid course design. We believe that the results presented in this paper can be of help to teachers designing student-active learning activities for online hybrid courses in general, and highlight some of the learning tools that students give good ratings as helpful for engaging a more student-active learning approach to hybrid engineering courses.

KEYWORDS

Online hybrid learning, Student-active learning, Digital learning tools, Standards: 7, 8, 10, 11

INTRODUCTION

The recent pandemic forced many institutions in higher education worldwide to transform traditional courses from physical face-to-face (F2F) courses into online courses. Also, in multi-campus universities offering the same courses to multiple campuses, there is a growing trend to create online hybrid courses (OHCs) where groups of students participate simultaneously in lectures either through physical F2F presence in the classroom, or through online participation using video conferencing software (Keengwe & Kidd, 2010). These OHCs require a careful balance when designing student-active learning methods between focusing on the students physically present in the classroom, and the students participating online.

Kyrkjebø (2020) proposed a guide to student-active online learning in engineering courses that highlighted the need to align the digital learning tools with the learning objectives, learning activities, and the evaluation methods used in the course. The author proposed a course design for an OHC in robotics, and gave recommendations for how to use different digital learning tools to enable student-active learning for students attending lectures either physically or online. The student-active online learning design was first applied to students in the year 2020 as an online course due to restrictions on students presence on campus due to the COVID-19 pandemic. Gradually, through the pandemic, students have been allowed back on campus, and the course design was applied to students as an OHC in 2021 and 2022. In this paper, we follow up on the proposed design of Kyrkjebø (2020) to show how some of the student perspectives on online and hybrid student-active learning have changed through the pandemic based on survey data collected from students in the years 2020, 2021 and 2022. We also analyse how some of the perspectives seem to indicate a more general opinion on digital tools for student-active learning.

In this paper, we use the term online hybrid learning (OHL) to describe learning methods with a mix of physical F2F learning activities and online (digital) learning activities. This is sometimes also referred to as blended learning. Learning activities can be a mix of synchronous learning activities (SLAs) and asynchronous learning activities (ALAs) (Goodyear, 2002). SLAs require that all students participate in the learning activities *at the same time*, and can also be hybrid SLAs – where some students participate F2F and physically in the same room as the lecturer, and some students participate online in the same lecture. Typical SLAs are real-time lecturing, supervision, discussions, lab exercises in groups, etc. On the other hand, ALAs allows students to take part in the learning activities at different times, and can also be a hybrid mix of using digital tools such as online lecturing videos, online quizzes, online simulations etc., and learning activities that requires a physical presence e.g. as self-supervised individual lab work.

The transformation from traditional lectures to online classes have for many universities been driven by the desire to become more competitive, but also to adapt higher education to a more diverse group of students (Keengwe & Kidd, 2010). Online learning have in some studies been reported to be preferred by students (Hannay & Newvine, 2006), and have also been regarded as more effective for large students groups. Recent political processes to create larger and more robust learning universities have also led to an increase in multi-campus universities where study programs and courses are delivered across campuses. While both pure online and hybrid courses, with a mix of physical and online activities, offer new opportunities to develop new methods in digital pedagogy (Hannay & Newvine, 2006), great care must be taken to ensure that online and hybrid learning does not allow students to become only passive participants in teacher-centred activities. Freeman et al. (2014) found that student-active learning, with more engagement from students in the learning process, is beneficial for learning, and can lead to lower fail-rates and higher examination scores. Wieman (2014) also supports this, and makes the claim that ”active learning methods achieve better educational outcomes”.

OHL can often encourage less motivated students to stay focused on the course, and to feel a greater sense of community, than in pure online courses (Olapiriyakul & Scher, 2006). Hannay and Newvine (2006) also found that some groups of students preferred online presence over physical presence in hybrid SLAs to better be able to balance learning with other commitments. Still, it is an open question whether the majority of students, when given the opportunity to participate either online or physically in SLAs, prefer physical or online participation.

