Design Thinking At Scale: A Report on Best Practices of Online Courses

Mana Taheri, Thomas Unterholzer, and Christoph Meinel

Abstract Design Thinking has arguably become a state-of-the-art innovation methodology. It has received increasing attention from both media and educational institutes around the globe. Consequently, there is an increasing demand for Design Thinking education. In this research we aim to answer the question of whether and how Design Thinking can be taught in the form of Massive Open Online Courses (MOOCs) that promise scalable teaching. In this chapter we discuss the potentials as well as challenges of teaching Design Thinking in a MOOC environment. In order to learn about the pedagogies and practices required for high quality teaching, we look into four Design Thinking MOOCs and through the lens of a widely used pedagogical framework called the *Seven Principles of Good Practice in Undergraduate Education*. We also pay careful attention to the technological features and the didactical methods applied in selected courses and how they support the fulfillment of these principles. Further, the research team aims at setting up an online course on Design Thinking in collaboration with the openHPI platform—one of the Europe's frontrunner MOOC providers. Thus, we compare the results to the capacities and features of openHPI and examine its potentials for supporting and hosting a design thinking MOOC. Finally based on the best practices observed in the selected courses and the literature, we propose general recommendations for course designers and report on results of interviews with Stanford d.school course instructors on the challenges and potentials of a digital Design Thinking learning environment as well as the path of future research.

M. Taheri (✉) • T. Unterholzer • C. Meinel
Hasso Plattner Institute for Software Systems Engineering, Campus Griebnitzsee, Potsdam 14482, Germany
e-mail: mana.taheri@hpi.de

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1 Introduction

Today's complex and intertwined challenges require fresh approaches and skills that guide us towards innovative solutions (Owen 2007). In fact one of the most sought after skills is creative problem solving and the ability to approach problems in novel ways. Design Thinking is undoubtedly among such skills. As a human-centered approach to finding unexpected solutions to complex problems, its popularity is growing steadily. Many educational institutions are either developing a special program around this topic—often along with a dedicated space—or including it in their traditional curriculum.

However, not everyone has access to a world-class Design Thinking education program. Considering the need for innovative solutions to our complex global challenges, and the fact that there are limited opportunities for learning Design Thinking around the world, there is a strong case for teaching Design Thinking at scale and to a broader global audience (Taheri and Meinel 2015).

On the other hand, in the last years the number of institutions opening their lectures to the global public through the internet in a MOOC format has increased. Although MOOCs initially covered conventional knowledge-based courses, as their popularity grew some began to offer courses on trendy and popular topics beyond the traditional university curriculum. Design Thinking was among such topics.

As researchers of the HPI-Stanford Design Thinking Research Program (HPDTRP) at the HPI in Potsdam, where both Design Thinking education and one of Europe's leading MOOC platforms *openHPI* (Meinel and Willems 2013) meet, we saw this development as a great opportunity to investigate the potentials and limitations of teaching and learning Design Thinking at scale—mediated through an open online environment.

In this chapter, we begin by providing a brief review on the development of MOOCs and their role in education today. We then argue that, despite the pre-assumed mismatch between Design Thinking and the MOOC model of learning, in order to create an effective online course on Design Thinking we need to look beyond replicating a real-life experience and instead focus on the learning outcomes and pedagogies. We further report on how Design Thinking is being taught online from an educational perspective. This chapter looks into four MOOCs on the topic that were accessible to us at the time of this study. For this purpose we apply a widely used pedagogical framework called *The Seven Principles of Good Practice in Undergraduate Education* by Chickering and Gamson (1987) to evaluate the selected courses. The framework suggests seven principles that high quality teaching should fulfill. Further, we present some of the best practices seen among the selected courses as well as in other MOOCs and research. In addition, we highlight the features and technological capacities of openHPI in supporting the principles that allow for quality teaching.

Finally, in order to hear the experts' views on the challenges and opportunities of teaching Design Thinking in an online environment, we conducted interviews with experts and course designers from the d.school in Stanford. We discuss the insights

gathered from these interviews on the potentials of teaching Design Thinking online in the final section.

1.1 MOOCs: Beyond the Hype

Four years have passed since the *New York Times* proclaimed 2012 "The Year of the MOOC" (Pappano 2012). The article acknowledges that MOOCs had been around for several years as "collaborative techie learning events," but since 2012 the number of institutes offering online courses around the globe has significantly increased, with that year witnessing a massive upsurge in MOOCs.

On the significant uptake of MOOCs in 2012, Martin Bean, the vice chancellor of Open University states: "In 2012 that wave of disruption hit higher education. By the end of the year, 18 of the top 20 universities in North America were offering MOOCs—so that's the "great brands" box ticked (Bean 2013).

