

Academy of Skills: Evaluating the potential of learning a practical skill by means of a (massive) online open course.

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ABSTRACT

Massive Online Open Courses (MOOCs) are mostly focused on theoretical knowledge leaving a gap in supporting the development of practical skills. The research evaluates the online learning of the practical skill of cardboard modeling by evaluating various ways of being taught this practical skill. The research aims to answer the extent to which a normal class in learning a practical skill can be replaced with the Academy of skills or a hybrid between online and in-class education by means of pros' and cons' for each way of learning based on the learning experience of students. Results regarding the quality of the models' indicate that the in class results are of better quality. Looking at the pros' and cons' of all three ways it can be concluded that the Academy of skills still needs some tweaks before being able to replace a regular class including the meaningful discussions and quality in feedback. Nevertheless both online manners of teaching show potential for education.

INTRODUCTION

MOOCs are becoming ever more popular. With 58 million students following courses from over 700 universities worldwide, online education is big. The database of available courses keeps growing and currently there are more than 6850 courses available. [1] These massive online open courses make education, provided by some of the best universities in the world, accessible for a wide public all over the world. That MOOCs work is proven by the options to receive certificates, college credit or even full degrees. [2] With college credit being offered for certain courses the MOOC replaces some regular courses already. [3]

The main reasons of interest in MOOCs are enhancing the reputation of the institution, engaging alumni, recruiting new students for fee-based degree programs, internationalizing place-based courses and trying new pedagogies, using the learning analytics for improvements to the course design. Next to this it opens up the option to replace traditional learning management systems and have course administrators run the courses. This usually frees up time for professors to create new content, add depth, do research or have more valuable physical meetings. [4, 5] Parts of a MOOC can improve efficiency of learning while in a classroom already. A hybrid of a MOOC and a normal classroom is the "flipped classroom model". Students are given videos and articles before each class and instead of lectures the class can have valuable discussions. The research done around this model is positive and even shows that students scored better during their final exams compared to the regular course. [6, 7] Students following a mostly theoretical MOOC or a hybrid version: "the flipped-classroom setting" also prefer this way of being taught theoretical knowledge for convenience reasons and the desire to watch videos at a different pace. [3]

MOOC courses are mostly focused on theoretical knowledge leaving a gap in supporting the development of practical skills that are not in the field of programming and computer skills [5]. NTNU professor Erik Severinsen argues that the MOOC is still struggling in the field of practical education

and that the MOOC as we know it today cannot handle the education of practical skills in Design and Product in the way it is given at NTNU. With this being due to the lack of ways to assess a practical skill, the lack of active discussion options and lack of access to machines. [4]

These same problems are seen when looking at the manner in which Industrial Design students are educated at Eindhoven University of Technology. The programs' focus on the development of competencies, or process, rather than final product (a focus on practical skills and process) [9, 10] creates problems with the ways current MOOCs are assessed (a focus on theoretical knowledge and end result).

By following similar argument as Severinsen, a platform to learn practical skills, online, is designed: The Academy of Skills.

The purpose of this research is to evaluate the online learning of a practical skill by evaluating various ways of being taught the practical skill of cardboard modeling. The research aims to answer the extent to which a normal class in learning a practical skill can be replaced with the Academy of skills or a hybrid between online and in-class education by means of pros' and cons' for each way of learning in different situations. Secondly it tries to answer what elements of the Academy of Skills and this hybrid form of education are essential in a possible replacement of a normal class and why they are essential. Lastly a recommendation will be made for improvements to the Academy of Skills platform.

RELATED WORK AND THEORY

Open colleges

Open colleges is an online platform offering paid courses including practical building and construction courses. To complete such courses students are asked to work on a simulated construction project. To learn,

students watch video tutorial. Next to that they get access to software support tools to learn basic physics and math concepts that need to be understood. Students are required to participate in online discussions, create and deliver documents for assessment and deliver pictures, audio and video files. Course participants are required to find a workplace or construction site with access to specific tools, to work on the simulation project, by themselves. Student work, that is admitted online, is assessed by an expert. [11]

Sketchdrive

Sketchdrive is a platform to easily give and get visual feedback on drawings. Sketches can be filed into folders and feedback can be given by drawing directly on top of the student's work. The feedback is given by means of drawing because good critique on visualization can be lost in translation. In other words, words aren't enough when critiquing visualizations. Sketchdrive can be used by professionals or students that create their own work folders and invite peers to join the folder. Everyone that has access to the folder can upload drawings to give feedback on and everyone can give feedback to others. Next to that Sketchdrive offers courses by means of video tutorials. Students can enroll to self-study, getting access to the videos; or buy a feedback plan, which means getting access to the videos and getting expert feedback on the drawings made during the course. Both, the only tutorials version and the tutorials plus feedback version are paid. [12]

YouTube tutorials

Many channels on YouTube produce vlogs and tutorials ranging from make-up tutorials and laundry folding tutorials to self-defense tutorials and learning foreign languages tutorials [13]. Videos on YouTube can be made by amateurs or professionals. Tutorial vlogs often give spontaneous talks rather than reciting a script. Because of the text facility enabling viewers to post comments; the site offers evidence of a vast and international community and also enables conversation between viewers and tutorial makers. [14] The use of YouTube is free.

Delft design MOOCs offered on edX.

The Technical university of Delft offers a few online courses on Design and product design. They differentiate their online offering in MOOCs which are free, online academic courses which are for credit and professional education courses. Most of these courses are theoretical and teach strategical business design strategies rather than practical skills. [15] There is however one course offered in making digital and physical architecture models. This course requires participants to create a simple scale model for their dream house using scrap materials and simple tools like scissors and glue, taking pictures of their final models with their smartphone camera to digitalize the model. Further on in the course participants will create this model digitally using free software. In the course students give each other feedback taking on the role of the client while giving peer feedback on each other's work as architect. The course and all materials are free; a certificate to verify student achievements can be pursued for an additional fee. [16]

Instructables

Instructables offers courses with step by step instructions for practical skills and small (non-mandatory) multiple choice quizzes about your knowledge for free. The step by step instructions are in written text and are sometimes paired with an image. When enrolled in a course you are enabled to ask questions to the course administrator which are posted on a 'wall' underneath the course instructions. In this way the other enrolled students can see the question as well. [17]

Coursera

An example of profitable MOOC platform is Coursera, led by Stanford University professors. It offers free courses. The courses mainly consist of short video lectures, exercises and discussion forums. The platform hosts courses from various different universities. It offers practical skill classes in music, visualizations, programming, and writing. [18] It offers some project-centered courses where a student can focus on a

personally meaningful real-world project. On this project peer feedback is given, often in exchange for a fee. [19] In music production classes home recorded MP3 files are the deliverables and assignments include peer reviewing the work of others using specific tools and strategies. The focus is on the end result. [20]

Summary and conclusion

Open Colleges enables students to learn a practical skill focusing on the end result. The courses are paid. There are planned discussions and experts assess the students' works. Besides that, Open Colleges only offers practical courses to get certificates in the job area of construction. Sketchdrive and YouTube both have a community for support. Where in Sketchdrive getting feedback on the end result is possible; using YouTube receiving this feedback is less likely. On the other hand YouTube is free while Sketchdrive is paid. Delft design MOOCs are free and mostly focused on theoretical design skills. They offer peer feedback in an online community and feedback on the end result. Coursera courses are also free and mostly theoretical. In the practical courses peer feedback is used to discuss the end result for free as well. For (own) project related courses tutors and peers give feedback in return for a fee.