Student perspectives on OHL have been studied in different works – both as perspectives from before the COVID-19 pandemic, and more recently during and towards the end of the pandemic. In Park (2011), students in a lab-based course on Construction management were exposed to 50/50 online and F2F activities. Students evaluated the hybrid approach as better than the traditional physical F2F approach. Students reported that OHL made students more self-responsible for their learning, and gave more flexibility of learning to suit individual students' preferences for learning style and needs. However, weaknesses in OHL was also reported as reduced contact opportunities with instructors, increased responsibility on students, and reduced class-interactions with their peers. Bruff, Fisher, McEwen, and Smith (2013) investigated how massive open online courses (MOOCs) could enhance traditional learning by a combination of online and F2F learning activities. Students regarded some elements positively, such as flexibility, customisation, accessibility and self-paced learning. Lack of alignment between online resources, and too little adaptation of the digital resources to take more advantage of the in-class components, were rated as negative aspects. Bruff et al. (2013) thus advocates for more complex forms of hybrid learning where the online course material is more customised for OHL. Nortvig, Petersen, and Balle (2018) presented a literature review of factors influencing e-learning and blended learning with respect to learning outcome, student satisfaction and engagement, and found that interaction with other students and instructors was the most important factor for learning. Interestingly, the review in Nortvig et al. (2018) found that no inherent features of either online, hybrid/blended or F2F learning activities produced either better or poorer learning outcomes for students, but that the learning outcome is instead very dependent on individual factors for each student.

Nikolopoulou (2022) investigated university students' opinions and preferences regarding F2F, online and hybrid modes of education shortly after the return to campus after the COVID-19 pandemic. The author found that students had positive perceptions of hybrid learning linked to the combination of the positive aspects of online learning (time and space flexibility) with the positive aspects of physical F2F learning (social interaction, ease of students' active participation). Hybrid learning was also regarded positive with regards to adaptability for working students, self-management of learning, and greater equality in education. Negative aspects of hybrid learning were often linked to difficulties in class organisation, a requirement for better teacher preparations, and a lack of familiarity with technology. Students in Nikolopoulou (2022) highlighted a future preference for both F2F and hybrid learning, where F2F learning was preferred in practical/lab activities, but online learning was preferred for more theoretical activities. The authors also report that student preparedness to adopt to OHL has increased during the pandemic. A limitation as stated by the author for the results presented in Nikolopoulou (2022) is that no quantitative data was collected, and that the analysis was purely descriptive.

In this paper, we investigate student perspectives and satisfaction with OHL in engineering for a course in robotics through quantitative and qualitative data collected through student surveys in the years 2020, 2021 and 2022. The paper presents and discusses results on overall satisfaction with OHL, overall satisfaction with digital tools used, and satisfaction with the use of short lecturing videos as ALAs, and with anonymous digital whiteboards and quizzes for hybrid SLAs. Student satisfactions when comparing OHL with F2F learning, and their evaluation of how well they could achieve the learning objectives of the course, are also presented. Lastly, student perspectives in the form of comments to different aspects of OHL are summarised and discussed, and some conclusions and recommendations for OHL are presented.

IMPLEMENTATION

Learning activities were implemented based on the recommendations of Kyrkjebø (2020) in a 10 ECTS course in robotics at the Western Norway University of Applied Sciences in Norway from 2020-2022. The course ran in parallel on two (2020) or three (2021, 2022) campuses, In this section, we provide a description of the learning activities and methods used in the course, and emphasise the hybrid approaches taken to learning for both SLAs and ALAs.

Synchronous learning activities

Lectures were scheduled two days a week for 2-4 hours a day with a maximum of 6 lecturing hours in total per week. Lectures alternated as physical F2F lectures and online hybrid lectures between campuses, where the lecturer was physically present at one campus teaching students F2F in a classroom, while also simultaneously making the lecture available online to students at other campuses, as shown in Figure 1. Online students could either participate together from physical classrooms at their campus, or as individuals from anywhere.

