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Students' and teachers' perspectives**

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SHIFTING FROM BLENDED TO ONLINE LEARNING: STUDENTS' AND TEACHERS' PERSPECTIVES

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ABSTRACT

The Covid-19 outbreak forced many universities across the world to transition from a traditional or blended format to fully online education. This paper presents a case study on the transition to an online education format for a circular design course. Both quantitative and qualitative data were collected through a survey with 26 students and interviews with six course teachers. The findings revealed that students preferred the on-campus versions over the online course components. They indicated the perceived lack of motivation, lack of sense of community, and a high workload as influencing factors. Teachers indicated the lack of connection with students as a drawback to online education but identified advantages to their teaching and the student's learning experience. Suggestions for addressing an optimal blended course format are provided.

Keywords: Design education, Online learning, Circular economy, Case study, Covid-19

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1 INTRODUCTION

Sustainable design is increasingly becoming a core topic within design education. Both the fields of design education and sustainable design are continuously evolving. Traditional face-to-face classes are transitioning into fully online or blended learning settings with the development of digital information and communication technologies, resulting in web-based education tools for both distance and on-campus teaching (Holmberg, 2005).

When the Covid-19 pandemic struck in the early spring of 2020, many universities were forced to convert from on-campus or blended teaching methods to fully online education overnight (UNESCO, 2020). The Covid-19 lockdown in the Netherlands happened in March when many courses at the Delft University of Technology (TU Delft) were half-way through. While posing many challenges, the lockdown also created opportunities to reconsider the current approaches to education delivery.

The continuing growth of online teaching suggests that online course delivery formats will be used increasingly in higher education (Aslanian & Clinefelter, 2013). Many existing studies focus on the teaching and learning effectiveness and outcomes of blended and online learning. There is a lack of studies exploring, through case studies, what can be learned from the transition to a fully online format and assessing the benefits and disadvantages of online education components in comparison to on-campus education. Specifically, in the context of circular design education that requires a hands-on approach to teach students how to analyze and design products for a circular economy. The purpose of this paper is therefore to describe and evaluate a case study that involved the blended course Towards Circular Product Design at TU Delft in its overnight transition from blended learning to fully online education due to the Covid-19 measures. It compares students' and teachers' perceptions of both formats used within the course and the assessment methods that were applied, with the intent to further improve the course. In doing so, the following research questions were addressed:

1. How did students perceive their learning experience of different online and on-campus course components before and after the shift to online education?
2. How did students perceive the interaction with staff and other students after the shift to online education?
3. What differences did teachers perceive in their teaching experience and students' learning performance after the shift to online education?
4. Based on the above, what learnings can be obtained for the choice of online tools in a blended education format?

The study begins with a background on the different teaching methods, followed by a description of the case study course in its original blended format and the revised, fully online format.

Teaching methods: online, blended and traditional learning

Online learning is education at a distance, where a variety of digital tools can be used, such as computer-based learning, web-based learning, virtual classrooms, and digital collaborations (Urduan & Weggen, 2000). Another type of learning that has become increasingly relevant in teaching is blended learning (Capone et al., 2017), which involves both traditional classroom and technology mediated distant education delivery (Porter et al., 2015). In blended learning, face-to-face classrooms are usually combined with online learning tools, such as virtual classrooms, online trainings and other web-based study materials. The most recent development in distance education is Massive Open Online Courses (MOOCs) (Daniel, 2014). These are designed as standalone online courses, provided freely by universities around the world through MOOC platforms, such as EdX and Coursera (Kay et al., 2013). Although MOOCs were originally intended to be delivered as standalone online courses, parts of the course can be integrated into formal university courses (Voss, 2012), resulting in a blended learning format.

When comparing the learning outcomes and experiences of online learning, blended learning and traditional face-to-face learning, some studies found better learning outcomes for traditional courses (Xu & Jaggars, 2013, Trawick et al., 2010). Others found higher learning outcomes for online courses (Hart et al., 2019; Means et al., 2013), but the majority of studies indicated no statistically significant differences between course formats (Cavanaugh & Jacquemin, 2015; Stack, 2015; Ni, 2013). Traditional on-campus education offers physical and psychological components, such as an environment where warmth and caring are conveyed, which is positively related to students' motivation (Mullen et al., 2006). On the other hand, online classrooms are flexible in terms of time and place (Al-Qahtani & Higgins, 2013), which provides instructors with more time for on-campus sessions in blended settings

(Estévez-Ayres et al., 2015). While both online education and traditional on-campus education seem to have deficiencies, blended education has the potential to combine the most advantageous parts of both methods (Allison et al., 2012; Broadbent, 2017) and to offer increased effectiveness of learning, efficiency, and satisfaction (Graham, 2013).