Parallel to these developments in North America, European companies as well as educational institutions started to build their own MOOC platforms. One of the first European educational/university institutes to offer MOOCs in both German and English on topics related to computer science is HPI, through the openHPI platform (Meinel and Willems 2013).

But what are some of the reasons behind the popularity of MOOCs? We will take a closer look at the major characteristics of MOOCs in the following.

The *massiveness* relates to the potential number of participants in any given course. Unlike the limited number of students attending a course held in a physical lecture hall, with an online course instructors can reach an audience of up to hundreds of thousands from around the globe. Regarding this essential characteristic, Sebastian Thrun, founder of the MOOC platform Udacity, who also offered one of the very first MOOCs, attracting more than 100,000 students, explains that he couldn't go back to his Stanford classroom after teaching the massive number of students in his Artificial Intelligence MOOC (Hsu 2012).

The word *open* promises a global audience free access to a world-class education. In fact many saw MOOCs as a revolutionary innovation and medium for liberating education by bringing courses taught by world renowned professors to remote villages and economically underprivileged communities around the world.

The most prominent factor regarding the appeal of the term *online* is that as long as there is an internet connection, learning and instruction can happen anywhere and at any time in the world. Thanks to MOOCs, students can now watch course videos in the comfort of their bedroom without struggling to stay focused at eight in the morning in a physical classroom. Because of this significant attribute, some MOOC evangelists even went a step further claiming that the role of universities will become obsolete in the near future.

And last but not least the content is offered in a course format. This means that unlike educational resources, which are freely accessible online (e.g., YouTube

videos or MIT's open courseware), in MOOCs the teaching materials are connected and structured within a timeline and with a possibility of receiving a certificate.

A combination of the mentioned attributes and the fact that a number of elite universities joined the trend of offering online courses, led to the hype around the MOOCs and the massive media upsurge. However, despite expectations about MOOCs revolutionizing access to education in deprived communities around the globe, a survey by the University of Pennsylvania in 2013 showed that most of the MOOC users were white males with college degrees (Christensen et al. 2013).

In addition, claims about the disruptive and innovative nature of MOOCs have been challenged. Many (e)learning researchers (e.g., Bates 2015) criticized that treating MOOCs as a completely new phenomenon ignores the prior research in the field of long-distant education. One example is the overemphasized role of video lectures in MOOCs; as Zahn et al. (2014) point out. While in fact peer-to-peer interaction, the key role of students and the connections they form are the components of MOOCs which enable active learning and should be highlighted. Focusing solely on video lectures ignores this potential.

No matter if you are one of the believers or sceptics of the MOOC model of education, one thing is clear: MOOCs are here to stay and are becoming more ubiquitous around the globe. Class Central confirms this notion by showing that the number of students signing up for MOOCs increased from around 18 million in 2014 to 35 million in 2015, reaching an all time high (Shah 2015).

1.2 Design Thinking Meets Video-Centric MOOCs

With the rise in popularity of MOOCs, a number of course designers began to create and offer MOOCs on non-conventional and popular topics including Design Thinking. But can the MOOC model of teaching be effective for courses that are usually not learned individually or are not purely knowledge-based? Consider a typical Design Thinking training for instance. Participants work collaboratively in multidisciplinary teams in an open and flexible space and then go through various hands-on activities and rituals led by a team of facilitators. On the other hand, the picture of an online course participant that comes to one's mind is an individual sitting alone in front of a screen (Taheri and Meinel 2015) (Fig. 1).

The skepticism about the effectiveness of teaching Design Thinking online comes from focusing only on replicating the real life Design Thinking training experience in an online environment. However, such a view neglects the opportunities and potentials that the online world has to offer. The sheer comparison between analog and digital environments doesn't necessarily take into account how well the respective environments were designed. This means whether they have incorporated the latest research and technology or if they use the full and often unique potentials of their medium. With this approach there is no doubt that replicating a collaborative and interactive learning experience of Design Thinking seems impossible in a MOOC format.

Fig. 1 The standard perception of online learning (*left*) versus design thinking training (*right*)

Such comparisons are not only relevant to the field of design. In regard to telecommunication, Hollan and Stornetta (1992) also mention the limitations of research that focuses purely on duplicating the analog experience. They propose instead to "develop tools that people prefer to use even when they have the option of interacting as they have heretofore in physical proximity". According to Hollan and Stornetta "we must develop tools that go beyond being there."