What all of the platforms, described above, have in common is that they are platforms offering some sort of support by experts or peers. Sketchdrive is the only online platform of these to truly focus on teaching a practical skill, but only on teaching drawing. Some of the platforms offer feedback, video tutorials, a defined step by step process, professional education or free education. But neither offers all of these. Next to this, none of the platforms support feedback on the process of making.

Peer reviewing

Research about peer reviewing indicates that in over 70% of the studies the reliability and validity are satisfactory. [21] Conflicting findings can partially be due to course level differences, the product or performance being

evaluated, the difference in context, the clarity of the judgement criteria and the training and support students were offered before giving feedback (learning to give feedback). The reliability and validity is typically slightly lower when assessing practice and is higher in advanced courses. Peer assessments are more reliable in general in case the students were supported by monitoring, training, checklists, teacher assistance and examples. [22] Thus peer feedback is quite reliable even though it might be slightly less reliable for the process assessment of practical skills. Within the Academy of Skills platform students are supported by examples as they have the example video of the expert. But students are also supported by the example of the feedback they themselves received on their lesson before a student has to proceed and give feedback to another student.

DESIGN OF THE ACADEMY OF SKILLS

The platform designers are Joep Frens, Joep Elderman and Migchiel van Diggelen. The Academy of Skills is programmed by Bureau Moeilijke Dingen. Later Michelle van Lieshout was added to the team as researcher. The Academy of Skills platform is taken into use, for the first time, for this research

The Academy of Skills platform aims to solve the problem of the lack of ways to evaluate a practical skill in a MOOC. Video, as currently used to teach most MOOCs has been proven to be an ideal means for teaching practical skills as well. Students using video's to learn from, instead of illustrated text, show significant superior craftsmanship and practical skill after following a course compared to their by text and illustration learning peers. [23]

But as it concerns a practical skill there should be an adjustment in what needs to be assessed. When learning a practical skill feedback on the process is crucial. For example, making quality models requires various skills in the process of making to come to a good result. Deriving from only the final result which skills need practice is very hard. Therefore the Academy

of Skills looks not only at the result but also at the process of creation..

The academy of skills consists of a pedal to mark important times in video recordings, a direct-able camera with lamp and a website. The academy of skills divides the process of making in small steps and enables student to record these steps in their process to make a process video. On this video feedback is given by a peer that is further along in the course. The assessing student is recorded in video format while he watches the compiled footage of the student practicing the skill. Next to giving verbal feedback, the assessing student can pause the footage of the student practicing the skill and draw on the video to help explain his feedback.



Picture 1, the academy of skills set-up.

A constructionist approach

Constructionism (Papert) [24] Talks about how gradual acquisition of actions leads to building knowledge structures particularly when the learner is consciously engaged in creating a public entity (e.g. a tower of bricks or a theory about colors). " The Academy of Skills takes on this approach as it attempts to consciously engage the learner in splitting up the making process in smaller actionable steps. Specifically within the course of cardboard modeling it breaks down the making of a model in actionable steps, structuring the process to achieving the goal of building the final model. Internalizing the actions within the simpler models and working toward building more complex models autonomously (without being broken down in steps). By making these steps explicit and asking the user to record them the user is consciously engaged with the steps and

with help of feedback he can analyze what he knows and still needs to learn to make the more complex models autonomously. The steps are all repeated in different manners within the various simpler models making the acquisition of the actions gradual.

For an elaborate explanation of the working of all elements within the Academy of Skills platform including pictures please see appendix A.

Application domain

The Academy of Skills ideally should be used for learning skills where the process is important. This is the case for practical skills such as drawing, woodworking, construction and applying make-up. Also for digital practical skills it can be very convenient to give feedback on the process. Creating a model in a tool such as solidWorks requires a student to use certain features to come to the best end result. The end results using different features look the same but do not enable a student to easily tweak the model. Just seeing the end product will therefore not be enough to assess the student. The ability to tweak a model afterwards is important when students start applying their knowledge to real world projects. E.g. A student can make a knife-set from the same basic model they created using tools that enable change in a very short time instead of having to start all over again.

From demo to research prototype

At the start of the research project the Academy of Skills platform was built as a demonstration version for the idea. To make the platform workable some adaptations were required. For the research the prototype was made workable by hardcoding the cardboard modeling course into the platform. Besides hardcoding the course, many of the in appendix A explained features still needed to be added. To make the platform operable within the timeframe a priority list was made. Next to many of the functions named in the explanation about the Academy of Skills, there were still some changes that should have been made before the research. Due to time constraints it was decided to leave out these

changes for now. The changes that were left on the wish list were as follows.

- Students need to watch the first video fully once. After that they should be able to use video controls such as fast forward and go back.
- Add a list (text) with instructions on what to do and what to keep in mind next to the video when recording.
- Display the duration of a video (before and during watching)
- See how many times a participant rerecorded a video when assessing this student.

Next to this the manner in which students are graded after a course is not included in the platform yet. The standing idea for the grading of the course, as thought of by Joep Elderman, is an adjusted version of the idea of Merrifield (2009). [25] Similar in the way that a selection of videos is send to each student and students are asked to rank them based on quality of the end result demonstrated in the video. But different from Merrifields proposal because two or three of the videos, that are supposed to be ranked by the student, are pre-graded by an expert. Because it does not matter for the student's own grade how well others did, in combination with the pre-graded videos, this should be a reliable way of grading that can be used within the platform in the future.

Peer grading pilot

To get an indication if it matters for the grading how students are asked to score the end result videos, a pilot was conducted with a similar learning case. The challenges that people document when learning practical skills are semi-open. Which means that they can be assessed on set qualities but that they still can be executed very differently e.g. making a camera or making a car from cardboard assessing the quality of the modelling in the same manner.

The case presented to participants was to learn how to draw a face with the right proportions by means of an instructional paper that they

had to hand in as soon as they started drawing. After handing in their deliverable they were asked to assess 4*6 drawings using different methods of which the order was varied throughout the experiment.

1. Ranging the six different drawings from good to bad.
2. Observing two drawings at the same time and deciding if one drawing is better or if they are equal. Also stating which drawing is better, if one is better.
3. Observing all six drawings and divide 100 point over the different drawings.
4. Receiving one drawing each time and giving it a score between 0 and 10.