2 CASE STUDY

2.1 The description of the course

This study evaluates the blended course ‘Towards Circular Product Design’, which is an elective offered in the third year’s third quarter (February-April) of the Bachelor’s Program Industrial Design Engineering at TU Delft. The course is designed to teach students the basic principles of a circular economy, covering subjects such as circular business models, (re)designing products for circular recovery strategies and evaluating the circularity of products. The course runs over 10 weeks and accounts for 7.5 ECTS (European Credit Transfer System). The course has always been rated positively by students. It has been running since 2014 with on average 60 students. In the academic year of 2019/20, 66 students participated.

The course is blended with the MOOC Circular Economy: An Introduction (Online learning TU Delft, 2020). The MOOC is led by TU Delft and has been co-developed with the Ellen MacArthur Foundation and the Leiden-Delft-Erasmus Centre for Sustainability. The MOOC explains the main principles of the Circular Economy, including design principles and business cases. The MOOC consists of seven modules, which contain video lectures, case interviews, quizzes and assignments.

The course content is divided into four themes that are delivered over eight weeks: an introductory week on circular product design, a three-week program about circular business models, a three-week program about circular recovery strategies, and a concluding week. In the tenth week a written exam takes place. In the original course format, course content was delivered via weekly on-campus lectures, each of two hours in length, focusing on theory about circular product design, demonstrating circular tools and giving instructions for the practicum sessions. The lectures were followed by four- to six-hour on-campus practicum sessions, during which student teams worked on assignments and received coaching from their coaches and support from lecturers. At the end of each practicum session, mini-presentations were held by some student teams and during the final practicum session, all student teams presented their work. The weekly workload of the course included 12 self-study hours to work on the week’s MOOC module, the group report and other homework, for which on-campus presence was optional. In the original setup of the course, students were assessed through two consecutive reports about business models and recovery strategies, an exam as well as a pass/fail for completion of the MOOC. Each report counted towards 25% of the final grade while the written exam was worth of 50% of their grade. TU Delft makes use of the digital learning portal Brightspace (d2l, 2020), where all information for a course is placed, such as the syllabus, course materials and announcements. Additionally, the Brightspace environment includes weekly plans, tests and a checklist to provide students with a clear overview of the weekly tasks.

2.2 The revised online course format

The course was in its fifth week when universities in the Netherlands were forced to switch to fully online education. Students had completed their business model reports in the fourth week and were working on the second of five assignments that made up the group report on recovery strategies. Within a few days, all on-campus course delivery had to be shifted to an online format from the sixth week onward. The lectures were replaced with online video lectures. These lectures were pre-recorded, reducing live interactions, and making them concise and shorter in length. The on-campus practicums were replaced by online practicums in a virtual classroom which students could optionally join for Q&A. Also, a discussion forum was set up for questions. The coaching sessions that took place during the practicums were replaced by pre-scheduled online coaching sessions. Taking into consideration the limitations of working from home, the course staff decided to keep the first two group assignments as they were, while the last three assignments were changed into individual assignments to be handed in as an individual report. This decision was made because the third, fourth and fifth assignments required students to dismantle and analyze the teardown process and

recyclability of a single product as a team, which was not feasible due to the Covid-19 measures. The written exam was canceled and replaced by a series of theory-related questions that related to the product the students had to dismantle and analyze because it was impossible to organize an online remote exam at such short notice. The increased time students spent resulting from the shift from team to individual report replaced the time they would spend on studying for the written exam. An overview of all on-campus course activities and how they were replaced in the fully online format, is shown in Table 1. The focus of this case study is to assess and compare the course activities that are replaced by an online component.

