Monitoring and supporting students in their learning – Example of a flipped hybrid course

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Monitoring and supporting students in their learning – Example of a flipped online and hybrid course *

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Abstract

This paper describes and evaluates an open advanced computational nuclear reactor physics course for students and professionals, offered in a flipped online and hybrid format. The preparatory phase consists of reading a handbook, watching short, pre-recorded lectures, and answering online quizzes. This is followed by a week-long set of synchronous, interactive sessions, during which the students discuss and reflect on various problems/questions and complete several hands-on assignments. Student participation, performance and satisfaction were analyzed. It is demonstrated that, thanks to the course design, high student engagement, performance and satisfaction are achieved. Significant differences in engagement and performance can nevertheless be noticed depending on whether the students participate in the synchronous activities onsite or remotely.

Sammanfattning

Den här artikeln beskriver och utvärderar en öppen, avancerad beräkningsbaserad kurs i kärnreaktorfysik för studenter och yrkesverksamma, som erbjuds i en flipped online- och hybridformat. Förberedelsefasen består av att läsa en handbok, titta på korta, förinspelade föreläsningar och besvara online quiz frågor. Detta följs av en veckolång serie av synkrona, interaktiva sessioner, under vilka studenterna diskuterar och reflekterar över olika problem/frågor och genomför flera praktiska uppgifter. Studenternas deltagande, prestation och tillfredsställelse analyserades. Det visades att högt studentengagemang, prestation och tillfredsställelse uppnås tack vare kursens utformning. Signifikanta skillnader i engagemang och prestation kan dock märkas beroende på om studenterna deltar i de synkrona aktiviteterna på plats eller på distans.

Keywords: *flipped classroom; active learning; hybrid teaching; online learning.*

1 Introduction

Advanced courses outside the regular curriculum or for professionals are often given as intensive “workshops” or “summer courses”. Limited to very few onsite students, the condensed, on-site format of such courses often focuses on traditional lecturing. The high pace of the courses and the limited use of active learning techniques result in poor student participation and engagement, and thus in poor learning. Online and hybrid learning environments eventually provide more accessibility and flexibility, but are often characterized by low engagement and high drop-out rates (Eriksson et al., 2017).

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Thus, there is an ongoing need to share and evaluate learning designs – in particular hybrid set-ups – that attempt to mitigate the weaknesses of online and traditional courses and foster their strengths. In the Horizon 2020 GRE@T-PIONEeR project (https://great-pioneer.eu), several advanced courses in computational nuclear reactor physics are offered as flipped online and hybrid courses. The course design mainly builds on the extensive literature about active learning (Freeman et al., 2014) and the flipped classroom approach (Stöhr & Adawi, 2018). Drawing on constructivist and social-constructivist perspectives on learning, the flipped classroom concept emphasizes the role of active learning as a better means to construct knowledge compared to traditional lecturing (Poh et al., 2010) and the importance of scaffolding by teachers and peers. Learners are typically encouraged to watch video lectures or read texts as preparation for class, and classroom time is dedicated to more active forms of learning, such as peer instruction or collaborative problem solving (Stöhr & Adawi, 2018). The flipped (or inverted) classroom method has been subject to extensive research with review papers published (e.g., Bishop & Verleger, 2013; O'Flaherty & Phillips, 2015; Karabulut-Ilgu et al., 2018) summarizing existing evidence of its effectiveness for learning, its benefits and challenges for both teachers and students.

In this paper, we aim to contribute to this field by evaluating one of the developed courses. The course, titled "Core modelling for core design", was simultaneously offered as an online course and a hybrid course. Our research questions are:

(1) What are the overall results and differences between the online and hybrid learning paths in the flipped course in terms of student activity and performance?
(2) How satisfied are participants with the flipped course design?

The course is based on the continuous development and assessment of different pilot courses by the authors during the last years (see, e.g., Demazière, 2020; Stöhr et al., 2020). The asynchronous learning phase of four weeks consists of reading a set of handbooks, watching short, pre-recorded lectures, and answering online quizzes. In case participants complete a sufficient fraction of the preparatory work, they are admitted to a week-long set of interactive synchronous sessions that they can attend on-site or remotely and that consist of both individual and group work. The work mostly revolves around answering quizzes, discussing various problems/questions and working on different assignments. Support from the teachers is offered during both the asynchronous and synchronous phases. When opting for remote attendance, the course is thus a 100% online course. In the case of onsite attendance to the interactive synchronous sessions, the course is hybrid.