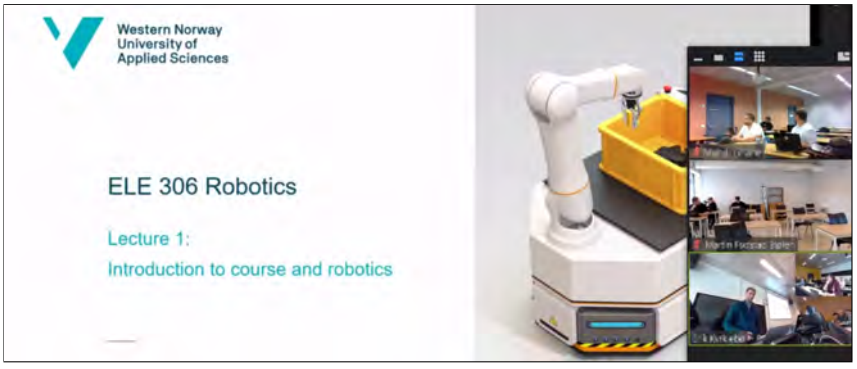

Figure 1. OHL with students participating in the same lecture from 3 different campuses (also as individuals online), and with video from all campuses.

Exceptions to the practice with the lecturer only being physically present at one campus was the first introductory lecture – where there was one lecturer present at each campus, and were each took turn presenting and lecturing from each campus within the same lecture. A limited number of lectures were also conducted as pure online lectures when circumstances did not allow the lecturer to be physically present at the scheduled campus (sickness, transport issues, etc.). A schedule for which campus would have a lecturer present physically, as well as all other relevant course information, was made available and kept up to date for students in a Learning Management System (LMS). In this particular course, Canvas was used as the LMS.

The scheduled lecture slots were used for all SLAs, and included traditional lectures, presentations, discussions, running through examples, quizzes, or project support sessions. In lectures, teachers used digital tools such as powerpoint-presentations or pdfs to go through parts of the curriculum. In discussions, teachers could ask students to reflect on today's curriculum individually before discussing in plenary, or to solve exercises that were followed by a discussion, and then the teacher showed the best way to solve the problem using a digital whiteboard. Quizzes using the software Mentimeter was used both to informally test students' learning achievements at the end of lectures, but also as a tool to explain theoretical concepts and their application to

real-world scenarios. A project counted for 25% of the grade in the course, and in addition to project lectures, online project support sessions were set up in some of the scheduled lecture slots where each project group could book meetings with the lecturers. The video conferencing software Zoom was used for all SLAs, and students could interact with the lecturer either through video and audio, through written messages in Zoom, or through the anonymous digital whiteboard flinga.fi (Flinga) for anonymous questions and feedback. Lecturers made a point of ensuring both good video and audio feeds for online students in the hybrid lectures. In parts of the course, the polling feature of Zoom was used to ask students about their expectations to the course, their preparations for today's topic (read material, watched short lecturing videos, or if they had tried implementing examples in simulations).

Asynchronous learning activities

The written learning material (Corke, 2017) was available to students either as a physical textbook, or as a digital book in pdf format. Students were encouraged to read chapters before the lectures. All of the topics covered in the book were also available as short lecturing videos (SLVs) to students – either made by the author of the textbook, or made by the lecturer teaching that particular topic when not available from the author of the textbook. Videos were made available to students either through the LMS, or on the homepage of the author of the textbook. Students were also encouraged to watch the SLVs before each lecture, or to choose either to read the material or to watch the videos. Most lectures thus did not go through all details of the topic, but instead focused on a summary repetition before more student-active learning activities such as quizzes, discussions or examples were started. Student were encouraged to use the LMS for asynchronous discussions under predefined topics. By request, a Discord-server with predefined channels (students were already familiar with and used this platform for other activities) were also set up to provide support with projects, simulations and implementations – mainly focused on solving problems involving code or software. Students also used the direct messaging (DM) feature of the LMS to contact lecturers outside of the scheduled SLAs.

RESULTS

Data was collected from students participating in the robotics course ELE306 Robotics at the Western Norway University of Applied Sciences in the fall of years 2020, 2021, and 2022. The curriculum for the course was the same for all three years, but the order of topics and lectures could vary slightly between years. Data on student satisfaction with online learning was collected through an anonymous survey using SurveyXact after the lectures and exams were finished. Students generally had one month to reply to the survey, and was reminded of the poll twice during this month. In this survey, students were presented with several claims for different aspects of digital learning, and asked to rate them on a five-point Likert scale from *strongly agree*, *agree*, *neither agree/disagree*, *disagree* to *strongly disagree*. The anonymous survey was sent only to registered students for the course, and 20 out 48 responded (41.7%) in 2020, 23 out of 81 (28.4%) in 2021, and 33 out of 79 (41.8%) in 2022).

