IPSDS Assessment Report #2

Flipping Classroom in Online Courses for Working Professionals: Challenges and Opportunities for Student Engagement

Evgenia Samoilova

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University of Mannheim

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1. Introduction

Until now meta-analysis studies failed to establish significant differences in outcomes between online and traditional classroom learning (Means, Bakia, & Murphy, 2014). Given different purposes, target groups and contexts of use of these two formats, their general comparison is hardly beneficial for further development of the field. Hence, some authors argued for shifting the focus of online learning research to identifying strengths and weaknesses of various online and blended-learning designs given specific objectives, learners and contexts (Fishman & Dede, 2015).

In the recent years, the flipped classroom design (also referred to as "inverted instruction" or "inverted classroom") attracted quite a lot of attention among researchers and practitioners alike (Prober & Khan, 2013). Although there is still some disagreement on what exactly constitutes the flipped classroom (FC), the common denominator of the definition suggests that FB includes rotation between two components: (pre-class) students' interaction with course materials and the actual in-class interaction (He et al., 2016). The "flipping" in this case stands for substituting traditional in-class lecturing with guided interaction, since lecturing can be done outside of the class for example via providing students with pre-recorded video lectures (Lage, Platt, & Treglia, 2000). Flexibility and engagement are often key variables of interest in FC research (Poon, 2017; Thai, Wever & Walcke, 2017; Hew, 2016). Advantages of flexibility are quite straightforward. When learning materials are offered online and asynchronously, students can engage with the material at any time, at their own pace, and regardless of their location. The aspect of engagement on the other hand requires a more detailed elaboration. Although engagement is often defined in different ways (see Ainley, 2012; Skinner & Pitzer, 2012), this concept is primarily used to refer to one's interactions with the learning environment (Järvelä & Renninger, 2014). Engagement literature also agrees on differentiating between behavioral, emotional, and cognitive types of engagement (Fredricks et al., 2004). Although FC design is expected to be more engaging due to increased flexibility and possibility of self-paced mastery (e.g. watching video-lectures at one's own pace), components of the FC design vary in a number of ways with different implications for student engagement. In addition, recent critique of online learning supporting (instead of overcoming) education disparities (Hansen & Reich, 2015; He et al., 2016), suggests that attaining a desired level of engagement across various subpopulations of online learners is a difficult task.

Against this background, understanding the learners, constantly evaluating and tailoring courses accordingly is highly important. This report describes implementation of FC for an international online program (International Program in Survey and Data Science (IPSDS)) designed for working professional in the field of survey and data science. It is structured in five sections. The following section describes relevant characteristics of IPSDS students. Section three discusses main featured of the implemented design and evaluation strategies used to guide further development and change. Sections four presents evaluation results based on the three qualitative intervention studies. Conclusion summarizes the key findings and limitations.

2. IPSDS Students

The International Program in Survey and Data Science (IPSDS) is a program for working professionals at the University of Mannheim that has been funded by the German Federal Ministry of Education and Research with the purpose to establish an online Master's degree program. The modular curriculum of the program is designed for people with a strong professional background who work with data on the daily basis, yet lacks sufficient data education or would like to advance her or his data expertise. Since the nature of data, their availability, the way in which they are collected, integrated, and disseminated have been changing a lot in the recent years, continuous education in survey and data science is on demand among professionals across various sectors and areas. Given that for those who work full- or part-time and/or have family responsibilities being part of a traditional degree program with physical presence requirements is extremely challenging, online delivery was chosen to make the program feasible. A 4-year funding (2014-2017) allowed to recruit two cohorts (in total 31 students) who could participate in the program free of charge and in turn contribute to program evaluation.

A web-based start-of-the-program survey conducted in February 2016-March as well as administrative data collected via application forms provided relevant information on the IPSDS student characteristics (the response rate for the survey was 100% for both cohorts). The two selected cohorts are a highly international body of students from15 different residence countries in total. While most students come from Europe (n=25), other countries include Chile (n=1), Brazil (n=2), Mexico (n=1), Oman (n=1), Qatar (n=1), and Kenya (n=1). In both cohorts, students are employed across the private, public and non-profit sectors. In total eight participants are employed in statistical agencies. Although the IPSDS participants differ in their professional biographies and backgrounds, they are very similar in their limited time due to long work hours, family responsibilities and/or commuting time. Most of the IPSDS participants are full-time employed (1st cohort: Median=41, SD=5.6; 2nd cohort: Median=43, SD=9.8). While only four students reported working less than 40 hours a week, 16 students regularly work over time (more than 40 hours a week). The share of men and women is almost equal (18 women and 13 men). Eight participants combine full- or part-time job with family duties (underage children or elderly parents). Most participants also spend at least some time commuting (1st cohort: Median=3, SD=2.5; 2nd cohort: Median=5, SD=4.0).