Since the goal of any training is that participants acquire new skills and knowledge, the focus of designing a learning environment—regardless of online or offline—should be on learning outcomes. When investigating the potentials of teaching Design Thinking online, we therefore focus on the pedagogies and learning outcomes rather than replicating the experiences.

2 Research Approach

Putting the skepticism aside, we started to look at the phenomenon of Design Thinking MOOCs from a research perspective. We asked the question whether it is possible to teach Design Thinking online. By the time of this study the popularity of teaching Design Thinking had already stepped into the virtual world and a handful of courses were offered on this topic. Thus, we started our investigation by looking into what is already there and how Design (Thinking) is being taught online. What are some of the practices and approaches applied in the existing courses?

Through a systematic web search we selected four Design (Thinking) courses that were running and accessible to us at the time of this research. We looked into the selected cases from the perspective of participant observers (Bali 2014) and enrolled and engaged in course activities. Since all the team members had some level of experience with both applying and teaching Design Thinking, taking the pure learners perspective was not possible. In other words we could not unlearn what we had learned already. But in order to understand the pedagogies applied in

these courses and the technical features behind each course, we engaged in an adequate number of course activities and assignments.

2.1 Theoretical Framework

In order to evaluate the performance of the existing courses regarding their pedagogical practices, we turned to the research field of pedagogy for guidelines. We applied the framework of the *Seven Principles of Good Practice in Undergraduate Education* by Chickering and Gamson (1987), which is one of the most popular and widely used instructional practices stemming from research (Bangert 2004). Chickering and Gamson highlight seven principles that, based on research, effective teaching should fulfill. These principles remain relevant and are used by educators and course designers to assure high quality teaching (Bali 2014). Good practice in undergraduate education has the following attributes:

1. Encouraging contact between the students and faculty
2. Encouraging cooperation among the students
3. Encouraging active learning
4. Providing prompt feedback
5. Emphasizing time on tasks
6. Communicating high expectations
7. Respecting and supporting diverse talents and ways of learning.

Beyond their application in the context of traditional course design, the *Seven Principles* framework translates well into the online education as well as the MOOC teaching model and can guide course designers to create good instructional practices (Siemens and Tittenberger 2009; Bali 2014).

Our aim is to evaluate to what extent the different principles of the framework were fulfilled in the courses and which pedagogical and technological features are behind the best practices. Thus a team of four researchers enrolled in the courses and each reviewer evaluated the performance in the courses regarding these principles. For this purpose we established an arbitrary rating metric: very low, low, medium, high or very high. It is worth noting that these metrics were chosen with the intention of helping us identify the best practices and the technologies and pedagogies behind them. Once all four courses were over, the research team met and discussed the ratings together and as a result an average was created that led to a more objective point of view. In general, the evaluation process was a relatively straightforward one thanks to the simple ranking metrics we chose and in most cases a consensus was reached among the reviewers.

2.2 The Selected MOOCs on Design Thinking

A systematic web search was conducted to identify MOOCs related to the topic of Design Thinking. For this purpose we used multiple MOOC aggregators and the homepages of major MOOC platforms to identify available courses. The result is a selection of four courses that were accessible at the time of the study which are presented in Table 1.

All these courses were offered on an introductory level, requiring no prior knowledge on Design Thinking from the participants. The timeframe of the courses varied from between 4 to 8 weeks and, despite some commonalities, there are some major differences among the courses. For instance, *Design Thinking for Innovative Problem Solving* (DTIP) focuses on the application of Design Thinking in the business domain whereas *Design Kit's* emphasis is on human-centered design for social innovation. The course *Design Creation of Artifacts in Society* focuses on the individual designer's working process in developing human-centered products. Apart from their focus the courses also vary with regard to their pedagogical practices and applied features, which we will discuss in detail in the following chapter.

Besides the abovementioned courses, we identified other courses which are not included in the evaluation. The reason for this is that the two courses of Design Thinking Action Lab (Stanford University) and Innovation and Design Thinking (University of Cincinnati) had concluded with no upcoming iterations being offered. In addition, the course Design Thinking for Business Innovation (Coursera) had just concluded at the time of this study and was therefore not included in our evaluation. However, although not free of charge, another course by the same instructor is included in our study.