The results generated by the 41 participants were compared to the grading done by an expert, which is seen as the ideal outcome. The results indicated that all methods of grading showed results that were very close to the teacher's grades, falling in the same cluster. The exception was method 2 which produced slightly different results. This means that considering the other three methods and picking the least costly method (in time and effort) is advisable. Full details and statistical analysis of the results of the experiment can be found in appendix B.

RESEARCH METHODOLOGY

To evaluate the possibility of replacing a practical skills class with an online taught practical skill (M)OOC this research aims to answer what the pros' and cons' are in 3 learning situations:

- In class
- Hybrid (M)OOC (flipped classroom model) Offering the video material at: <http://cardboardmodeling.com/>
- Specially designed practical skills (M)OOC platform / Academy of Skills

It looks at which elements in both the hybrid (M)OOC and the (M)OOC are essential when considering replacing a regular course.

Furthermore problems experienced with the specially designed practical skills (M)OOC

platform - the Academy of Skills platform - needed to be detected. These will be used to make recommendations for a redesign.

To enable these goals the practical skill of cardboard modeling is taught to students. Because this is a practical skill where the process of making is very important while not all feedback that needs to be given can easily be deduced of the end result of a model; this makes that it fits the purpose of this research very well.

Cardboard modeling

Cardboard modeling is a course at Industrial Design at the TU/e. The course is taught by expert cardboard modeler Joep Frens. In the course students are taught how to quickly prototype interactive products using sensors and actuators combined with advanced cardboard modeling techniques. [26] The first lesson of the course requires students to make 6 basic models. This is a time investment of 8-10 hours. As this is already quite a time investment the first lesson was set up to be a mini-basic course in cardboard modeling.

Elements to be measured and used tools

To define pros' and cons' and experienced problems in each way of teaching, the learning experience of participants is important. Therefore a questionnaire was designed to ask about all elements the class consists of especially the elements that differ in the ways of teaching. These elements are:

- Timing of the feedback (given at the right moment)
- Usability of feedback
- Experienced expertise level of the feedback
- Waiting time for the feedback and how this is experienced
- Quality of the feedback (In other words clarity and specificity [27])
- Clarity of the demonstrations
- Timing of the demonstrations
- Experience of support in the learning process.
- Experience of a step by step process.
- Satisfaction of the working rhythm.

- Usability of the platform (in the hybrid (M)OOC and the (M)OOC)
- Motivation to continue
- Experienced fun
- What was missing
- What was unnecessary
- What were the best aspects
- Experience of giving feedback

Questionnaire

The designed questionnaires consist of statements about these subjects on a 7 point Likert scale (behavioral categories and attitudinal categories). Furthermore participants are asked about their previous education and experiences (characteristic categories). Some open questions are added to get more information about the reasons for a participant's experience. The questionnaires can be found in appendix C.

Usability part of the questionnaire

For the usability assessment the SUS (System Usability Scale) is used. Due to its short length and inclusion of the statements that lead to more extreme expressions of attitude it is ideal to be added to the experience questionnaire. [28] The statements from the SUS were complemented with the statements about the interface design from the CSUQ (Computer System Usability Questionnaire) [46]. The choice for the SUS over the CSUQ was made based on the statements. The SUS statements provided a better fit to both platforms (the website for the hybrid (M)OOC and the Academy of Skills for the (M)OOC).

Interview

After the questionnaire the researchers intent was to find patterns in the answers of the questionnaires and define clusters. Then from each cluster two participants would be invited for an interview.

Due to the limited amount of participants and the importance of a deeper understanding of their choices all participants were invited for an interview. In the interview participants were asked to explain their previous experiences and make a comparison to other previously experienced methods of being

taught a practical skill. The interview also enabled to ask for more information and examples explaining the participant's choices in answers.

The standard interview questions can be found in appendix D.

Panel assessing the final models

Next to the experience the quality of the model-sets were used as a predictor of the quality of the teaching manner. For this a panel of experts was selected to separately rank the model sets in quality.

In Pictures 2-4 show the panel of experts ranking the models on their quality.



Recruitment of participants

Participants were recruited based on their interest in learning cardboard modeling. Students that subscribed to the regular cardboard modeling course of the TU/e became the website / hybrid (M)OOC participants. These students were asked to fill out the questionnaire and participate in the interview, 7/24 students did. The recruitment of the other groups was done by means of

advertising the opportunity to follow a mini cardboard modeling course. In first instance the Academy of Skills version of the course was advertised on the Industrial Design Facebook pages. As soon as this course was full (14 participants) the participants signing up were placed in the workshop / in class condition of the course. Due to this workshop being close to deadlines also a separate poster was placed, promoting the event in an attempt to recruit more participants whom did not see the first promotion four weeks earlier.

Picture 5 and 6 show the promotion posters.



Picture 5

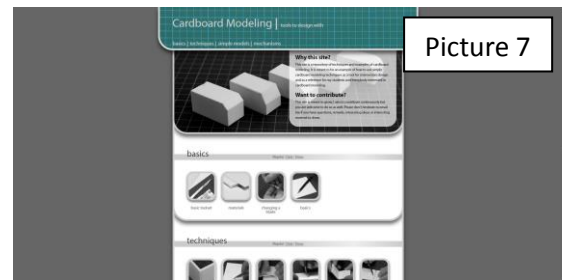


Picture 6

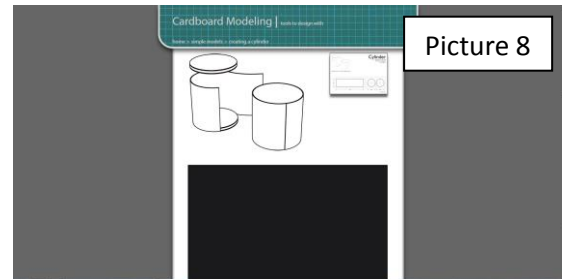
Different conditions - website

Students in the website condition (hybrid (M)OOC) were emailed about their tasks. Students needed to complete the first six models with the information and videos offered on cardboardmodeling.com. After one week the students were asked to come into class and bring their models. During this class a feedback session was held involving the lecturer (Joep Frens) offering feedback to everyone individually and explaining classically how certain problems (such as an opening between the edges of a cylinder) could be solved. A week after this feedback session, students received the questionnaire and were requested to fill it out; signing their consent form at the first page of the questionnaire.

Picture 7 and 8 show the cardboard modeling platform used in the hybrid condition (the website).



Picture 7



Picture 8

Different conditions – in class

Students in the in class condition were explained the research and asked to participate. After that Joep Frens started the class and demonstrated how to make the first three models. The students received handouts and some explanation for the last three models. After each demonstration students had the opportunity to work on the model and receive feedback while working on the model. The last three models had to be made at home. A week later participants had a feedback session discussing the last three models. As the participants asked for it they were also shown more advanced cardboard models learning what more they could do with cardboard modeling. They received the questionnaire after their feedback session; signing the consent form at the first page of the questionnaire as well.

Picture 9 illustrates a demonstration in class. Picture 10 shows the giving of feedback during the making process and picture 11 portrays the feedback session after. Picture 12 shows the extra models the participants in this version of the course were shown.