Data on expectations to the course were collected through the anonymous polling feature in Zoom within the first week of the course, and were only collected from students participating in the synchronous hybrid lecture when it was given – where also students physically present in the classroom were encouraged to log on, and answer the poll online.

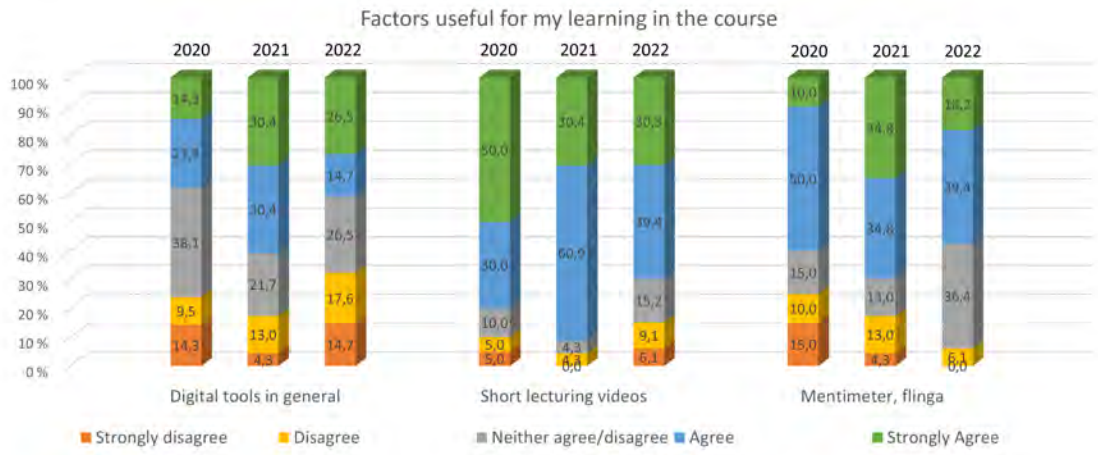

Figure 2. Overall satisfaction with use of digital tools in general (left), satisfaction with the use of SLVs (middle), and satisfaction with the use of Mentimeter and Flinga (right). Data shown for years 2020, 2021 and 2022 in each category. Respondents: 20 (2020), 23 (2021), 33 (2022).

Satisfaction with use of digital tools

Students were asked to rate their overall satisfaction with the use of digital tools in learning. Digital tools included both synchronous and asynchronous tools. Synchronous tools used were the video conferencing system (Zoom), digital whiteboards for writing, sketching and running through examples, standard presentation software (Microsoft Power Point or Adobe Acrobat PDFs), interactive presentation software (Mentimeter), anonymous whiteboards for student questions (Flinga), or polling features in the video conferencing system (Zoom). Asynchronous tools used were the LMS (Canvas), asynchronous SLVs made for the course, Discord-channels for support, and recorded lectures. The satisfaction of students with the use of digital tools in learning is shown to the left of Figure 2. Overall, positive satisfaction with digital tools (including *strongly agree* and *agree*) was 38.1% in 2020, 60.9% in 2021 and 41.2% in 2022, while negative dissatisfaction (*strongly disagree* and *disagree*) was 23.8% in 2020, 17.4% in 2021 and 32.4% in 2022. Of the respondents, 38.1% in 2020, 21.7% in 2021 and 26.5% in 2022 were neither satisfied nor dissatisfied with the use of digital tools in the course.

Students were also asked to rate their satisfaction with the use of SLVs as the most used asynchronous digital tools during the course. The satisfaction of students with the use of SLVs is shown in the middle of Figure 2. Overall, positive satisfaction with asynchronous SLVs (including *strongly agree* and *agree*) was 80.0% in 2020, 91.3% in 2021 and 69.7% in 2022, while negative dissatisfaction (*strongly disagree* and *disagree*) was 10.0% in 2020, 4.3% in 2021 and 15.2% in 2022. Of the respondents, 10.0% in 2020, 4.3% in 2021 and 15.2% in 2022 were neither satisfied nor dissatisfied with the use of asynchronous lecture videos during the course.