Finally in cooperation with openHPI, SAP offers a course called Developing Software Using Design Thinking (DSUDT) on its enterprise MOOC platform, openSAP. Since the course was offered as a pilot and not open to the public it is not included in the investigated sample. However, the research team studied this course closely and had several meetings with the technical and educational course instructors. Since openSAP was developed in cooperation with HPI and they use the

Table 1 A list of the selected MOOCs on Design (Thinking)

Course name	Provider	Platform	Duration	Code
Design thinking online course	Macromedia University	Iversity	4 weeks	DTOC
Design thinking for innovative problem solving	Darden School of Business	NovoEd	8 weeks	DTIP
Design creation of artifacts in the society	University of Pennsylvania	Coursera	8 weeks	DCOA
Design kit: the course for human-centered design	IDEO.org & ACUMEN	NovoEd	7 weeks	DK

same technological features, studying this course helped us to better understand and experience the technological and pedagogical features behind openHPI.

3 Results

Looking at the four selected courses from a pedagogical perspective, using the *Seven Principles* framework, provided us with the clues about how each principle is supported in an online environment. This allowed us to answer the question of whether Design Thinking can be taught with a high pedagogical quality in MOOCs. Table 2 demonstrates the evaluation results. Since the point of this evaluation was to identify the best practices, we decided to omit the course names and refer to the courses using successive numbers.

The results show that all the seven principles have been supported in one way or another in these MOOCs, although the level in which they are fulfilled varies from course to course. Thus the pedagogical principles assuring high quality teaching can be achieved in a MOOC environment. In addition all the principles except for two, namely *providing prompt feedback* and *respecting and supporting diverse talents and ways of learning,* could be fulfilled on a *very high* level based on our evaluation metrics. *Respecting and supporting diverse talents and ways of learning* never received any rating of *high*. This raises the question of whether this principle can be supported on a higher level in a MOOC environment and if yes which pedagogies and features can enable this? Considering the fact that MOOC participants are very diverse regarding their educational and cultural background compared to a typical campus classroom, this principle becomes even more relevant and important, and offers a potential for future research.

Table 2 An overview of the evaluation results based on the framework of *The Seven Principles of Good Practices in Undergraduate Education*

	Course 1	Course 2	Course 3	Course 4
1. Encouraging contact between the students and faculty	Very low	Very high	High	Low
2. Encouraging cooperation among the students	Very low	High	Very high	High
3. Encouraging active learning	Very low	High	Very high	Very high
4. Providing prompt feedback	Low	Medium	Low	High
5. Emphasizing time on tasks	Very low	High	Very high	Low
6. Communicating high expectations	Very low	Very high	Very high	Very high
7. Respecting and supporting diverse talents and ways of learning	Very low	Low	Low	Medium

4 Best Practices

In this chapter we will highlight the best practices seen in the evaluated course and show examples of how all principles can be supported in MOOCs. The courses are presented with their given codes. Furthermore, we discuss the advantages of online courses in comparison with a typical classroom regarding some of these principles. Finally, beyond the four selected courses we report on learnings from other MOOCs and research as well as the potentials of openHPI regarding each principle.

1. Encouraging Student-Faculty Contact At first glance this principle seems very challenging to support in MOOCs. Considering the large number of students attending a given MOOC compared to the limited number of faculty members, effective contact between faculty and the students seems challenging—if not impossible. However some of the courses we observed tried to overcome this hurdle in different ways.

In the DK course, active support for student questions and discussions were provided thanks to an extension of the faculty through the introduction of two roles. The roles were: *course catalysts,* who were alumni of the course and volunteered to use their learnings to support new students, and *teaching assistants*. With the help of these extended faculty members all the students' questions were answered. In addition utilizing the pool of alumni and including them in activities related to supporting students during the course while at the same time offering former students a good chance to put their learnings into practice. On the other hand, the core faculty can take a supervision role and moderate these interactions if needed.

Another best practice was found in the DTIP course itself, which offered live Q&A session in the middle of the course. Here, the students' questions were collected in advance through a forum thread. Adjunct lecturers and community mentors also extended the faculty's presence in the forums. The DTIP course encourages interaction with the faculty on a very high level and has a full time employee to answer questions. It is worth noting that this is a paid course, which results in a lower number of participants (around 200) due to the enrolment fees and in turn makes it easier to manage effective interaction.

Another useful method and feature seen in most of the courses were the weekly emails or video announcements in which the faculty usually encourages participants to pose questions in forums and participate actively in the discussions. In one of the courses some responses to forum questions were contributed and signed by the faculty, which gave credibility to the answers.

Beyond the practices seen in the four selected courses, some MOOCs introduce course-related hashtags (#) for communication and to monitor trending topics through their social media channels. In the course Delft Design Approach (EdX) the most raised questions and topics were collected with the help of related hashtags and instructors could address them in short videos prepared weekly. This gives the impression that the faculty is constantly engaged and is monitoring the course progress instead of having one set of pre-recorded videos for every course iteration. Another common tool that offers the possibility of moving away from standardized

videos is Google Hangout. Incorporating at least one Hangout session during the course allows students to get to know the course instructors better and beyond pre-recorded videos.