Given that all of the IPSDS students reported to have very limited time due to their long work hours, family responsibilities and/or commuting time, it is not as surprising that the online format constituted an important reason to apply for the program. In answering the question "How important were the following reasons in choosing to apply for the IPSDS program?" (1-Not at all important, 2-A little important, 3-Somewhat important, 4-Very important), nine students in the 1st cohort and 10 students in the 2nd cohort indicated that the online administration was very important for their application decision.

3. IPSDS Design and its evaluation

The IPSDS FC design consists of two elements: 1) (pre-class) interaction with course materials and 2) guided learning activities.

(Pre-class) Interaction with the course materials:

The (pre-class) course material is delivered asynchronously on the course website (currently Moodle). Materials include pre-recorded video lectures, readings (required and recommended), programing exercises, other additional resources. Instead of simply uploading resources on the web (as practiced in many educational settings), the IPSDS design emphasizes students' ability to interact with the resources. For example, video lectures make it possible for students to pause, move forward or backward within the video, as well as change the video speed (both increase or decrease the speed) (see Fig 1). In addition, lectures for each unit are also broken into smaller segments to allow focusing within relatively short time windows, since the latter are common for working professionals.

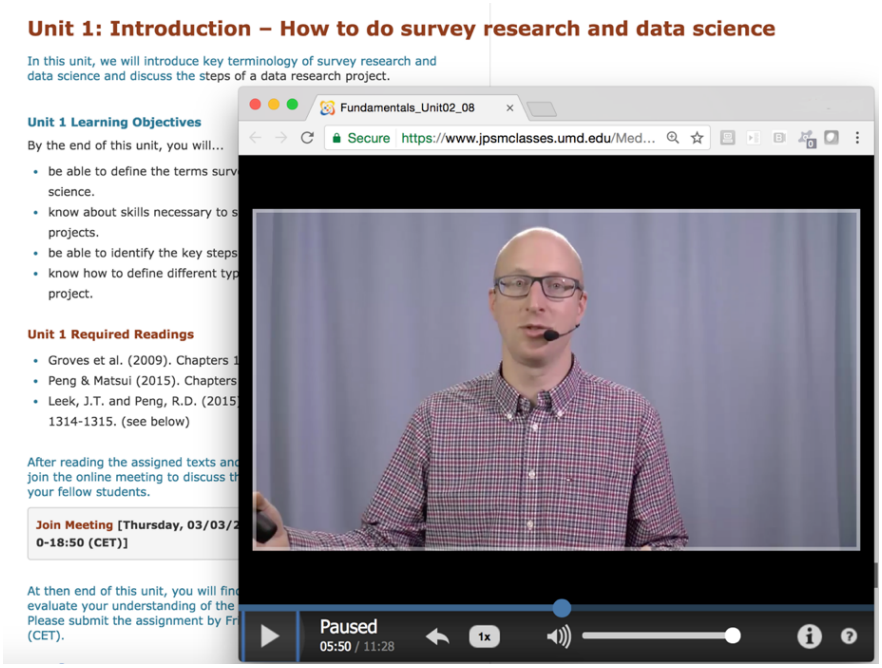

Figure 1. An example of a Moodle course page with provided resources

Guided learning activities:

The in-class activities of the FC design are conducted with the help of online video conferencing (currently Zoom) and discussion forums (see Fig. 2). Each week, students join an online session that lasts from 50 minutes to one hour. Participation in the online sessions is obligatory for students and usually accounts for 10% of the final

grade. The sessions are organized with small groups of students (max 18 participants) and are aimed to give students an opportunity to discuss their questions, get immediate feedback from the main instructor(s) (not a course TA) and help students stay motivated by connecting to the peers and instructors. Before joining the discussions, students are expected to go through the course material and prepare their questions. The meetings are also scheduled in such a way that they take place before students have to submit their (bi)weekly assignments to give them an opportunity to clarify all possible questions. The discussion forums are used to allow for additional (often optional) communication (e.g. pointing to relevant news, websites, articles, etc.).