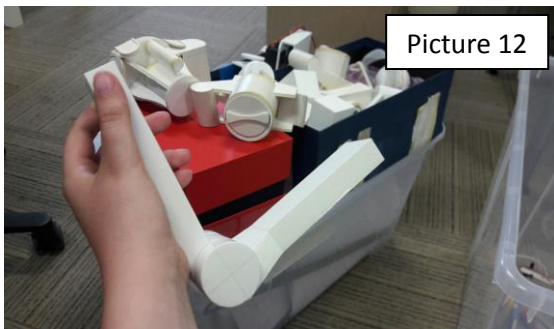
Picture 9



Picture 10



Picture 11

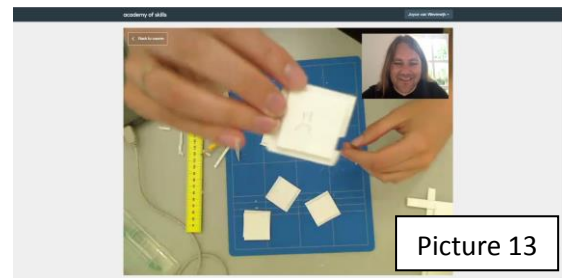


Picture 12

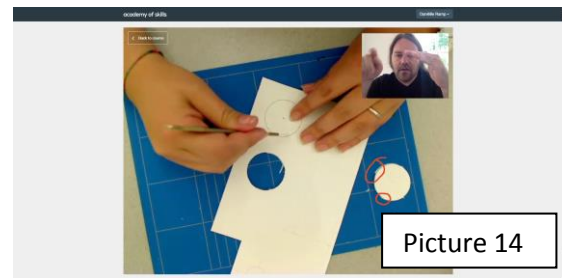
Different conditions – Academy of Skills
 Students in the Academy of Skills condition ((M)OOC) were emailed a consent form, account information and an information sheet (see appendix E). Accounts were already created by the researcher, enabling the researcher to log in on the participants account as well, to check for problems. Next to that participants were asked to reserve the room

where the materials and platform set-up could be found, when intending to work on the models. Due to limited cameras that were available, students were restricted to working in that room at the University. Nevertheless the students could plan their own times. The first lesson as student planned, the researcher came by to check the functioning of the platform (connection with the camera), answer questions and have the participant sign the consent form. When a student completed the course he was send the questionnaire.

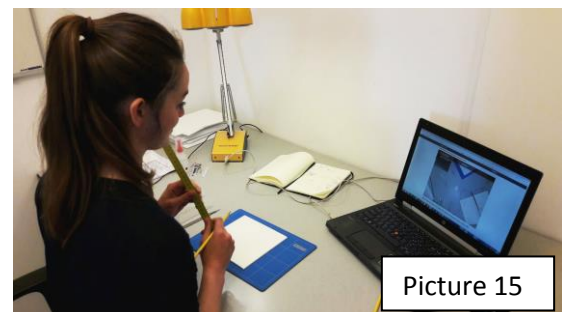
Picture 13 illustrates Joep Frens giving feedback to one of the participants. Whereas the participant is trying to communicate a mistake she made. In picture 14 drawing is used within the video to clarify the feedback that is given. Picture 15 shows one of the participants starting to document herself making the cube.



Picture 13



Picture 14



Picture 15

Intervention protocol

In the in class version of the course the lecturer would handle the same rules as in class. If

participants had questions they could e-mail or come by. The same rule applied to the students following the website version of the course. The academy of skills user could only contact the researcher, whom in this case was also the course administrator. Contacting the researcher was advised when platform or planning related problems were experienced. The platform related problems causing trouble were immediately solved.

Alterations in the Academy of Skills

During the course the following alterations were made immediately:

- The cap on the amount of minutes the platform could record was lengthened as participants did not finish a step in five minutes and the recorded feedback stopped in the middle as the cap was reached due to pausing the video while giving feedback.
- The feedback videos were +/- 5 seconds out of sync with the process videos. This issue was solved with a more fanatic sync controller. Leaving the videos sometimes a few frames out of sync.
- Participants couldn't continue to a next lesson when there was no one to give feedback to. This was changed so also the last participants within the course could continue.
- The PDF handout download was hard to find. And some participants did not find it. Therefore it moved to another location.

RESULTS

- A class of 24 was in the hybrid (M)OOC or 'website' condition. 7 students chose to participate when they were asked.
- 14 students were in the (M)OOC / 'Academy of Skills' condition. From these students 3 dropped out before starting. 1 dropped out after the first lesson due to planning issues and 2 did not finish the full course within the planned time but did intent to

continue, leaving 10 participants in this condition.

- 5 students were in the 'in class' condition. 1 student dropped out before the feedback session due to planning issues.

COURSE EXPERIENCE

To analyze the content and experiences discussed in the interviews and questionnaires closed coding was used with predefined topics of development, cardboard modeling, Time, Feedback, video tutorials, demonstrations, step by step and platform tips, platform tops and platform issues. Added to this list during the coding were 'feedback session' and 'motivation' and the subheadings. Answers to the questionnaires and transcribed interviews can be found in appendix F.

Development

Participants feel as though they learned something and can point out specific examples of what they learned in all categories. They named similar examples such as neatly constructing models and making corners in all conditions.

Cardboard modelling

In the different conditions participants point out similar experiences of liking cardboard modeling with some exceptions. Nevertheless many participants doubt if they will use it as it is very time consuming. Participants who have a working style that is more products focused and that really see the value of using cardboard modeling or how they could use it within their projects would like to continue cardboard modeling. Other participants are hesitant, but feel confident enough to experiment with it when the opportunity presents itself.

Time – Academy of Skills

Many students enjoyed the flexibility of planning own working times. However it felt like a big time investment. Sometimes it was a burden because making the models was spread out so much. Some students preferred to continue working over receiving feedback

some times. On the other hand a student mentioned that waiting for feedback made it feel more serious and that it was nice. Going to a certain location helped students to plan it and instead of it being only a burden due to restrictions in the research this might have even been a motivator to finish the course. *"Because I had a strict planning of when I had to do it, so. I finished the course. So this is the first. I finish like a whole um. Online course. Because normally I forget about it. Or I don't really plan it."*

Time – Website

Similar to the Academy of Skills students enjoyed the flexibility *"In the beginning with the video you can work at your own convenience at any time you want. And the feedback is still there in principal."*

Time – In class

Some of the students had trouble with a class taking up time. *"Class takes more time in like moving to the class and like staying there and wh-you also. It happens. And it happened to me like in the past. I mean like some, some topics they are explaining in class. In lectures. You already know them. So if I would like follow it the same lesson like in a website. Then I probably would skip that part and go to another one so I will save some times."* The student mentions he prefers online lectures for practical courses which do not involve discussions about ethics or design. He rather has video lectures as they can be navigated through enabling him to plan his time as he wants. Other students had less trouble with the times of the course as it would be at the same time each week over a longer period of time. Although some of them actually would appreciate more flexibility to fix broken prototypes or plan meetings.