These examples show that despite the fact that the number of participants poses challenges in achieving the first principle, course designers have displayed creative work-arounds such as recruiting former students, or using common technologies to overcome the hurdles; The former strategy was applied in DSUDT by openSAP, where they created a pool of "coaches" from former course students as well as interested and experienced personnel within SAP.

A relatively recent experience of openHPI offering a course called *Spielend Programmieren* Lernen (playfully learning to program), shows the importance of interaction between faculty and students (Loewis et al. 2015), especially in hands-on and interactive courses that are targeted towards novices or a young audience.

2. Encouraging Cooperation Among Students One of the best practices seen among the selected courses in encouraging student cooperation is the DK course. In this course it is highly recommended that participants form physical teams (i.e., with friends or colleagues). Prior to the start of the lectures there is a week dedicated to forming teams and signing up to join a team.

For those individuals who do not form a team, there is the option of joining already existing teams. However building entirely virtual teams might be problematic since it's required that teams meet up and go through workshop guidelines together to prepare the assignments. Moreover the course administrators provide a map that shows where the participants are located as well as a number of opportunities for in-person meetups in different cities, encouraging participants to create real life communities and stay connected.

Another good example was seen in some courses which require assignments. Here, students are encouraged to review their peers' work and give feedback. The course DCOA enforces peer review by making it mandatory for participants to give feedback on each other's work and penalizes those who do not carry out fair and thorough peer reviews by withdrawing 20 % of their final credits.

In order to spark interaction and exchange among students in the DTIP course the instructor highlights some of the students' posts from the forums in her weekly announcement. Further other students are encouraged to add comments and engage in discussions. On the impact of forum participation, a statistical evaluation of the first two courses at openHPI found that high forum participation directly correlated with better overall results (Gruenewald et al. 2013).

Some examples from other non-Design-Thinking MOOCs include instructors posting questions in forums to initiate discussion threads, encouraging students to seek inspiration by reviewing their peers' works, asking students to upload pictures from their teamwork, and encouraging students to cooperate with peers, at least in certain tasks such as brainstorming.

To facilitate peer interaction one of the solutions from the field of Computer Supported Collaborative Learning (CSCL) that is incorporated in some courses is TalkAbout (Kulkarni et al. 2015b). It connects students to their peers around the

world through synchronous video discussions. By forming international discussion teams on the course topics, they also tap into the diversity in the pool of MOOC participants.

A further solution for encouraging peer interaction is forming ad-hoc groups of participants that are online simultaneously working on a group exercise, which takes away the pain of finding a timeslot to meet (Sharples et al. 2014). In general, there is a great opportunity for future research on teamwork and peer interaction in the research fields of CSCL and Computer Supported Collaborative Work (CSCW).

The course DSUDT also applied a practice similar to DK, encouraging participants to form teams. In their latest iteration of the course, they introduced a concept called *week 0*, a week prior to the official start in which participants get acquaintance with the course environment and build teams. According to the course instructors, this leads to a significant increase in course completion.

Moreover, apart from such approaches that can be taken by the instruction team and course designers, from a techonological perspective openHPI offers features that support and facilitate cooperation between students. The platform offers a dedicated space for teams called *collab space*. This space is comprised of forums which can be explicit to team discussions (optional), uploads for different file types, google hangouts, and a virtual whiteboard called *tele-board*. In addition, it contains a group awareness feature that shows the latest status and edits of team members on a participant's dashboard. However, the weak usage of the *collab space* in the first pilots shows a need for improving usability aspects and better integration in the courses (Staubitz et al. 2015).

3. Encouraging Active Learning As Chickering and Gamson put it "Learning is not a spectator sport," in other words high quality teaching requires students to engage in projects, discussions and structured exercises (ebd., 1987). This principle is especially important in teaching Design (Thinking), which applies a project-based approach where students learn "by doing."

Some of the evaluated MOOCs went beyond teaching the process steps and methods and required students to work on a design challenge and apply their learnings. In DCOA, for instance, students had to set up their own homepage using a simple drag-and-drop website creator to upload their weekly assignments and create a portfolio and receive comments and feedback on their work. In DK and DTIP, students worked on a project. The project involved everything from identifying design gaps in everyday life to creating prototypes and uploading the work in progress for feedback. In DK there were weekly workshop guides in a PDF format that guided teams through different activities and tasks. In enforcing project-based learning, submitting all project assignments was a requirement for passing the course, along with completing the course material.