Table 1. Overview of course component replacements

| Original blended course format | | Revised fully online course format | |
|-----------------------------------|--|------------------------------------|---|
| Course component | Description | Course component | Description |
| Lectures | Weekly 2-hour on-campus lectures | Online video lectures | Short instructional videos accessible through Brightspace |
| Practicum sessions | Weekly 6-hour studio sessions for coaching & presentations | Online Q&A sessions | Virtual Q&A classroom with experts (optional) |
| | | Online discussion forum | Brightspace tool to ask questions, visible to all students and teachers |
| | | Online coaching | 1/2h skype meetings/team/week |
| Self-study & optional studio work | Q&A with available course staff | Self-study from home | |
| Second team report | Consisting of 5 team assignments | Individual report | Consisting of 2 team assignments, 3 individual assignments and 7 theory related questions as replacement for the exam |
| Written exam | Covering lectures and study materials | | |

3 METHOD & APPROACH

This section explains the method, setup and analysis of the research process. To better understand how students perceived the shift to a fully online course format, quantitative and qualitative data were collected through a survey. Simultaneously, interviews were conducted with course teachers to gather qualitative data on their perspectives of this shift. Both were conducted shortly after the end of the course.

3.1 Evaluation survey: setup and data analysis

The survey was sent through e-mail and a Brightspace announcement to all 66 students who participated in -and completed- the course. Participation in the survey was voluntary and it was available from April 17th to May 15th 2020. The survey comprised of five open-ended questions and five questions that were measured on five- and ten-point Likert scales and matrix questions. The questions focused on students' experiences of the different course components in the blended and online formats of the course. The questions included perceived contribution of course components, teaching elements, involvement and interaction in the original and fully online formats of the course. The evaluation of teaching elements was based on TU Delft's pedagogical model for online and blended education: The Online Learning Experience (Jorge et al., 2016). The model defines design principles for a successful online or blended course, namely: flexible (in time, space & content), diverse (activities, resources & assessment), inclusive (accessible, cultural & gender), supportive (guidance & feedback), interactive (learner-learner/teacher/content), active (learning by doing), contextual (real-world situations & problems) and innovative (new tools, strategies & insights).

The data was collected in Google sheets. Closed-ended questions were analyzed by calculating the frequency distribution, using Microsoft Excel, after which the data was converted to graphs. The open-ended questions were analyzed by identifying patterns in the opinions of students. This data was grouped into positive and negative perceptions of the shift to online learning.

3.2 Staff interviews: setup and data analysis

Semi-structured interviews were conducted with the teaching staff to obtain insights from their perspective on the shift to fully online education. Six out of nine course staff members were interviewed, namely the course coordinator and five teachers. The interviews were conducted via Skype meetings. They were held between May 6th 2020 to May 14th 2020 and lasted between 18 and 36 minutes. Answers were recorded by an audio recorder with consent.

A semi-structured interview setup was chosen based on the following four questions: (1) What can you tell about your support towards students in the original and revised online formats of the course? (2) What can you tell about the difference in the interaction between you and students before and after the switch to online education? (3) Do you think students learned and performed better in the online format? (4) What did you like in the online format, what not?

A thematic analysis was performed on the outcomes of the interview. The coding process focused on the opinions of teachers regarding interaction with students, the performance of students and the teachers' perception of the online course format. As a result, eight themes were identified.

4 RESULTS

This section highlights the results from the survey with students and the interviews with teachers. The results indicate recurring themes in how students and teachers perceived the learning experience and interaction in the original and revised online formats.

4.1 Students' feedback on the shift to online education

The survey was completed by 26 students. The results were compiled into two categories. First the overall perception of students on both course format and the different course components and teaching elements are shown, followed by their perception on the interaction in the online course format.

4.1.1 Impact of online education on the learning experience

Figure 1 shows how students rated the course in the fully online format, compared to the original blended format.

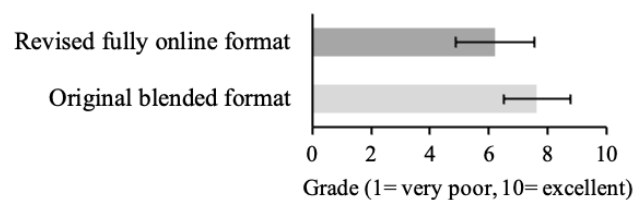


Figure 1. Comparison of students' ratings of the blended and online course formats

Of the students that gave comments in the open question on which of the new online course components they would choose to keep or disliked in the course (N=17) the most prevalent positive aspects were: the short video lectures (N=4), the Brightspace discussion forum (N=4), and the theory related questions as a replacement for the exam (N=3). The course components they disliked about online education were: the individual report (N=8) and working from home/the absence of human contact (N=3). Figure 2 shows a plot of the perception of students on the course components. The vertical black line indicates a neutral stance. The majority of students perceived the online versions of the activities to support their learning experience less.