Students were also asked to rate their satisfaction with the use of Mentimeter and Flinga as synchronous interactive digital tools used during lectures. Mentimeter was used for interactive quizzes across students participating either physically or digitally in class, and Flinga used as an anonymous question board where both students participating physically and digitally could ask any question anonymously during lectures. The satisfaction of students with Mentimeter and Flinga is shown on the right in Figure 2. Overall, positive satisfaction with Mentimeter and Flinga

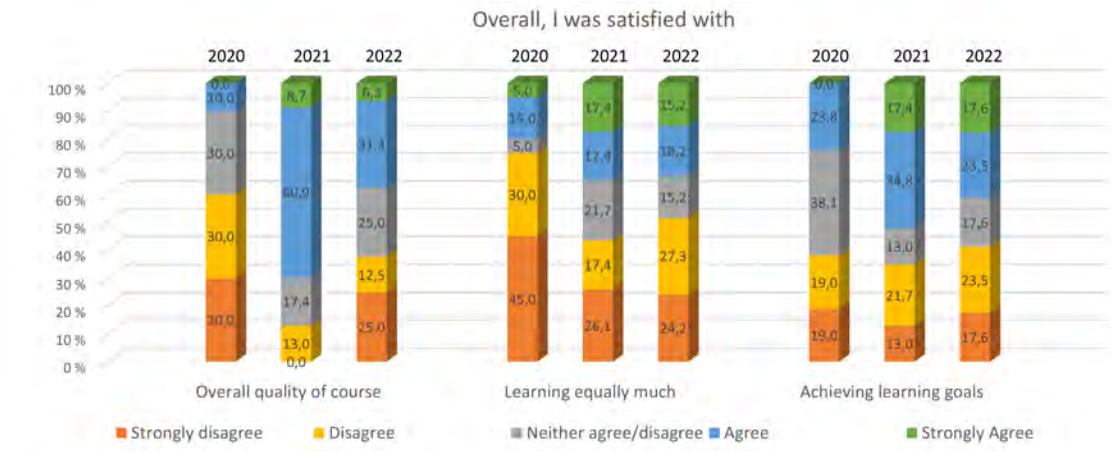

Figure 3. Overall satisfaction with the quality of the course (left), satisfcation with online learning compared to physical lectures (middle), and student satisfaction with achieving the overall learning goals of the course (right). Data shown for years 2020, 2021 and 2022 in each category. Respondents: 20 (2020), 23 (2021), 33 (2022).

(including *strongly agree* and *agree*) was 60.0% in 2020, 69.6% in 2021 and 57.6% in 2022, while negative dissatisfaction (*strongly disagree* and *disagree*) was 25.0% in 202o0, 13.0% in 2021 and 6.1% in 2022. Of the respondents, 15.0% in 2020, 13.0% in 2021 and 36.4% in 2022 were neither satisfied nor dissatisfied with the use of interactive digital tools during lectures.

Overall satisfaction with online hybrid learning

Students were asked to rate their overall satisfaction the course. The satisfaction of students with the course is shown on the left of Figure 3. Overall, positive satisfaction with the course (including *strongly agree* and *agree*) was 10.0% in 2020, 69.6% in 2021 and 37.5% in 2022, while negative dissatisfaction (*strongly disagree* and *disagree*) was 60.0% in 2020, 13.0% in 2021 and 37.5% in 2022. Of the respondents, 30.0% in 2020, 17.4% in 2021 and 25.0% in 2022 were neither satisfied nor dissatisfied with the quality of the course.