In general, MOOCs with a strong focus on learner-centeredness encourage participants to create their own content and thus step beyond passive video lectures that are common in many current MOOCs. Lloyd (2013) argues that in an online environment, this many-to-many knowledge transmission should be in the center of the course design and be supported by learning activities. This would allow

Fig. 2 Passive video watching (*left*) versus active learning in online courses (*right*)

participants from different backgrounds and expertise to be involved in the problem solving process. Videos on the other hand only add value with the right design (e.g., when embedded into relevant tasks) (Koumi 2015; Pea and Lindgren 2008) (Fig. 2).

Regarding this principle, openHPI is also experienced in offering courses that go beyond sheer video watching and self-assessment tests. Both *Spielend Programmieren Lernen* (see Loewis et al. 2015) and DSDUT have integrated practical tasks and projects in their courses.

4. Providing Prompt Feedback Students need to receive constructive feedback along their learning journey, which also presents them with opportunities for showcasing their progress. In a classroom environment, depending on the number of participants, there are various ways to assess and give feedback. These ways include tests, project results or simple verbal or nonverbal communication. The massive number of participants in MOOCs makes one-on-one instructor feedback an impossible task. That's why MOOC designers need to incorporate new strategies and build on the potentials of digital features that enable prompt feedback and reviews during the course. The most prominent strategies we observed are automated assessments, peer-feedback systems and prompt replies on forum posts.

Peer review was carried out, for example, as part of the students' assessment and final grading. To engage students in reviewing the work of their peers the DCOA course made it obligatory for students to review a certain number of peer works in order to receive feedback on their own work. The instructors provided guidelines and examples of good feedback upfront to assure a fair assessment among peers. In this way all the assignments received some feedback and comments from peers.

Automatic feedback on multiple-choice quizzes and self-assessment questions embedded in videos and course forums are some of the common practices and features applied in MOOCs. Sometimes the faculty members get engaged and respond to some questions in the forums, although due to the number of discussions and questions this is not a scalable solution.

In search of good practices beyond common solutions, it is helpful to look at e-learning for inspiration. For instance, true or false feedback in multiple choice quizzes won't help students to learn about their mistakes and how to improve their abilities, whereas providing hints that help in recognizing the right answer is

helpful. This can be achieved by offering a hyperlink to the relevant point in the video lecture or providing additional readings.

In order to facilitate prompt feedback, Kulkarni et al. (2015a) introduced PeerStudio, a platform for peer assessment that taps into the potential of a large number of participants to give feedback on work in-progress. Students who want feedback have to first submit their in-progress work and then give feedback on the work of two peers according to rubrics provided by the instructors. They can then incorporate that feedback into their work and submit again. One of the benefits of this solution is that receiving feedback on work-in-progress allows students to refine and resubmit their work. This is especially useful for design projects as receiving feedback on rapid prototypes can be very helpful for further iterations. Furthermore Kulkarni et al. (2015a) show that in a typical MOOC a median participant received feedback in intervals of no longer than 20 min. They further show the positive impact of prompt feedback on in-progress work using PeerStudio as reflected in students' final grades.

PeerStudio is a great example of a digital solution that is beneficial to both online and physical courses. Because providing feedback on all students' work in a physical classroom is time consuming as well, PeerStudio is able to reduce this time and therefore offers a solution that goes "beyond being there" (see Hollan and Stornetta 1992). At the same time, it is very important that course instructors provide clear guidelines on how to give constructive and fair feedback to peers (Kulkarni et al. 2015a).

In general it is more common to receive feedback on the end results (e.g., product artifacts) than on the learning process, even in a real life settings. Oftentimes the test grades are the main feedback that students receive. These are then relatively general and do not indicate weaknesses and where there's room for improvement Verbal and written comments might solve this problem to some levels. This is also important when providing peer feedbacks.

Regarding this principle, openHPI has also implemented a peer feedback workflow inspired by the existing peer assessment tools. However Its distribution system allows for students who provide more feedback to also get more feedback as a reward (Staubitz et al. 2016).

Experts from the openHPI team suggest that an experienced and highly motivated teaching team can provide for prompt feedback, e.g., through highlighting and linking forum posts with the same topics (using the 'sticky post' feature as mentioned by Staubitz et al. 2015). Further intelligent text-input fields can help to reduce duplicate questions and therefore make the task of providing prompt feedback more achievable.

5. Emphasizing Time on Tasks As Chickering and Gamson (1987) point out, it is important for students to learn to manage their time and allocate an adequate amount of time for effective learning. At the same time, this is also a crucial point for faculty members for effective teaching. Thus it is important to plan the tasks and learning activities with care and to clearly communicate the time needed with students.