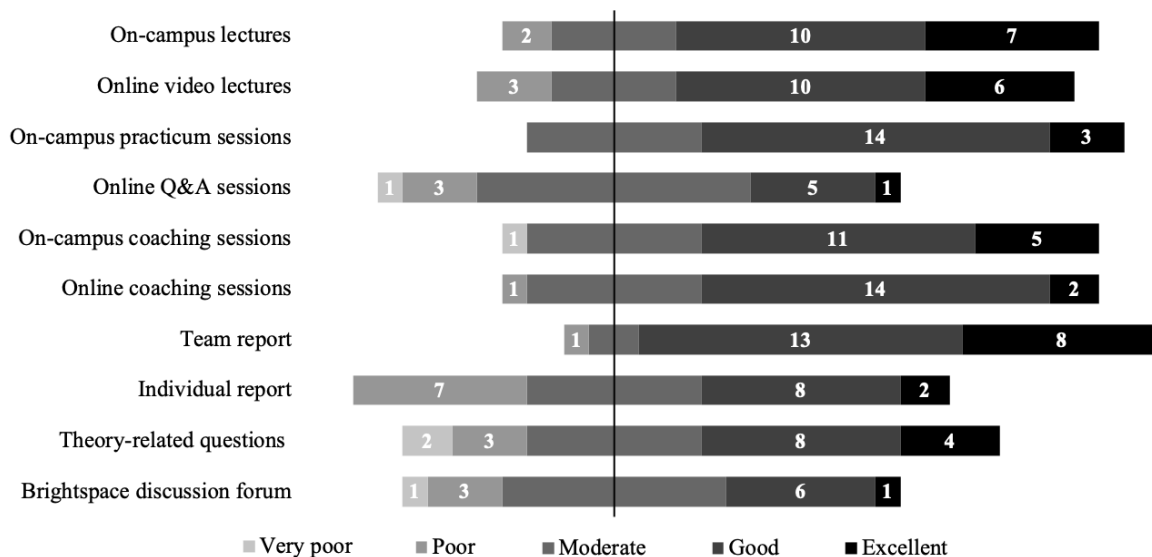


Figure 2. The contribution of course components to students' learning experiences

Most students rated the individual report as poor compared to the well-perceived team report from the original format. They motivated their choice by explaining the high workload that they perceived due to the shift from team to individual work: “The individual report was just too much for one person to do on their own”.

A comparison of the different teaching elements in both education formats revealed that all teaching elements were perceived as ‘slightly worse’ or ‘much worse’ in the online set-up (see Figure 3).

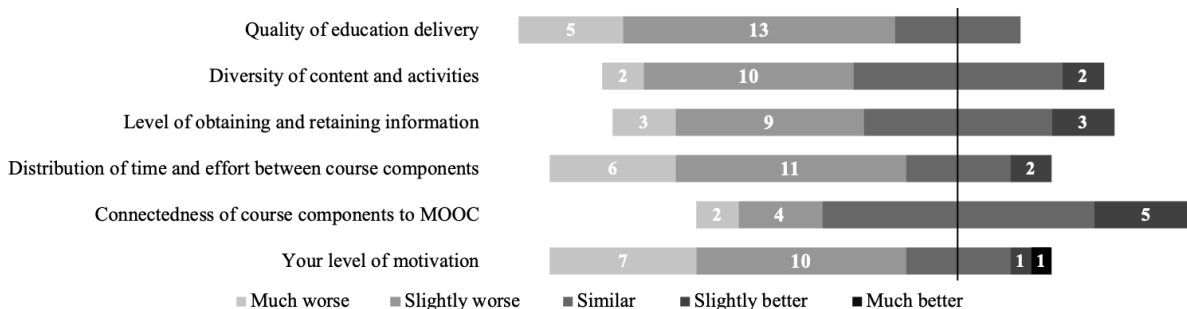


Figure 3. Students' perceptions on online teaching elements compared to the original format

Figure 4 shows the extent to which students agree with statements regarding the online course components. Students’ opinions differed on whether they had learned more or less through online or on-campus education. This did not necessarily relate to the online nature of education: “Also, in group work, you divide tasks while now you have to do all the tasks, so you learn more.” Despite the overall negative perceptions of online education, most students agreed that more courses should switch to a blended or online structure.