Students were also asked to rate their overall satisfaction with OHL as compared to only F2F lectures in the course, and if they felt that they had learned equally much with OHL as they would have with only F2F lectures. The satisfaction of students with OHL is shown on the middle of Figure 3. Overall, positive satisfaction with OHL (including *strongly agree* and *agree*) was 20.0% in 2020, 43.5% in 2021 and 33.3% in 2022, while negative dissatisfaction (*strongly disagree* and *disagree*) was 80.0% in 2020, 39.1% in 2021 and 51.5% in 2022. Of the respondents, 0.0% in 2020, 17.4% in 2021 and 15.2% in 2022 were neither satisfied nor dissatisfied with OHL compared to physical lectures.

Students were also asked to rate if they had achieved the overall learning goals of the course through the OHL format. The satisfaction of students on achieving the learning goals through OHL is shown on the right of Figure 3. Overall, positive satisfaction with achieving the learning goals of the course (including *strongly agree* and *agree*) was 23.8% in 2020, 52.2% in 2021 and 41.2% in 2022, while negative dissatisfaction (*strongly disagree* and *disagree*) was 38.1% in 2020, 34.8% in 2021 and 41.2% in 2022. Of the respondents, 38.1% in 2020, 13.0% in

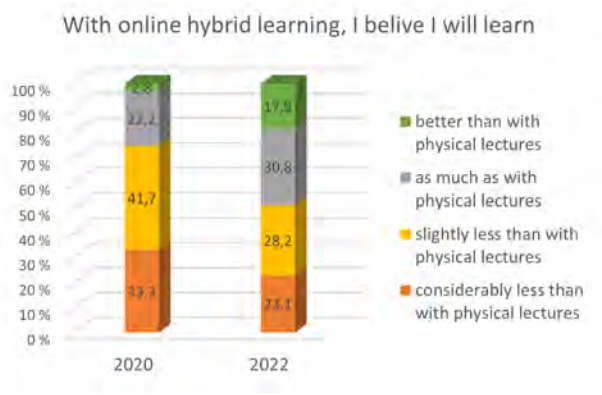

Figure 4. Expectations to OHL for students in year 2020 and 2022. Respondents: 36 (75.0%) in 2020, 39 (49.5%) in 2022.

2021 and 17.6% in 2022 were neither satisfied nor dissatisfied with how they could achieve the learning goals of through OHL.

Expectations to online hybrid learning

Students were also asked about their expectations to OHL through the anonymous polling feature in Zoom in the first week of the course as shown in Figure 4. Data for the year 2021 is regrettably not available. Of the respondents, 75.0% in 2020 and 51.3% in 2022 expected to learn less (including *considerably less* and *slightly less*) than with physical lectures, while 25.0% in 2020 and 48.7% expected to learn *as much* or *better* with OHL than with only F2F lectures.

Qualitative remarks to online learning

Students could also give written remarks to the OHL methods employed in the course. Relevant remarks have been anonymised and grouped, and are shown in Table 1.

Table 1. Statements from students to OHL

Statement	2020		2021		2022	
	Positive	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**
Online vs F2F	Good (1)	Prefer physical (2), Physical always better (1)		Too few physical lect. (1), Physical always better (1), Poor (1), No relationship with lecturers (1)	Very good (2), Allows for repetition (1)	Prefer physical (12), Poor (2), No relationship with lecturers (1)
Short lecture videos (SLVs)	Good (8), More (1)		Good (4), Positive (1)	Only for repetition (1)	Good (4), Activating (1)	
General use of digital tools	Good (4)			Can improve (1)	Good (4), Activating (1)	PowerPoint gives poor learning (4), No use of blackboard (1)
Use of Mentimeter	Good (2)		Fun way to learn (2)	Unnecessary (1)	Very positive (1), Good (1)	
Use of Flinga	Good (1)		Good (1), Fun way to learn (1)	Unnecessary (1)	Excellent (2)	
Use of Discord	*(not used)*	*(not used)*	Good (1)		Good (2), Excellent (1), Positive (1)	Long wait for replies (1)
No. of pos. and neg. comments	**16**	**3**	**10**	**8**	**23**	**21**