Among the reviewed courses DTIP presented a clear guide on the amount of time needed for each task during the 8 week course plan. DK went even one step further and provided micro timing for each step and small tasks in weekly workshop guides. Weekly deadlines for assignment submissions and announcements are some of the common practices seen in many MOOCs.

Whereas the emphasis is usually reached through communication, some courses on openHPI make use of a time-script for assignments that can only be accessed once and need to be finished in a certain time span.

6. Communicating High Expectations Learning a new skill and knowledge requires time and effort regardless if the class is taught online or offline. Thus communicating clear, measurable, and demanding learning outcomes is important. Most of the evaluated courses emphasize that students need to apply their learnings to a real life design challenge in order to learn the methodology. The course DK, for instance, required students submit all four assignments in their design challenge in order to receive the certificate of accomplishment. Incorporating various tasks related to the teaching material sends the signal to students that they need to take an active role in learning—in contrast to the passive consumption of videos.

Many MOOCs seem to shy away from communicating the amount of work and preparation needed to learn the new knowledge and skills and instead keep the learning goals on the level of generic and vague statements. One possible reason is the fear that students might lose motivation and dropout. Examining how to implement meaningful tasks that maintain students' motivation while at same time fulfilling high expectations would be an interesting research topic. Despite these dangers connected to communicating high expectations three courses were rated *Very High*.

Although as the name of this principle suggests it is all about the communication between course providers and the learners, it might be interesting to think of different ways that technological features could support this principle.

7. Respecting and Supporting Diverse Talents and Ways of Working Teaching is not a "one size fits all" activity since individuals learn in many different ways. Respecting and supporting diverse talents and ways of learning is one of the most challenging principles for course instructors to fulfill in real life. It requires them to provide various opportunities and media for their students to choose from. At the same time it is necessary to offer students diverse opportunities to showcase their learning progress.

Many MOOCs, however, tend to put the video lectures in the center of their course, often combining it with multiple choice quizzes and some additional readings. Apart from standard approaches, the course DK provided most of the content in readings combined with visuals in a PDF format. There were short weekly videos, but the main focus was on the readings and workshop guidelines. Moreover, DK offered students various design challenges to choose from: students could either pick one of the three pre-defined challenges offered by the course designers, or identify a challenge from their own social context and apply their learnings to it.

One of the major factors differentiating a MOOC from a campus course is having a massive number of participants from all over the world with diverse cultural and educational backgrounds. Thus apart from supporting the different learning preferences of individuals, language barriers (e.g., non-natives), technology limitations (e.g., internet access) and cultural differences should also be taken into account. In fact while designing a MOOC, designers should consider their global audience and the context in which the course material will be used. For instance creating high quality videos might not be useful for those without a good internet connection and low bandwidth. Another factor in designing a course with a global audience is the language barrier. Avoiding references and examples that are specific to the course providers' culture, including subtitles in the videos or providing a text version of the video lectures are among some of the helpful approaches.

Despite the seemingly challenging nature of this principle, the digital setting seems better suited to treat a massive number of learners individually than a typical classroom. This offers an interesting research opportunity in the field of adaptive learning environments.

Regarding this principle, HPI-run platforms offer solutions such as introducing bonus tasks for those who wish to learn more than the requirements, and different paths and learning journeys for participants to chose from in the course. However incorporating these solutions into a course increases the workload (and eventually the cost) for course designers, as mentioned by the experts.

General MOOC design recommendations derived from the best practices	
Encourage student-faculty interaction • Offer Q&A sessions in the middle of the course to answer the most raised student questions • Extend faculty's appearance by engaging adjunct lecturers and volunteers (e.g., alumni) as moderators *Encourage cooperation among students* • Recommend students to form teams and try to have physical meetings to prepare the assignments • Encourage students to organize in-person meetups • Establish central role of peer review in all assessments • Pick up interesting but unanswered student posts in weekly announcements and encourage others to reply *Encourage active learning* • Let students create their own learning portfolio (e.g., by setting up a personal homepage) • Create a procedural journey with consecutive tasks throughout the weeks	*Provide prompt feedback* • Make peer feedback obligatory for course completion • Apply CSCL/W tools that facilitate peer-review *Emphasize time on task* • Offer (weekly) guidelines that clearly communicate how much time should be allocated per each task • Suggest micro-timing for smaller tasks (e.g., for different brainstorming techniques) *Communicate high expectations* • Communicate your expectations through course videos • Set demanding tasks *Respect diverse talents and ways of learning* • Provide all course materials in a single PDF for those who prefer reading or have limited internet access • Give students options to submit their assignments through different media (e.g., PDF or video) • Provide subtitles • Be mindful of the global audience and