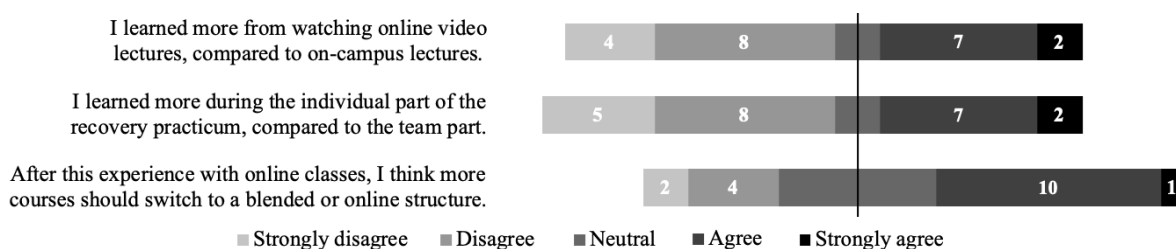


Figure 4. Students' opinions on statements regarding their learning experience

4.1.2 Interaction in an online course format

The social elements; the sense of community and the interaction with other students are rated worst compared to the original format of the course (see Figure 5).

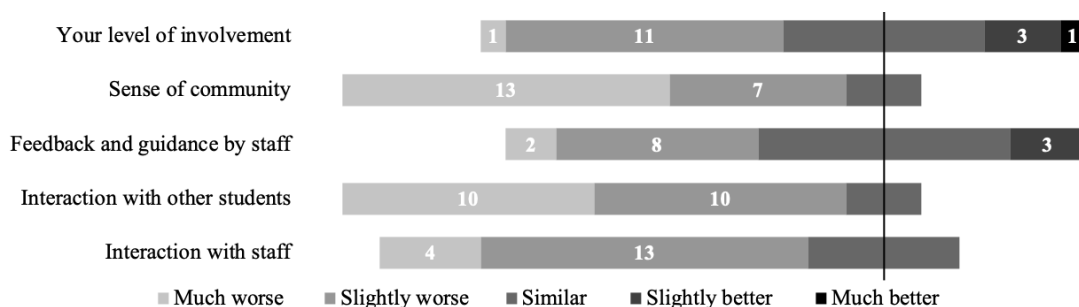


Figure 5. Students' perceptions on social elements compared to the original format

The majority of students who commented, mentioned that the lack of social contact with other students and staff and the missing sense of community affected their motivation and learning experience negatively: *“The online education was good, but it can never compare to the motivation, energy and learning experience you get from interacting with people in person.”* Some students mentioned the online contact moments to be limited and that they felt *“disconnected”*: *“I lost connection with the rest of the staff apart of my coach”*. Most participants rated the interaction and involvement in the online course activities poorly, compared to the on-campus activities: *“Working on this course on my own gave me little / no pleasure, which made it very difficult for me to motivate myself.”*

4.2 Teachers' feedback on the shift to online education

The themes identified in the interviews with six teachers of the course were grouped into three overarching themes, namely related to the interaction with students, the students' learning performances, and the online teaching activities. They are explained in more detail in this section.

4.2.1 Interaction with students

Feeling of connectedness

Most teachers found the interaction with students ‘different’, not necessarily better or worse. The main limitation teachers experienced was the lack of opportunity to observe student teams in action. T6: *“So, during on-campus activities, you can see who’s struggling, they can come to you. You can also see individuals who have problems, you can see group dynamics, which you cannot see to that extent when you are online.”* Most teachers mentioned feeling more disconnected compared to the on-campus practicum sessions; some found that turning cameras on and using screen sharing was helpful.

Quality of coaching

Teachers asked their students to prepare slides to present their progress for the online coaching sessions. Compared to the on-campus practicum sessions, most teachers saw an increase in the quality of their conversations with students, which might have to do with the relatively one-on-one and ‘no place to hide’ nature of online meetings. Three teachers mentioned having planned extra online meetings on request by several students, who either could not attend the planned coaching sessions or wanted additional support. One teacher perceived an improved connection with the group who joined the extra online coaching sessions, even compared to the on-campus conversations. She could remember the names and work of students better. T1: *“For the student who made use of that [extra meetings], I felt that I could coach better and I felt more connected with them.”* Another teacher also found that extra coaching sessions had a positive impact on students. Some teachers missed the ability to consult other teachers or refer to the work of other student groups.