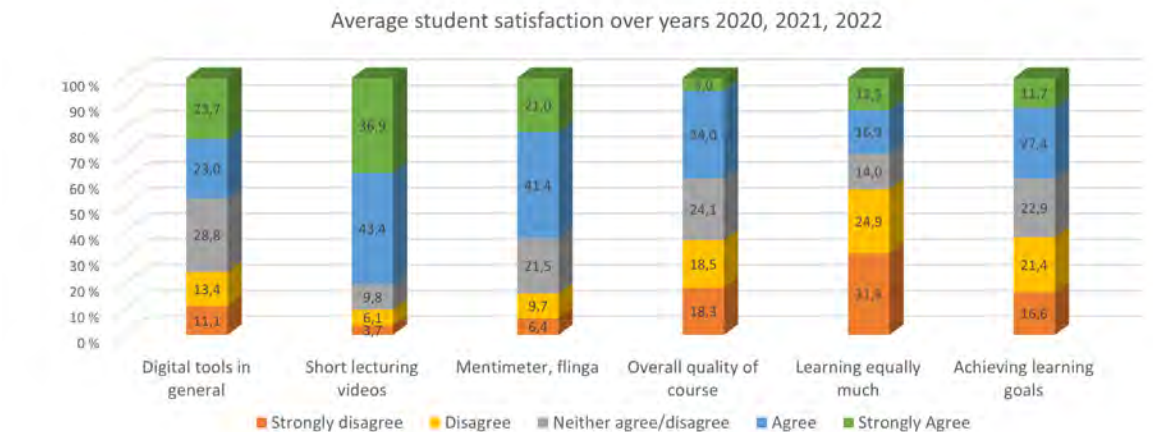

Figure 5. Average student satisfaction with OHL averaged over years 2020, 2021 and 2022 in each category.

DISCUSSION

Students were overall more positive than negative to the digital tools used in the course (46.7% vs 24.5%) when looking at averaged data over all three years as shown in Figure 5, and also very positive to the use of asynchronous SLVs (80.3% vs 9.8%) and to the use of the synchronous digital tools Mentimeter and Flinga during lectures (62.4% vs 16.2%). Students were, however, divided between being positive (39.0%) or negative (36.8%) to the overall quality of the OHC in Figure 5, and did not rate OHL equal to F2F lectures (29.4% positive vs 56.7% negative). Students were also divided with respect to achieving the learning goals of the course with OHL (39.1% positive vs 38.0% negative).

Students in the year 2020 were forced into an online learning situation by the COVID-19 pandemic and restrictions on social interactions, and had all of their SLAs online except for some physical lab sessions. Their expectations to OHL were low as seen in Figure 4, and only 25% expected to learn as much or better through OHL, while 75% expected to learn less than with F2F lectures. Students in 2021 had become more accustomed to the OHL format, and also received a third of lectures as F2F lectures due to the lift of restrictions on social interactions. Students seem to have accepted the situation of OHL, and responded consistently more positive on the use of digital tools in Figure 2 and on satisfaction with OHL in Figure 3 than students in years 2020 or 2022. Students in the year 2022 had higher expectations to OHL in Figure 4 than students in 2020, and also rated overall satisfaction with the quality of the OHL outcomes in Figure 3 more positively than in 2020. However, based on the number of negative remarks in Table 1, and also the lower positive rating of achieving overall learning goals to the right in Figure 3 in 2022 than in 2021 (41.2% vs 52.2%), there are indications of a polarisation among students between those who have come to appreciate the positive aspects of OHL, and those students that strongly prefer to go back to only F2F lectures. This can be supported by the results from Nortvig et al. (2018) where the learning outcome was seen to depend more on individual factors for each student than the inherent factors of the hybrid or F2F learning activities.