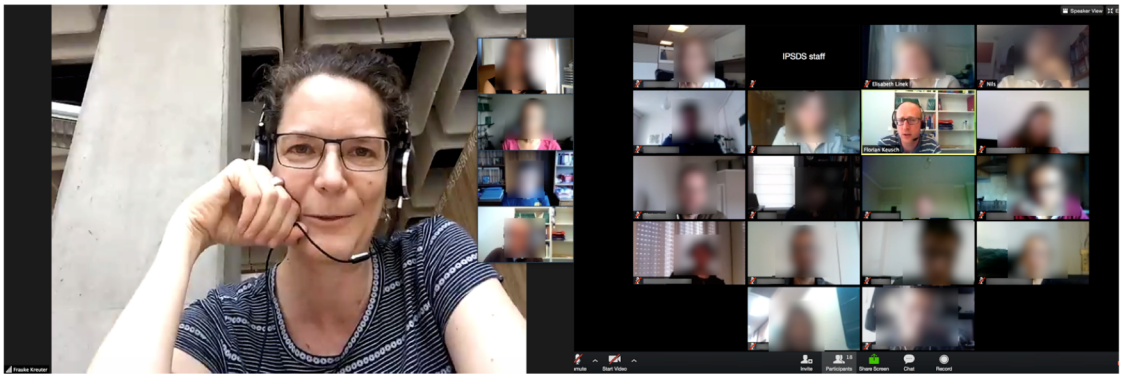

Figure 2a/b (from left to right):
a. Zoom interface in speaker view; b. Zoom interface in the full screen view. Faces (other than the authors') are blurred for privacy reasons.

Further design features:

Means et al. (2014) suggested a list of further design features that could be helpful in describing and comparing online- or blended-learning course designs. Below, we use some of these features to elaborate on the used FC design in more details.

- *Pacing of the instruction*: In order to preserve a cohort-based structure as well as small class sizes of the classes, the pacing is relatively fixed. The length of the courses ranges from four (1-credit point/2ECTS) to twelve (3-credit points/6 ECTS) weeks. To help students engage in learning on regular bases and avoid binge learning at the end of the course, the pace of the course is divided into theme-based units that usually correspond to a calendar week. Each topic/unit progress is assessed upon the respective week's end with the help of the graded assignments.

- *Assessment*: Instructors use both formative (asking students to submit their questions) as well as summative (paper, quiz, programing assignment, presentation, etc.) assessment tools.

- *Feedback mechanism:* Types of feedback include immediate automated feedback in quizzes, detailed feedback provided by the instructor for (bi)weekly assignments

and online discussions, as well as in some courses peer-to-peer feedback. Peer-to-peer feedback is in-turn evaluated by the instructor(s) and discussed in class with other participants.

- *Level of interaction* (instructor/student-students): Due to intentionally small class sizes, the degree of interaction between instructor(s) and students is very high. In addition to mandatory weekly meetings, students interact via receiving feedback for their assignments as well as using discussion forum or/and email for additional communication. The level of interaction between students differ from course to course and depends on the course subject and assignments (i.e. more interaction in courses with peer-to-peer or group assignments).

In order to make sure that the course design corresponds to students' needs and learning outcomes, evaluation of the program includes systematic data collection from various stakeholders. With respect to the course design, the following data sources are used:

- *Post-course student survey*: At the end of each course students are invited to take part in the post-course-evaluation-survey. The self-administered web-based surveys are programmed in Qualtrics. The questionnaire includes questions about learning experience of students and their perceptions of teaching quality and various online course elements.

- *Learning analytics*: We are currently testing the use of anonymized learning analytics logs of online activities. The purpose is to help instructors improve their course materials (especially video lectures) by providing them with visualized anonymized data at the aggregate level (e.g. which parts of the video are skipped and which are watched repeatedly). The later in combination with other data sources can help improve video lecture quality and learning experience of the students.

- *Interventions*: In addition to regular course evaluation, the IPSDS conducts small-scale interventions in single courses. Such interventions serve the purpose of evaluating design components against education research by testing new approaches.