Engagement of students

Teachers mentioned having received more questions from students during the online coaching sessions, compared to the on-campus sessions. Working from home increased the online availability and flexibility of teachers to support their students online. This lowered the barrier for students to approach

teachers more conveniently via e-mail. The downside of online coaching was that it sometimes required more effort to keep students engaged. Also, the optional online Q&A sessions were less visited.

4.2.2 Students' learning performances

Effects of individual work

All teachers recognized that the individual differences in the quality of work of students became more noticeable after the shift to online education. This was mainly the result of the shift to individual work and therefore no statements could be given regarding the influence of the shift to online education on the performance of students. Teachers felt that students learned more because they had to work on the assignments individually. They also noticed a decrease in quality in the overall results of the individual work. Most teachers agreed that students would benefit from more in-depth knowledge in a team or with the presence of other students. T3: *“Since they were doing individual work, the students would not be able to discuss ideas with anyone else”*.

Challenges of learning from home

A challenge mentioned by some teachers was that the third assignment required students to dismantle a product. Not all students had tools, but many solved this by borrowing tools. T2: *“It was a group assignment. Students have to dismantle a product, they need tools, and this may not be possible at all [in a lockdown]. Well, apparently it is possible if you have to.”*

4.2.3 Online education activities

The value of online course components

Most teachers were satisfied with the way online education worked out in general. All teachers agreed that video lectures could not replace on-campus lectures but most found the video lectures to be a valuable addition. T2: *“It is so difficult to put into words what the added value of being there physically is, regardless of whether it is cozy or not. (...) You convey them a kind of energy and [with online teaching] you have a kind of interaction that is missing”*. All teachers perceived the discussion forum on Brightspace as very beneficial. One teacher mentioned that it has the added value of being useful as a Q&A database for next year's course. T2: *“Normally [during on-campus activities] you walk around and answer questions, but you don't keep track of that”*.

Barriers to online teaching

Two teachers missed the plenary on-campus presentations by students in the online format because they felt a lot of collective learning occurred there, and one missed not being able to sketch ideas to think along with students. Some teachers missed being able to have informal chats with other teachers to exchange experiences.

Required effort

Most teachers mentioned to have spent more effort and time to support students after the shift to online education, e.g. due to addressing student problems, answering more questions through e-mails, spending time on the discussion forum, and planning additional meetings with students and other teachers. Most teachers perceived more structure in the online coaching sessions: there were fixed time slots and most students came well prepared, which led to effective conversations.

5 DISCUSSION

There are several relevant learnings from this case study. Despite the considerable efforts of teachers to connect with students through digital means, teachers and students highlighted how the lack of physical presence and interaction had a negative effect on the motivation and energy of students. The online Q&A sessions were not visited by many students, and paired with the change to individual work, students lost the ability to discuss insights and learn from other students. On the other hand, using video calls and screen sharing increased the feeling of connectedness from the teachers' perspective. While the majority of students disliked the shift to individual work in an online setting, teachers felt it contributed positively to students' learning experiences, because more students engaged actively. One teacher mentioned that students who performed well in the group setting, out-performed their team members in the individual setting. This may be related to the finding of [Cavanaugh & Jacquemin \(2015\)](#), where students with

higher Grade Point Averages (GPAs) will perform better in online courses, while struggling students perform worse when taking courses in an online format, compared to a traditional format. Students of this course seemed less positive about the shift to online education than other students from the same faculty. Industrial Design Engineering bachelor students rated the quality of online education in quarter three as good as their original format in a survey (N=343), (Pouw, 2020). One reason for the negative responses in our course could be the students' perceived high workload (moving from team work to individual work). Additionally, the formats chosen for students to interact with each other and with the teachers may not have worked optimally. Social elements were identified as key factors that influenced the perception of students and teachers in the online course format. A study by Priego & Peralta (2013) found that promoting socialization in an online course, increased students' engagement and motivation, and that the involvement of educators in a virtual environment, positively influenced learners' attitude towards the course. It is remarkable that despite the overall negative perception of the online version of the course, most students agreed that more courses should switch to a blended or online structure. In conclusion, this case study confirms that for this course, blended learning offers an advantageous combination of on-campus and online learning (Allison et al., 2012; Broadbent, 2017).