Students were overall more positive than negative to the use of digital tools during lectures. Short lecturing videos got very positive feedback on average (80.3%), but one student remarked

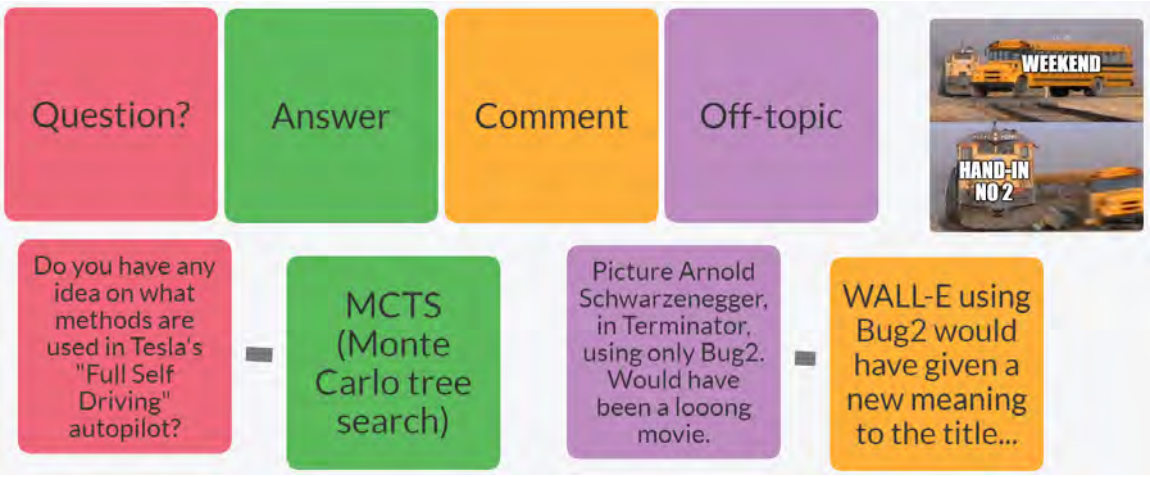

Figure 6. Example of Flinga anonymous discussion board from a lecture on mobile navigation (translated from Norwegian).

that the videos should only be used for repetition of material, and not for preparations (Table 1). Overall, videos were viewed as a very positive resource to the course, and also helpful in activating self-learning and making it easier to prepare for lectures. Mentimeter and Flinga as digital tools were also rated positively by students, and Mentimeter was described as a ”fun way to learn” and to be a positive student-active learning activity by students in Table 1. Flinga as an anonymous whiteboard for students to ask and comment anonymously was also rated positively by students. In some lectures, students took advantage of the off-topic category in the Flinga board as shown in Figure 6 to post memes commenting on the course, and had students laughing simultaneously at the same jokes across three campuses and across F2F and online attendance. The authors would also like to comment that online students became more active in discussions and in asking questions during lectures when Flinga was used for anonymous comments. However, one student remarked that similar features as Mentimeter and Flinga existed in Zoom, and that the use of additional tools was unnecessary. In 2021 and 2022, a Discord server was also set up to give support to students. This was overall positively rated by students from remarks in Table 1, but one student complained about having to wait too long before answers to questions were provided.

Overall, while students were positive towards the overall use of digital tools, they also remarked that there is room for improvement (Table 1), and that reading out loud from PowerPoint slides gives poor learning for students. Students remarked that they want more student-active learning activities in OHL, and that lecturers should use (digital) blackboards more in lectures to run through examples and exercises. This is also supported by the requirement for lecturers to prepare better for OHL found in Nikolopoulou (2022). However, students are also generally satisfied with the use of student-active digital tools such as Mentimeter and Flinga, which supports the recommendations in Kyrkjebø (2020). One of the biggest challenges with OHL for multi-campus courses is that the number F2F lectures are reduced for students at each campus, and they report in Table 1 that it is more difficult to establish a relationship with lecturers. These results are also consistent with the findings in Nortvig et al. (2018); Park (2011) where reduced interactions with lecturers is the most negative aspect of OHL. However, students also report, as in Nikolopoulou (2022); Nortvig et al. (2018); Park (2011), that time and space flexibility are very positive aspects of OHL.

CONCLUSION

The results presented in this papers suggests that there is still some way to go before OHL is evaluated as equal when compared to F2F lectures. In general, digital tools used for OHL are evaluated positively, and especially short lecturing videos and interactive tools such as Mentimeter and Flinga was evaluated as positive for student learning. However, students also reported that there is potential to make OHL activities even more student-active, and that lecturers need to take more care in preparing for student-active OHL activities than for F2F activities. Future work will look into how group projects can be even further developed to motivate self-supervised learning and more student-active learning strategies.

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