Sections below describe results obtained from the above mentioned interventions. Up to date, we have conducted three interventions aimed at investigating behavioral and emotional engagement of students given changes to the following dimensions of the FC course design: synchrony of main online communication, presentation of video material, and pacing of the course material. The studies were conducted during the period from February to September 2016.

4. Interventions

Synchrony of online communication

One of the most important design dimensions in online learning constitutes the synchrony of instructor-student and student-student communication (Means et al., 2014). Interestingly, online learning literature rarely differentiates between different media used in both synchronous and asynchronous communication modes (e.g. which components are synchronous or asynchronous: text, audio and video or their combinations). Instead, interaction is often categorized as asynchronous, synchronous or a combination of both, regardless of the used media. Asynchronous communication is often referred to as most frequently used mode of communication in computer-based education (Oztok, Zingaro, Brett, & Hewitt, 2013). Literature reviews of studies on asynchronous communication suggest that it can be best applied for discussion of and reflection on complex topics (Hrasinski, 2008; Oztok, Zingaro, Brett, & Hewitt, 2013). Since asynchronous communication does not require immediate response, it is argued to provide more time for reflection and hence to increase time students invest in respective course activities (Meyer, 2003). Main advantage of synchronous communication is expected to be higher level of social presence (Oztok et al., 2013).

The current study was conducted in two IPSDS introductory courses taught consecutively by two different instructors. The 1st course *Fundamentals of Survey and Data Science* took place between February and May 2016. The main student-student and student-teacher communication was conducted synchronously via weekly 50-minute online discussions (at the time Bluejeans software was used for video-conferencing). Although students could use discussion forums, it was not obligatory and they were used for optional activities (e.g. sharing links to relevant materials). Upon the completion of this course, 15 out of the original 16 IPSDS students engaged with another 3-month course *Data Collection Methods*.[1] In this course, we have changed the main mode of communication from synchronous to asynchronous. Although the very first meeting covering introductions and course overview was held synchronously, the rest of the communication took place within asynchronous discussion forums. In both courses, obligatory components of participation included posting questions and answering/commenting on questions of other students. This obligatory activity had to be administered via synchronous (first course) or asynchronous (second course) communication and accounted for 10 % of the final grade in both courses.

Behavioral engagement as a part of graded course participation (asking questions and commenting on questions of other students) in the two courses had to be measured differently. In the synchronous course, the length of the online sections was constant throughout the course. Since instructors recorded participants' presence or absence during the online sections, it was easy to collect data on the amount of time they spent on the synchronous participation. In the asynchronous course, students' time investment in the discussion forum had to be measured via survey self-reports.

[1] One participant decided to take another course offered at the time. Only *Fundamentals of Survey and Data Science* was mandatory for everybody.

At the end of each week-based unit, students were asked to report how much time (in hours) they spent on engaging with discussion forums to post and answer questions[2]. The web-based surveys were programmed in Unipark EFS survey software (version EFS 10.9). Although most students reported to have spent on average more time on participation in the discussion forums (average minutes/week: M=54.2, SD=24.1) compared to the synchronous meetings (average minutes/week: M=44.7, SD=6.0), variation in the self-reported time spent on discussion forums is high and the difference between the two means is rather negligible (only two students reported an average difference larger than 30 minutes). Paired t-test indicated that the differences were not statistically significant ($t(12) = -1.45$, $p>0.1$). While all of the registered participants successfully finished the first course, during the asynchronous course 2 out of 15 participants dropped out. As reasons for the dropout, one participant indicated lack of time, while another referred to personal circumstances.