The limitations of this case study are that it is based on an evaluation survey with 26 students and interviews with six staff members and is thus a relatively small sample. Additionally, it compares two different parts of the same course, but at different stages. The changes did not only concern the shift to online education, but also the shift from team to individual work. Lastly, the abrupt transition to a fully online course delivery format, the uncertainty caused by the virus, the social restrictions, and being required to work from home, may have influenced the outcome.

6 CONCLUSIONS

This study evaluated the transition from blended to fully online education for the elective course 'Towards Circular Product Design'. Due to its blended nature, the transition to a fully online format during Covid-19 lockdown was expected to go relatively smoothly, but our findings revealed that the development of online learning is a complex process that requires time and careful planning. Teaching elements such as a diversity of activities in an online setting and the creation of a sense of community could have been incorporated better. While in retrospect students wanted to keep some elements of the online version, such as the short video lectures, they had a strong preference for the on-campus versions of most course components.

In the future we expect many courses to start incorporating 'the best of both worlds': combining online and on-campus teaching in the most pleasant and effective way possible. For such blended courses, we have the following recommendations:

Short instructional video lectures, interactive Q&A and discussion sessions, and online discussion forums, in combination with live on-campus hands-on activities, seem to offer the most benefit in a blended course format.

Maintaining socialization in online learning is important. Even if an assignment requires individual work, a group 'feel' can be facilitated in an online setting through presentations, plenary discussions and peer-review assessments.

Hands-on design practicums require on-campus presence for optimal results, but we learned that these too can be shifted to a blended format: shorter (max 2-hour) on-campus practicum sessions, combined with additional online coaching sessions at a later date, allow students to more effectively present and discuss their work with their teachers. The fixed timeslots of the online sessions (as opposed to the more fluid and informal coaching that takes place on campus) means that most students come well-prepared, which increases the quality of conversations, and as a result, the support of the teachers.

REFERENCES

- Allison, C., Miller, A. H. D., Oliver, I. A., Michaelson, R., & Tiropanis, T. (2012). *The Web in Education. Computer Networks*, 56(18), pp. 3811–3824. <https://doi.org/10.1016/j.comnet.2012.09.017>
- Al-Qahtani, A. & Higgins, S.E. (2013) Effects of traditional, blended and e-learning on students' achievement in higher education. *Journal of Computer Assisted Learning*, 29(3), pp. 220-234. <https://doi.org/10.1111/j.1365-2729.2012.00490.x>
- Aslanian, C.B. & Clinefelter, D.L. (2013). *Online college students 2013: Comprehensive data on demands and preferences*. Louisville, KY: The Learning House, Inc.