Giving feedback

Only participants using the Academy of Skills had to give feedback. All participants that had to give feedback point out that the first time giving feedback is awkward or weird and that they feel uncomfortable. Participants giving feedback more often also point out that even though they find it hard and they do not feel experienced enough they also learned a lot

from giving feedback. *"Like, mistakes you see. If you see someone else making a mistake, I tend to think about it when I'm doing it and yeah it helps me as well."* And *"it helped as well for me to actually check how much I learned. So um. I don't want to say that I really learned a lot from this course. But it was surprising to me that I now know for example how to use this scalpel. Because I didn't really think about this in the beginning. And now, also because of giving feedback and seeing how others do it um. I know how to do it. So. So in the end, it was nice, yeah."* However participants feel too little support in their feedback giving experience as they do not receive feedback on the feedback they gave, feeding into the insecurity they already feel about their expertise. *"The teacher is much more secure about what he's saying. And that was not when it was just another student."*

Timing feedback

Almost all participants in the Academy of Skills condition point out that they really miss real time feedback. *"But then again a disadvantage for me is that I get the feedback later instead of at that moment. Cause then I tend to, oh yeah, oh yeah I get that. And then you start to model again and then you just do what you did in the first place, when you do it again."* Also in the other interpretation of timing participants experienced a wait sometimes before receiving feedback. Planning wise these participants sometimes rather wanted to continue with the next model than receive feedback. Also participants in the website condition experienced trouble with the timing of the feedback. *"The feedback I got for the first lesson is not like applicable for the first lesson again. Because I already made the models."*

Content feedback and questions

Sometimes feedback was given about something the participant already learned; in each of the versions of the course this problem was experienced. Especially the Academy of Skills participants were generally annoyed by this. *"I think the feedback thing in essence is very positive. Because um. I did stuff wrong that I didn't know about. But on the other hand I also did stuff wrong that I knew that I did wrong. And I knew how to do it the right way. But there is no*

way to communicate that in the platform. So you get feedback on it and you think 'Yeah, I know. Shut up, continue' "

The feedback during the course generally was focused on model building skills and had the same content in each condition. Although Academy of Skills participants sometimes experienced a bit more difficulty in applying this feedback as a few participants experienced trouble with not being able to ask questions. *"I'm doing that but it still fails, right? And of course he said "you need a lot of practice" but um of course I need practice but if I don't know what I am doing wrong then I can practice all I want I am still going to hit a brick wall because I don't know where I am going wrong."* Some of the other participants in this condition didn't really have questions but were merely wondering if they were doing something right; they ended up figuring it out on the go. *"And sometimes I had questions like I will just see if he comments anything on this and then most of the time he did but also sometimes he did not. But most of the questions I had was just somethings I figured out while making other things. Like Oh this is the way you should do it."*

But also students in the website condition were sometimes left with unanswered questions. *"Sometimes I really struggled. And then I was like Aahrg I need help but then I couldn't receive help because I was on my own."*

Quality feedback

Students were generally positive about the quality of the content of the feedback in all conditions. *"I liked the overall feedback really well"* In the Academy of Skills version of the course students were somewhat more positive about receiving feedback from Joep than about receiving feedback from other students. *"Oh, so I was lucky"* a participant said about receiving feedback from Joep. Another participant said *"The last couple of courses. It was always from Joep. And I believe I did not receive any feedback from someone else. At least not something that I could apply. In my mind it is always from Joep. Maybe it happened but it was not valuable enough for me to remember then."* Other academy of skills participants had less

trouble with the feedback from peers *"So yes, sometimes I needed to wait for feedback, while I wanted to continue. But in hindsight this feedback was useful. Um. And sometimes I was able to use it in the next um. Lesson as well."*

Feedback medium

For the Academy of Skills it was really enjoyed that the person who was giving feedback was actually talking to you and that his facial expressions could be seen. Next to that the drawings were very much appreciated to clear up the feedback. *"Half of the time they were really helping. Or focusing on what he was telling about. And especially one time. He made a drawing for me about what it should have been like; the circular thing in the cylinder-cube um. So that was really, really helpful."* It also enabled students to watch their feedback whenever they wanted to and enabled them to re-watch it. The only problem with the medium was that 2D feedback needed to be given on a 3D model which wasn't considered optimal by the participants.

Receiving feedback in real life was appreciated much by the in class and website participants. *"Because that's what I got from the feedback. That um, it's also about the things that you cannot see in a video. It's about the things you can perceive in real life. Thus feeling and um. Well of course the resolution of a video is not that high. That you can see all the little spots on the. Yeah. On the dirty areas of the.. Glue. Those things."*

Cardboard modeling website (tips and tops)

Website students believe the website to be clear and simple in use. The website scores higher in terms of usability than the Academy of Skills platform. Only students feel as if the website wasn't really designed to be an online learning platform. Also they miss a full screen option for the videos. *"I feel like the website was. Was made for a different purpose than video lessons. And that reflects in its design and the way how the videos are implemented. For instance, you cannot look at them full screen."*

Feedback session

Students in the website group agree that they like the feedback session although some

believe the feedback sessions are a bit too long. *"I think if I would only do the online tutorials, I wouldn't notice what I'm doing wrong. So I thought that the feedback sessions were really good to see what you are not doing well and what you could do to improve."* In class students however were less convinced by the feedback session. A participant mentioned he lost a lot of time going to that session, in transport and in the session itself while the feedback could also be given over email or video or audio. He did however like the feedback and would have liked the feedback session if it was at the same day the cardboard modelling workshop was so he could work in one 'spurt' to the end. Another in class participant did believe the feedback session was very helpful and didn't take too long. He *"would not change anything"*.

Platform issues

Participants in the Academy of Skills condition experienced the most issues with the platform. The most important of these issues being the lack of quality in the camera and other participants' microphones. This rendered the peer feedback sometimes unusable. *"But I really had some problems with the quality of the feedback. Only the last feedback I get. I could really understand. But the other ones you just had to yeah. Do my ear on my laptop to really hear it. And Joep Frens was stuck all the time. So. It just didn't work well in my computer. I don't know what was um, going wrong."* These problems also made giving feedback harder *"If there was something like glue on it or a little cut out of it. Then um. You cannot. You could not really see it."*

Video tutorials

Academy of Skills participants believe the tutorials to be extremely useful as well *"Because the video was so clear and precise I didn't have the feeling that while he was doing I would have wanted the possibility to ask him something. Cause there was no need for it."* and *"the videos were nice and clear"*.

This belief is shared by the website course participants. *"But the video is like this close so you actually see and measure all the things. And in class there are a lot of people and you can make a*

demonstration for example. So I don't think that. Yeah, I think that the videos are more useful cause they are close."