Emotional engagement was measured via survey items on social presence (emotional connection to instructor(s) and students) upon the end of each course. Students were asked how true each of the following statements was: 1) I felt connected to other students through the weekly discussion sessions/ discussion forums; 2) I felt connected to the instructor through the weekly discussion sessions/ discussion forums (1-not true, 2-slightly true, 3-somewhat true, 4-very true). The perceived connection to other students was almost identical in both courses (weekly meetings: M=2.8, SD=0.9; asynchronous forum: M=2.8, SD=0.8). Although students reported to have felt a bit more connected to the instructor during the weekly meetings compared to the forum discussion, paired t-test indicated that the difference was very small (weekly meetings: M=3.2, SD=1.0; asynchronous forum: M=2.7, SD=0.9) and not statistically significant ($t(12) = 1.07$, $p>0.1$). Nevertheless, qualitative interviews (n=12) demonstrated a strong preference towards synchronous communication mostly due to (as reported by students) a stronger sense of community and belonging. Only two students preferred the asynchronous communication (via discussion forum). As main reasons for their preferences, they named greater flexibility and smaller workload (these students were among the only four who reported to have spent less time on the discussion forum than on synchronous online meetings). The rest of the students preferred synchronous online meetings. All of them reported that they prefer synchronous online meetings over asynchronous discussion forums, because regular live meetings helped develop a sense of community and belonging. Three students also added that regularity of the online meetings (i.e. takes place every week for a fixed amount of time) helped them with their time management. Four students preferred being able to ask spontaneous questions and receive immediate feedback instead of having a delayed answer via forum. Five students admitted that they did not read all of the posts on the discussion forum. Eight students felt they learnt less from the asynchronous discussion forums compared to the synchronous meetings. It is important to note, that although in the second course, students were offered to meet for study groups activities (via synchronous online meetings) on a regular basis (software was provided and meeting dates were suggested in the syllabus), none of the students used this opportunity.

[2] In a follow-up study, students were asked to report their study workload for various activities in minutes. The cognitive interviews however indicated that all of the students estimated their weekly workload in hours and then converted it into minutes.

Although we did not observe notable differences in behavioral engagement, most students prefer regular synchronous meetings over regular communication via asynchronous forums. Reasons reported by most of the students included emotional engagement (sense of belonging to a community) and perceived learning. The failure of the survey instrument to detect the difference could be traced to a small sample size and potential validity problems (social presence is only one particular aspect of emotional engagement). Given that combining studies, work and family responsibilities over a long period of time is challenging, enhanced sense of belonging and perceived learning can be an important motivational factor. Although only three students reflected upon the importance of regular and obligatory live meetings for their time management, it should be explored further, since time management is one of the biggest and unresolved challenges for online professional education (Kizilcec & Halawa, 2015; Nawrot & Doucet, 2014).

Content scaffolding

The second study centered around the content of the video-lectures. While a number of recent studies have been focusing on the format and length of video-lectures (Kizilcec, Bailenson, & Gomez, 2015), the role of content in supporting student engagement (especially in the context of adult learning) was not sufficiently covered. Research suggests that content scaffolding could promote interest and motivation and hence increase one's engagement (Järvelä & Renninger, 2014). In this study, we have focused on one particular way of content scaffolding - promoting utility value (Hulleman & Harackiewicz, 2009). The utility value scaffolding was implemented by supplementing course video lectures with videos of interviewing experts with the focus on practical application of topics covered in the respective video lecture (see Figure 3 for an example).

The study was implemented in the same course used for the first study *Fundamentals of Survey and Data Science* – a three-month introductory course aimed at introducing students to the main terminology and concepts in the field. Given that the course introduces a broad spectrum of topics, elaborating on topics' real-life application could help students to better understand the relevance and importance of the covered material. Four out of 12 weeks of the course were supplemented with the expert interviews. The choice of the weeks for the additional material was primarily guided by the unit content (i.e. units with topics that most lend themselves to the expert interviews were selected). Because interview videos were used as an additional material, units with the expert interviews were on average slightly longer than units with no interviews (on average unit with no interviews and those with the additional material contained about 84 and 96 minutes of video material respectively). Video material in each course unit was split into several videos (between four and nine video segments). Interview videos were always placed as the last video segment in the sequence.

Figure 3: Example of a video of interviewing an expert. The respective course unit covered the topics of various modes of survey data collection. In this interview, the course instructor interviews the manager of the Survey of Consumer Attitudes conducted by the University of Michigan. The interview addresses changes in the mode of this survey as well as practical aspects of survey operations.