- Broadbent, J. (2017). Comparing online and blended learner's self-regulated learning strategies and academic performance. *The Internet and Higher Education*, 33, pp. 24–32.
<https://doi.org/10.1016/j.iheduc.2017.01.004>
- Capone, R., Caterina, D.P. & Mazza, G. (2017). Blended Learning, Flipped Classroom and Virtual Environment: Challenges and Opportunities for the 21st Century Students, *Proceeding of EDULEARN17 Conference 3rd-5th July 2017, Barcelona, Spain*. ISBN:978-84-697-3777-4, pp. 10478-10482.
- Cavanaugh, J.K., Jacquemin, S.J. (2015). A Large Sample Comparison of Grade Based Student Learning Outcomes in Online vs. Face-to-Face Courses. *Journal of Asynchronous Learning Network*, 19(2).
<http://dx.doi.org/10.24059/olj.v19i2.454>
- D21 (2020). Brightspace for Higher Education. Available at: <https://www.d21.com/higher-education/products/>
- Daniel, J. (2014). Foreword to the special section on massive open online courses MOOCs: Evolution or Revolution? *Journal of Online Learning and Teaching*, 10(1), pp. i-iv.
https://jolt.merlot.org/vol10no1/daniel_foreword_0314.pdf
- Estévez-Ayres, I., Alario-Hoyos, C., Pérez-Sanagustín, M., Pardo, A., Crespo-García, R.M., Leony, D., Parada, G.H.A., Delgado-Kloos, C., (2015). A methodology for improving active learning engineering courses with a large number of students and teachers through feedback gathering and iterative refinement. *Int. J. Technol. Des. Educ.* 25, pp. 387-408. <http://dx.doi.org/10.1007/s10798-014-9288-6>.
- Graham, C. R. (2013). Emerging practice and research in blended learning. In M. J. Moore (Ed.), *Handbook of distance education* (3rd ed.), Routledge, New York, NY, pp. 333–350.
- Hart, C.M.D., Berger, D., Jacob, B., Loeb, S., Hill, M. (2019). Online Learning, Offline Outcomes: Online Course Taking and High School Student Performance. *AERA Open*, 5(1). DOI:
<https://doi.org/10.1177/2332858419832852>
- Holmberg, B. (2005). The evolution, principles and practices of distance education Vol.11. Oldenburgh: B/S-Verslag der Carl von Ossietzky Universitat, ISBN 978-3-8142-0933-3
- Jorge, N., Valkenburg, van W., Dopfer, S. (2016). The TU Delft Online Learning Experience: From Theory to Practice. Re-Imaging Learning Environments. *Proceedings of the European Distance and E-Learning Network 2016 Annual Conference*, Budapest, 14-17 June 2016. ISBN 978-615-5511-10-3.
- Kay, J., Reimann, P., Diebold, E., Kummerfeld, B. (2013). MOOCs: So Many Learners, So Much Potential ..." *IEEE Intelligent Systems*, 28(3), pp. 70-77. <https://doi.org/10.1109/MIS.2013.66>
- Means, B., Toyama, Y., Murphy, R., Bakia, M., (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, 115(3), pp. 1-47.
- Mullen, G.E., Tallent-Runnels, M.K. (2006). Student outcomes and perceptions of instructors' demands and support in online and traditional classrooms. *The Internet and Higher Education*, 9(4), pp. 257-266.
<https://doi.org/10.1016/j.iheduc.2006.08.005>
- Ni, A.Y. (2013). Comparing the Effectiveness of Classroom and Online Learning: Teaching Research Methods. *Journal of Public Affairs Education*, 19(2), pp. 199-215 <http://dx.doi.org/10.1080/15236803.2013.12001730>
- Online Learning TU Delft (2020). Circular Economy: An Introduction. Available at: <https://online-learning.tudelft.nl/courses/circular-economy-design-and-technology/>
- Porter, W.W., Graham, C.R., Spring, K.A., & Welch, K.R. (2014). Blended learning in higher education: Institutional adoption and implementation. *Computers & Education*, 75, pp. 185–195.
<https://doi.org/10.1016/j.compedu.2014.02.011>
- Priego, R. G., Peralta, A. G. (2013). Engagement factors and motivation in e-Learning and blended-learning projects. *Proceedings of the First International Conference on Technological Ecosystem for Enhancing Multiculturality (TEEM '13)*, Salamanca, Spain, November 2013, pp. 453-460.
<https://doi.org/10.1145/2536536.2536606>
- Pouw, P (2020). *Findings of evaluation emerging remote education at IDE*. Concept Report. Faculty of Industrial Design Engineering, Technical University of Delft.
- Stack, S. (2015). Learning Outcomes in an Online vs Traditional Course. *International Journal for the Scholarship of Teaching and Learning*, 9(1). <https://doi.org/10.20429/ijstl.2015.090105>
- Trawick, M.W., Lile, S.E., Howsen, R.M. (2010). Predicting performance for online students: is it better to be home alone? *Journal of Applied Economics & Policy* 29(1), pp. 34-46.
- UNESCO. (2020, March 13). *COVID-19 educational disruption and response*. Available at:
<https://en.unesco.org/themes/education-emergencies/coronavirus-school-closures>
- Urdan, T. A., & Weggen, C. C. (2000). *Corporate e-learning: Exploring a new frontier*. WR Hambrecht Co.
- Voss, B. (2012). What Campus Leaders Need to Know About MOOCs. *An Educause Executive Briefing*.
<https://library.educause.edu/resources/2012/12/what-campus-leaders-need-to-know-about-moocs>
- Xu, D., Jaggars, S.S. (2013). The Impact of Online Learning on Students' Course Outcomes: Evidence from a Large Community and Technical College System. *Economics of Education Review*, 37, pp. 46-57.
<http://dx.doi.org/10.1016/j.econedurev.2013.08.001>