The website students also made a more critical comment *"like it's nice when you are starting from zero. However when you need like one kind of specific information which you might have heard or you don't know. You're like ah, oh. I think I heard about this. But I don't remember how to do it exactly. And you need to go through all the videos and you need to scroll through it and that stuff."* This problem being experienced by website participants but not by the Academy of Skills participants might be due to the deviation in steps for the Academy of Skill participants enabling them to find information quicker.

Participants in each condition believe video tutorials in general to be convenient because tutorials have proven to the students to be quite reliable. There are many tutorials and it is easy to find what you are looking for. Participants mostly use video tutorials to solve problems and sometimes to learn a new skill from scratch. The most experienced issue with video tutorials is that they can be too slow and therefore boring. This is mostly named in the website condition.

Demonstrations

Participants in class enjoyed the demonstrations but found it a pity that they couldn't re-watch. This is how one participant ended up looking for videos himself to be explained how to make the truncated cone again. *"I really liked the lecture because he explained everything in a calm but really thorough way so you know every single detail. But he does that the same with the, with the online video so. But you do get feedback from the like. From the workshop. So that is better. Well. I don't know, I like both. But it's like one advantage is feedback and one advantage of the videos are that you can look back."* On the other hand sometimes the demonstrations were enjoyed over the video lectures due to their physical character. *"Well, yeah. It depends on where I am standing in class. But then I can actually look at the models in real life. That he made. And I can touch it. So it's easier to see what it is about. And in the video tutorials it's also pretty clear. But um. Less touchable."*

Other website students rather made use of videos.

Step by step

Most of the in class participants and website participants have experience with step by step. They like this because *"I like it that the video first tells you what to do and then it explains it step by step. But, so you can skip steps if you understand it already. But you can actually look at the harder part."* Students in class liked step by step tutorials for the same reason. Academy of Skills students mentioned that this experience was a different version of step by step tutorials but that they really enjoyed it to split up their process like that. *"I think now you are really forced to do it step by step. And if you see another tutorial you just see it step by step and you watch all the steps and then do it. And then fail. And then watch again. And maybe then pause. But now you were really forced to. Really go step by step. And I think that makes your model, in the end, better. And the process in general."*

Motivation

In class students had more motivation to continue the course than using the other platforms. Being in a class was deemed motivating due to peers working alongside of the student *"it's motivating me more to work on something. Because otherwise if I get like really somebody who is like we are going to work on this. Than it is easier for me to actually work on it instead of just having planned it in and then being like. Oh shit. It is the end of the week and I didn't do it."*

Overview of pros' and cons' for each way of learning.

Academy of Skills pros'

- Flexible in planning
- Ability to re-watch videos.
- Step by step video recording structuring the process.
- Feedback on the whole process of making.
- Offering a safe learning environment where students feel confident trying out something new without their

peers seeing them do something terribly wrong.

- Plain and simple in usage.
- Community that supports and helps out each other.
- Giving feedback and therewith testing one's own knowledge.

Academy of Skills cons'

- The feedback on the process is only seen later. (no real-time feedback)
- No video navigation.
- No physical interaction with the demonstrations of physical models.
- No motivation to finish besides internal motivation.
- Lack of peers to discuss with.
- No (real) opportunity to ask questions.
- Waiting for feedback (preventing users to follow more lessons in one day)
- Bad camera quality.
- No feedback on given feedback.

Hybrid (M)OOC pros'

- Partially flexible in planning.
- Ability to re-watch, pause and navigate videos.
- Feedback on end result from an expert.
- Plain and simple in usage.
- Offering a safe learning environment where students feel confident trying out something new without their peers seeing them do something terribly wrong.
- Enables discussions and demonstrations in class.

Hybrid (M)OOC cons'

- No real time feedback
- No process feedback.
- No opportunity to ask questions until the models should be finished already.

In class pros'

- Ask questions directly (until it's time for homework).
- Get direct feedback.
- Feedback on process.

- Enables interaction and comparison with peers.
- Motivating.
- Enables discussions.

In class cons'

- Seeing a demonstration only once
- Not having a good view upon the demonstration
- No flexibility in planning

COURSE RESULTS

Model-set quality

The quality of the models was assessed by cardboard modeling expert Joep Frens, basic form giving skills expert Bart Hengeveld and previous student of the full cardboard modeling course Simon Bavinck. With the latter being added due to his continuation of using cardboard modeling widely throughout his last project. Each of the experts in the panel organized the cardboard modeling model-sets from good to bad. This resulted in three lists with a score of 1 being the best and a score of 21 being the worst.

Each of the experts was asked to communicate the criteria based on which they assessed the model-sets. They were asked not to take completeness of the sets into account due to some broken models that were thrown away. The criteria with which they chose to assess the models were as follows:

Joep Frens: Building quality, gaps between the joints (neatness), quality of the cut-outs, cleanliness (no glue), drawing lines (precision and lightness meaning thin and finished lines and no double lines).

Bart Hengeveld: Neatness / care, edges of the cubes, gaps between the joints, finishing.

Simon Bavinck: Working of the mechanical models, the fit (gap between the joints), neatness (or sloppiness), finishing.

The qualities that each of the experts picked are very similar and the models are therefore assessed on the same qualities each time. The quality score that each of the experts gives should therefore also be similar. For the full lists from each expert, including notes, please

consult appendix G. For pictures of all model sets and detailed model shots consult appendix H.

To compare the lists of the different experts assessing the model quality, a cluster analyses was conducted. The ILLMO program, with which the analysis was conducted, recognized one cluster containing all three lists. Using an Eigenvalue of 1,0. This cluster has a Cronbach's alpha value of 0.907692. This indicates an excellent fit for all three lists within this cluster. This means that the data is very similar, even though assessed separately. The data can therefore be used as repeated measurement data for further analyses between the different conditions. Per condition it is noted at which position the participants of this condition hold up on the three lists. This data is used for further analyses of the scores within conditions.

It can be assumed that the data has a normal distribution with varying standard deviation. This can be learned from the K-squared test from d'Agostino.

'In class' condition K-squared (d'Agostino) = 3.86107 (p=0.145071) < 5.991 (p=0.05) (Gaussian).

'Academy of Skills' condition K-squared (d'Agostino) = 0.5034 (p=0.777478) < 5.991 (p=0.05) (Gaussian).

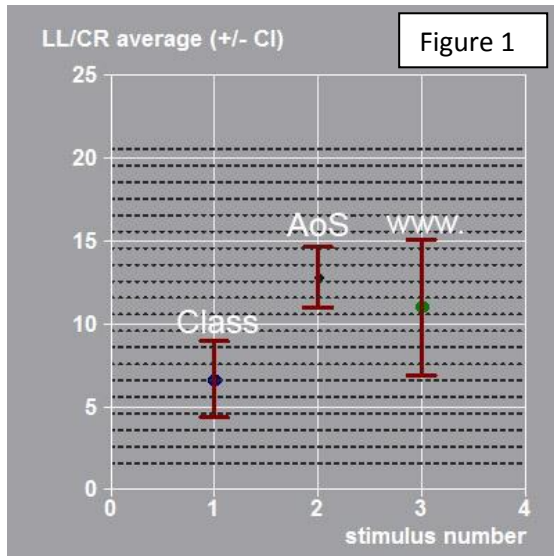
'Website' condition K-squared (d'Agostino) = 0.312393 (p=0.855391) < 5.991 (p=0.05) (Gaussian).