Behavioral engagement in this study was measured via Learning Analytics – log data of student activity collected by a software tool Mediasite. Videos were embedded in the learning platform Moodle for streaming. The data on video watching (including how much of a specific video was watched (in percent) and how long the video was played by each student) was collected for each video. Learning analytics data were strictly confidential and were collected upon receiving informed consent of the participants. Since interview videos were always placed last in a video sequence for a respective unit, for each student we have compared percentage of the watched video material for interview videos versus last video segments (hence keeping the placement constant) in other course units. Although students watched on average 44 % of the interview-video material compared to 53 % of last videos in other units, paired t-test showed no statistically significant difference ($t(15) = -1.44$, $p>0.1$). However, last videos in all of the units were viewed less than those placed earlier. For example, participants watched on average 81 and 76 % of the first videos in units with and without interviews respectively. Moreover, there were only six students who watched at least 50% of the interview videos. Five out of them were the same students who watched at least 50% of the last video in other units. Given a small sample size, it is difficult to compare these two groups of students with respect to other characteristics. Visualization of the data showed only one notable difference - the amount of free time that they reported in the course weekly survey. Those who watched at least 50% of the lecture-videos placed last within a unit reported to have more time for leisure (see Fig 4). Qualitative interviews conducted with the students at the end of the course (n=13) indicated that some students perceived interview videos as optional material (no reference to them as optional material was made in class). The latter could be explained by the placement of the interview videos (as a last video in the sequence) as well as the lack of explicit reference to these videos in the assignments.

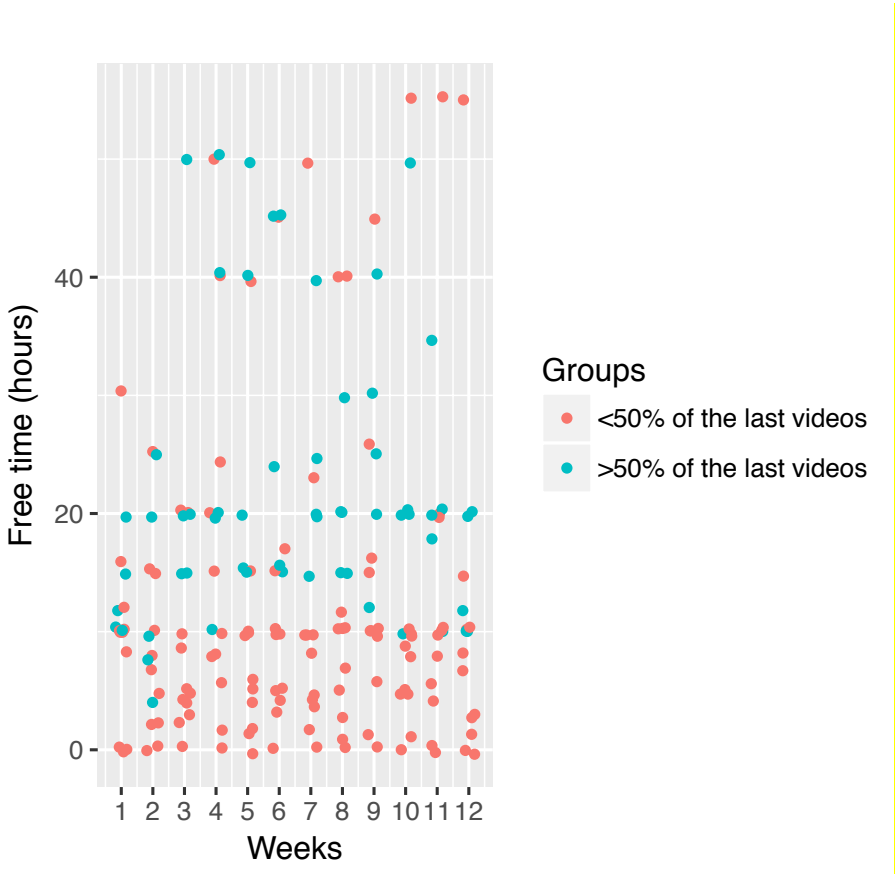

Figure 4: Plot of self-reported free time (in hours) for each week of the course by two student groups (those who watched less or more than 50 % of the last video material)

While no differences in behavioral engagement were observed, future studies applying a similar approach should consider expected increase in overall workload (high increase can lead to favoring those with more leisure time available), placement of the material (early exposure is preferred) as well as make sure that the intervention material is not perceived as optional (e.g. connecting it to the course assignments).

Self-paced format

Flexibility is considered to be an important strength of online learning when compared to face-to-face options. Students often refer to flexibility as a main reason for or a benefit of online formats (Smyth, Houghton, Cooney, and Casey, 2012). Some authors argue that students focus on flexibility over actual learning benefits of online learning, because costs of not having flexibility of time and place for learning (e.g. having to commute) are too high and can prevent learning all together (Daymont & Blau, 2011). Therefore, despite emphasized advantages of flexibility by students, online learning designers need to provide sufficient flexibility and yet take into account difficulties that come hand-in-hand with flexibility such as greater need for time-management and self-discipline (Shapiro et al. 2017). In other words, choosing the right degree of flexibility while supporting students' motivation and time-management is a highly important task that needs to be tailored to learning objectives and learners' characteristics.