(continued)

General MOOC design recommendations derived from the best practices	
• Provide templates and encourage learners to complete them in teams	potential cultural differences • Integrate bonus tasks or alternative paths

5 Insights from Experts Interviews

In March 2015 we had the chance to conduct interviews with a number of experts involved in MOOC and Design Thinking curriculum-design, both in executive and in student programs at the d.school Stanford. One of the main focuses of the interviews were the challenges and opportunities for teaching Design Thinking online. In this chapter we present a selection of insights that were synthesized from the interviews by a team of four researchers.

Regarding the challenges and limitations of the online world for Design Thinking education, some experts mention the challenge of creating a state of flow in online world, which is very distinctive for real-world Design Thinking trainings. Creating "hooks" and engaging tasks that maintain the audience's attention in an online scenario might be a solution to this problem. Furthermore, the co-location of team members was mentioned by some experts. One of the interviewees pointed out that being accompanied by another person is crucial in developing empathy, overcoming personal bias and integrating a second perspective. Finally, despite the benefits of diversity among the virtual teams, the difficulties arising from cultural differences in cross-cultural teams were also mentioned in one of the interviews.

Despite the abovementioned challenges, most of the experts saw great opportunities and advantages in an online Design Thinking training. While in a typical training there is one format offered to all participants; online, adaptive learning and individualized training can be achieved. Moreover as learners advance in their learning process and become more proactive, there is a need for a contextualization of their learning process. According to some experts, this need is (left) unfulfilled in structured workshop trainings.

In a typical Design Thinking training, participants go through various activities in a fast pace. Although some use design documentations to capture their main activities, many details get lost in the process. The fact that everything is recorded in a digital environment not only enables the possibility to document what's going on. It also provides participants a great chance for reflection on their learning journey. An interviewee points out the benefits of peer-learning in an online environment, he described as "crowdsourcing effects." The instructor compared his experience of teaching a university course with a MOOC he had taught. In the MOOC he had observed a greater number of high-performers willing to take over responsibilities, such as acting as team leaders or moderators, compared to his classroom course. Another opportunity, seen from the instructor's perspective, is the need to be more precise and concise when giving instructions in an online course. This is due to the lack of live teacher-student interaction. In other words, instructors must make sure that content is understandable and to the point. Some

experts stated that their experience preparing a MOOC has enhanced their instruction in the classroom.

Scalability was also mentioned as an asset of the digital Design Thinking education. The practice of scalability empowers individuals with the tools and methods to tackle complex problems in their communities. Finally, as a recommendation it was mentioned that a technology-mediated learning environment should not try to copy the real world but build on its unique possibilities.

6 Summary and Outlook

In this work we have tried to answer the question of whether it is possible to teach Design Thinking effectively in an online environment. We started by looking at MOOCs that are offered on Design Thinking through the lens of the pedagogical framework of the *Seven Principles*, while taking into account the technological features and functionalities behind the course pedagogies. We concluded that although challenging at times, the principles that assure high quality teaching and are used by course designers in real life can also be well satisfied in an online course. Interestingly, some principles can be supported even better in an online environment than in a typical classroom thanks to technological advancement. We further highlighted some of the best practices exhibited in the evaluated courses as well as outstanding examples from research, other MOOCs and experiences from the HPI-run platforms openHPI, openSAP and mooc.house.

In conducting research on learning and teaching Design Thinking online, it is worth noting that although Design Thinking and MOOCs have become popular in recent years, there is a lot to learn from various established research streams such as distant education, pedagogy, and design education.

In this light, in comparing the effectiveness and quality of different courses, it is important to focus on learning outcomes rather than learning experiences. This is also the focus of our future research. In other words, instead of aiming at replicating the experience of a real life Design Thinking training to an online environment, we will investigate the desired learning objectives of Design Thinking education.

For our future work, building on the principles that assure high quality teaching as well as aiming for achieving a set of realistic learning objectives, the research team will create an online course on the topic of design thinking. We have the great chance of collaborating closely with openHPI which, as mentioned above, allows for the fulfilment of the principles required for good teaching, on a relatively high level, with its various technological features as well as a highly experienced team behind the platform. Following a design based research approach we will create interventions and survey acceptance as well as effects on the participants' learning progress. Furthermore, by researching Design Thinking and MOOCs we expect a positive side effects for MOOC research in general in other fields from the perspective of didactics, course design as well as technical support and the feature set. potential new features.

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