The data has an unequal variance due to different amounts of participants in the conditions. The Chi-squared test indicates that this Gaussian model with unequal standard deviation fits the data.

$\chi^2(54) = 62.63$ (p=0.1968) < 72.1582 (p=0.05) (model fits data)

Figure 1 shows the confidence intervals for the standard deviation. On the left the 'In class' condition (blue), in the middle the CI for the 'Academy of Skills' condition (black) and on the right the CI for the 'Website' condition (green). The

length of the confidence interval indicates the variance. It can be observed in the model that the variance of the 'Website' condition is higher than the variances in both other conditions. It can also be observed that the variances of the 'In class' condition and the 'Academy of Skills' condition are likely to be assumed equal. This means that the level at which the participants score within the 'Academy of Skills' condition and the 'In class' condition are more consistent.



Comparing the 'in class condition' with the 'Academy of Skills condition' the T-test produces the T statistic with value $|T| = 3.7556$ ($p=0.000550837$) > 2.5763 ($p=0.05$) and therefore significant.

Difference (T-test) $d = -3.7556$, with 95% CI = $[-9.35589, -2.81078]$.

$JND = 0.907060 \geq 0.8$ This indicates a large size effect. Meaning that there is a difference in quality of the models between the 'In class' condition and the 'Academy of Skills' condition. In this new hypothesis is assumed that the participants in the class make higher quality models.

Comparing the 'in class condition' with the 'Website condition' the T-test for unequal variance produces the T statistic with value $|T| = 2.2705$ ($p=0.0305189$) > 2.0425 ($p=0.05$) and therefore significant.

Difference (T-test) $d = -2.2705$, with 95% CI = $[-8.66106, -0.457992]$.

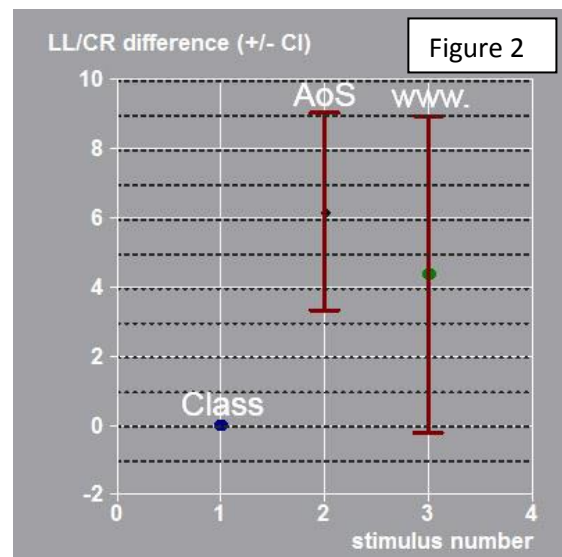
$JND = 0.501450 \geq 0.5$. This indicates a medium size effect. . Meaning that there is a

difference in quality of the models between the 'In class' condition and the 'Websites' condition. In this new hypothesis is assumed that the participants in the class make higher quality models.

However, in both comparisons with the 'in class' condition it should be taken into account that there were only limited in class models.

Comparing the 'Academy of Skills condition' with the 'Website condition' the T-test for unequal variance produces the T statistic with value $|T| = 0.8242$ ($p=0.413905$) < 2.0110 ($p=0.05$) and therefore insignificant. Meaning that there is no difference in quality of the models between the 'Academy of Skills' condition and the 'Websites' condition.

Figure 2 shows the confidence intervals for the average of a Gaussian distribution used to approximate the observed histogram. On the left the 'In class' condition (blue), in the middle the CI for the 'Academy of Skills' condition (black) and on the right the CI for the 'Website' condition (green). The closer the point, on the graph, is to 0, the higher the score of the students in this condition.



Taking a closer look at the data from Joep's list it can be divided in four categories as marked out by Joep. It can be seen that most of the in class participants score in the category 'Good' and most of the 'Academy of skills participants' score in the category 'sufficient'. Website participants vary most with a

variation from 'Excellent' to 'insufficient'. For the full list, including notes, please consult Appendix G.

Progress

Also the development of the students, throughout the set of cardboard models they delivered, was assessed by cardboard modeling expert Joep Frens. With four possible categories: negative development (-), no improvement (0), some improvement (+), a lot of improvement (++). But as some sets of the 'Academy of Skills' condition were incomplete (due to broken models from transport and lost models) many of the model sets in this set could not be assessed on their actual progress leaving them with a 0. This in combination with no extreme improvements in any group results in close averages and leaves too few data to draw significant conclusions. The list with the progress assessment can be found in Appendix G.

DISCUSSION

I studied the Academy of Skills in comparison to a hybrid (M)OOC / flipped classroom setting and a normal classroom setting aiming at evaluating the possibility of replacing a practical skills class with an online taught practical skills class. I was particularly interested in the pros' and cons' of each way of teaching and the problems that were experienced using the Academy of Skills.

I found that there were some essential elements that needed to be taken into consideration when thinking of replacing a regular class with an online practical skills course. Next to that a few notes should be made regarding the data that was gathered and interpreted during this research.

Essential elements when replacing a class

When trying to replace a regular class with an online taught class it should be noted that the elements that make the pros' and cons' for each situation should be taken into account. If there are supposed to be a lot of discussions

within the course it is more logical to choose a hybrid (M)OOC than a full (M)OOC.

Besides the clear pros' and cons' university students still choose to come to university and follow courses there because of the interaction and spontaneous discussions with experts and peers. This is also one of the reasons why the participants in this research were hesitant concerning following another course through the Academy of Skills platform. Maybe a practical skills (M)OOC shouldn't necessarily replace a university course but enable people from all over the world to join and learn a skill not offered in their neighborhood. The university students participating in this research would still like to join these courses and learn an extra skill. With the freedom in planning a MOOC offers, it is an excellent opportunity to learn the skill on top of their already picked curriculum rather than having it replace one of their courses.

In other words, the online courses can replace the in class version of cardboard modeling and teach cardboard modeling quite well. But it cannot immediately teach the course with the same quality that is currently expected by students. Looking at the pros' con's in the future it should be possible to implement many of the pros' of a regular class within the practical skills platform maybe eventually making it a preferred choice by students as the regular class can never take on the same flexibility an online course offers. This flexibility is one of the biggest pros' for the online courses.

Possible problems concerning the data

The participants in the 'website' condition continued in class as they were following the normal course. This might have influenced their answers to the questions making the answers less reliable or more similar to the participants in the 'in class' condition.