All of the IPSDS courses are characterized by fixed deadlines for assignments on a weekly or biweekly basis. The purpose of the last study was to explore a possibility of providing more flexibility to the students by employing a predominantly asynchronous mode of communication in combination with self-paced learning elements. Although self-paced (or independent) learning is often contrasted against instructor-paced learning, it should rather be viewed as a continuum. In the respective study, students had to start and finish the course within the defined time framework (eight weeks), but could decide on when they want to submit course assignments (in total five assignments) within the time framework of eight weeks. The final test also had to be taken within the defined time framework – the ninth week of the course. To help students manage their time, the syllabus included a suggested schedule for working on the course assignments. At the very start of the course, students were obliged to participate in a synchronous introductory 50-minute online conference led by the instructor. The study was conducted in the course *Casual Inference from Randomized and Observational Data* that took place between July and September 2016. Since the course was not required, only eight of the participants chose to participate. Only four out of eight students managed to finish the course. Moreover, only one student (among those who finished) followed the suggested schedule. The rest of the students finished the course within the last two weeks (used 50% less time). During qualitative interviews, conducted at the end of the course all eight participants mentioned time management as one of the biggest challenges to finish the course. Although all of the students mentioned that they appreciate a certain degree of flexibility with assignment deadlines (e.g. in case of unplanned and urgent deadlines at work or family responsibilities), only one student had no difficulties with time management. Similar to the results reported in study #1, two out of the four who completed the course reported that they learnt less from using the discussion forums when compared to the regular online meetings.

5. Discussion and Conclusion:

The design of engaging digital learning environments for non-traditional students requires more research on experiences of learners and instructors in small scale (non-MOOC) settings. Even with a high teacher-student ratio, the course designers may need to take active steps to address major educational constrains (e.g. lack of flexibility) without compromising the quality of student engagement. In this report, we have described the IPSDS flipped classroom design features as well as attempts of its further improvement. It is important to note that due to strong limitations of the small-scale studies such as confounding of time when the courses took place, different instructors as well as small sample sizes, only qualitative conclusions are possible and studies can be used as pilots for designing larger subsequent studies.

The above described pilot studies did not indicate any strong evidence to introduce major changes to the main course design described in section 3. Working with asynchronous discussion forums instead of synchronous video conferences did not result in students investing notably more time in communication. Instead the predominantly asynchronous format was associated with a diminished sense of community as well as decrease in perceived learning when compared to the format with live online meetings. The content scaffolding via adding expert interview videos indicated problems with implementation that should be considered in further studies.

Introducing the self-paced format to one of the courses and allowing students choose submission deadlines of the course assignments resulted in time-management problems coalesced with binge learning and dropouts. Two of the pilot studies made it clear that sense of community as well as the ability to manage one's time (both aspects can be linked to motivation) should not be underestimated in helping online students to succeed. Research on Massive Open Online Courses (MOOCs) also points out that isolation (Alario-Hoyos et al., 2013) and belonging (Kizilcec, Saltarelli, Reich & Cohen, 2017) as well as problems with time management (Shapiro et al. 2017) constitute one of the biggest challenges for retention in online courses. The pilot studies indicated the potential of regular online video conferences with small classes to address these problems (at least within the above described context).

Despite small sample sizes, the pilot studies identified heterogeneity of students' preferences. While the question whether meeting students' preferences in online learning directly translates into better outcomes is an important research question in its own right (Kizilcec, Bailenson, & Gomez, 2015), providing personalization of learning experiences within small-scale online courses can be challenging. While online large-scale courses (so called Massive Open Online Courses – MOOCs) usually run with thousands of students per sessions, who then in turn could be split into various tracks (e.g. depending on their preferences of working with synchronous or asynchronous communication), the main advantage of small scale courses is easy access to the course learning community and personal communication with its members. Therefore, splitting the small online class into separate tracks can be a problem, since it can impede the quality of the in-class communication. At the same time, a certain degree of personalization (e.g. being able to access the entire course material at the start of the course and finish assignments earlier) should still be possible.

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