Due to the small test groups the different conditions contained an uneven number of boys and girls in each condition. This small dataset also resulted in the quantitative data of the questionnaires being too little to really

draw conclusions. Luckily the qualitative data made up for this and provided rich insights. The coding of the interviews that led to these insights was however done by one researcher maybe leaving some unintentional bias. Besides this there were only very limited results of the 'in class' condition. This condition did also not fully represent the in class experience as participants pointed out. In a normal class it would be harder for students to see the demonstrations and get feedback as there would be more students that need attention.

Next to this usability issues were experienced with the Academy of Skills platform. Especially concerning the quality of the camera and audio recordings. This could have had a large negative impact on both the final results (students received less (qualitative) feedback) and the experience. This means that there are still some major issues that need solving. Even though this could have had a negative impact many of the participants enjoyed using the platform nevertheless and would want to follow another practical skills course using the platform. Although they would much rather want to do this if it was an extra course rather than a supplement for a regular course.

Furthermore the Academy of Skills students spread their working on the course over a longer period of time. This made the course feel more like a process and full course. This left participants with more experiences. Therefore the participants had more to tell the interviews. This was opposite to the students in class who noted that it did not really feel like a process or course that had a rhythm. These students also indicated that for this reason they had some trouble filling in the questionnaire.

Moreover all the participants in each of the research groups were Industrial Design students at the TU/e which makes generalizing the results harder. On the other hand the course is intended and optimized for design students. This makes the selection of this group of participants a logical option to get

results on a more general level excluding possible distress caused by the course not being optimal for a participant's background, rather than distress caused by the platform.

As said, the course of cardboard modeling was used for the research. Therefore generalizing the results to all MOOCs is impossible. However many of the Academy of Skills users saw possibilities for other courses they would like to follow using the online platforms. Academy of Skills students named sketching as one of those courses. One student even left the remark that she taught it would be more valuable to use this platform than to use Sketchdrive, which she used to follow a sketching course, as feedback could also be given on wrist movements.

RECOMMENDATIONS

Situations that fit each way of learning

We shouldn't aim to replace a regular course with an online course when it concerns University students right now. A hybrid (M)OOC would fit better in the classroom. Especially when requiring much discussion and less process feedback. This still enables students to experience the social qualities of in class education while profiting from the advantages from online instructions as well. The Academy of Skills would be more suited for learning an extra skill on top of a student's curriculum or for people that are not in university. However, with some changes to the platform the practical skills (M)OOC and the Academy of Skills could become close to being able to replace a regular course. In class learning is recommended for students that are interested in discussions with peers and experts; students that are motivated by working alongside other people.

Peer feedback

Student assessors were experienced to give lower quality feedback than the expert; when looking at the videos they also often touched up on fewer points than the expert and lecturer in their feedback sessions. This could partially be due to the short term at which the students had to learn to be good peer

assessors. Falchikov alerted this already as good quality peer assessment requires time for organization, training and monitoring. [21] This is also experienced by participants as almost all students that gave feedback indicated that the first time they assessed their peers they experienced it to be awkward and very hard. Next to the example the students received, a second supporting tool to help out the student assessors in giving feedback could also be of help. Rubrics or assessment criteria could improve the quality of their feedback as it is less likely that they forget some of the criteria for a good model. [22]

Recommendation: Changes to Academy of Skills platform

Looking at the data, observations and suggestions of users I compiled a list of adaptations that I recommend to be made to the Academy of Skills platform.

I highlighted a few functions that would be extremely valuable to add to the platform as they could solve the cons' of the platform making it more similar to an in class experience. This experience is still something almost all participants prefer largely due to the contact with other students.

- Live feed of other students that make cardboard models and the possibility to chat with them. This enables students to get real time feedback. The real-time feedback is one of the biggest misses in online education. With numbers of participants of a MOOC going into the 10000 there should always be someone modeling as well. Seeing this student working and communicating with him enables real time feedback but also results in learning from the mistakes of others and with others being there students can be more motivated to finish a course.
- Making comparison material available that can be accessed or played during the making of a student's own model. According to the participants this enables them to learn from the mistakes of others and can motivate them.
- A question or comment adding option should be added. So a question or comment can be send textually with the process video to give feedback on as audio is not perceived as convenient by participants due to loss of focus and the feedback would become more valuable for the participant.
- A list of assessment criteria should be displayed while peer reviewing. Based on the research explained above and the experience of the assessing students whom felt a bit lost sometimes when assessing.
- Being able to note down the feedback when watching it so a student is able to look back at the feedback while making the next model.

The other functions that should be adapted in the Academy of skills to increase usability and quality are:

- Peers should be much further in the course before starting to give feedback so there is time to create some more feeling of expertise before a participant starts giving feedback.
- Video controls should always be available as the lack of these is named as one of the most bothering qualities of the platform and one of the best qualities of online education. (the option to watch something back) The controls should especially be available in the feedback video as participants couldn't go back when they missed one little detail.
- A much better quality camera should be taken into use as using this set possibly leads to lack of quality in feedback.
- Up the limit on the recording time of the user (more than 5 min) as participants felt rushed by this limit.
- Look into the pausing of the video and the frame that is drawn on as the two are slightly out of sync which makes the drawings unclear.
- Using the pedal to mark a beginning and an end to the selected seconds

rather than selecting the middle. Participants currently did not understand what they marked (beginning / end / middle) and thought it wasn't working properly.

- Clicking next to a procedure video while recording should mean pausing rather than, because of the overlay, result in the recording to stop.
- Selecting two different parts in one process video.

CONCLUSION

Looking at the list of pros' and cons' for each learning situation combined with the proposed changes to the Academy of Skills platform a MOOC offered on the platform should be able to replace a regular course provided that the platform has no usability problems. Currently this means that the practical skills MOOC of cardboard modeling, offered through the Academy of Skills cannot replace a regular course in quality of feedback / meaningful discussions and ability to ask questions. Students creating models in class also create models that are superior in comparison with their online course following peers. Nevertheless both the hybrid MOOC and the Academy of Skills show potential for education as students taking part in both courses did learn the cardboard modeling skills and participants proved enthusiastic about following another course in this manner provided that this was a course on top of their curriculum rather than a course replacing a regular in class course. This because students do not merely go to class to learn the skill but also to experience meaningful discussions and for social reasons such as being motivated by means of working alongside their peers. Learning by means of one of the MOOC versions of the course (hybrid or full) does create a good fit to learn at least the practical skill of cardboard modeling for people with no access to university education. Probably also practical skills such as sketching can be taught, as this was indicated by participants.

ACKNOWLEDGEMENTS

I thank Joep Frens for all the support during setting up the research, for assessing the models, giving feedback to students using the Academy of Skills platform and teaching all of the cardboard modeling courses. I thank Michgiel van Diggelen for sharing his expertise on education and learning experiences and for helping design the questionnaire. I thank Bureau Moeilijke Dingen for all their efforts in programming AoS and quickly changing parameters during the research when something didn't function as it should, to ensure optimal usability. I thank Joep Elderman for his ideas and feedback. And lastly I thank the CRIGS squad at the TU/e and the coaches in particular, for their feedback and support.

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