2 Methodology

The asynchronous (online) learning phase took place between November 25, 2022, and January 8, 2023 (exceeding four weeks because of the Christmas holidays). The synchronous (online and onsite) learning phase took place between January 9 and 13, 2023. Four extra weeks were also given to the participants to complete the synchronous activities.

In terms of course set-up, the following measures were implemented:

- To be accepted to the synchronous sessions, the participants should have watched at least 50% of the pre-recorded videos and taken at least 50% of the online quizzes.
- To obtain a course certificate, the participants should have got at least 50 points (out of 100 possible points).

All activities undertaken by the students were monitored through a Moodle-based Learning Management System (LMS) and were used for grading, during both the asynchronous learning phase and the synchronous interactive phase. The points were associated with the asynchronous quizzes (with a weight of 25% to the total number of points) and all synchronous activities (with a weight of 75% to the total number of points). Most of the points were automatically assigned by the LMS, whereas some activities required manual grading.

The paper adopts a quantitative course evaluation approach. The learning analytics data (see, e.g., Ferguson, 2012) generated by the LMS were the basis to conduct analyses of activity completion (the extent to what learners engaged in the activities) and performance (the extend to what the results of the learning activities was correct). Moreover, a course evaluation survey (see, e.g., Marsh, 1987) was distributed among students gather learner reactions to the course set-up containing six statements about learner satisfaction with a 5-point Likert scale and two open questions, where participants named with up to three things they liked and disliked about the course and which were analyzed thematically.

3 Results

Out of 59 applications received to attend the course, six were discarded, as the upper limit for each course was set to ca. 50 participants. 12 participants had chosen an onsite participation to the synchronous sessions, the remaining 41 opted for the full online version of the course. Out of those 53 accepted applications, 31 participants qualified for the synchronous sessions (12 onsite and 19 online). An analysis of the student participation, performance and satisfaction is presented below in an aggregated manner.

3.1 Analysis of student participation

Student participation was measured via the completion rate on the asynchronous elements (videos and asynchronous quizzes) and on the synchronous elements (synchronous quizzes and all other synchronous activities) – see Tab. 1. In this Table and the following ones, the results are presented separately for the student who chose the synchronous onsite option (12 students) or the online option (41 students). Furthermore, for the online option, the students were differentiated depending on whether they qualified for the synchronous sessions (19 students) or not (22 students) (see the course description in section 2).

Table 1: Mean values of the completion rates [in %] on the asynchronous and synchronous elements (with standard deviations given in parenthesis).

	Asynchronous activities		*Synchronous* activities	
	Videos	Quizzes	Quizzes	Activities other than quizzes
Students who chose the *onsite* synchronous attendance (12 students)	91.4% (±16.3%)	80.7% (±29.2%)	99.2% (±2.9%)	86.7% (±11.9%)
Students who chose the *online* synchronous attendance and *qualified* for it (19 students)	93.5% (±12.4%)	90.6% (±13.1%)	82.1% (±26.8%)	58.6% (±26.5%)
Students who chose the *online* synchronous attendance and *did not qualify* for it (22 students)	16.5% (±28.9%)	2.1% (±6.8%)	Did not qualify	Did not qualify

As Tab. 1. demonstrates, a high completion rate on the asynchronous elements for the onsite and online qualifying students can be noticed, with even the online cohort slightly outperforming the onsite. On the other hand, the online participants who did not qualify had a very low completion rate, explaining why they were not accepted to the synchronous activities. For the synchronous elements, the onsite students were significantly more engaged than the online qualifying students. The difference between those two cohorts is even more significant for the synchronous activities other than the quizzes.

3.2 Analysis of student performance

Student performance is reported in Tab. 2. It is measured by the average value of the grades for each of the categories of graded activities (irrespective of whether those activities were taken or not). The final grade is also reported in this Table. The final grade was estimated with a relative weight of 25% on the asynchronous quizzes and a relative weight of 75% on all synchronous activities.

Table 2: Mean values of the grades on the asynchronous and synchronous elements (with standard deviations given in parenthesis). All data were renormalized to 100 points representing the maximum number of points on each of the categories of the activities.

	Asynchronous activities	*Synchronous* activities		Final grade
	Quizzes	Quizzes	Activities other than quizzes	
Students who chose the *onsite* synchronous attendance (12 students)	76.5 (±16.5)	79.4 (±11.3)	61.3 (±11.6)	76.2 (±8.9)
Students who chose the *online* synchronous attendance and *qualified* for it (19 students)	72.4 (±16.1)	44.9 (±22.7)	44.2 (±17.5)	55.7 (±10.6)
Students who chose the *online* synchronous attendance and *did not qualify* for it (22 students)	1.4 (±3.9)	Did not qualify	Did not qualify	Did not qualify

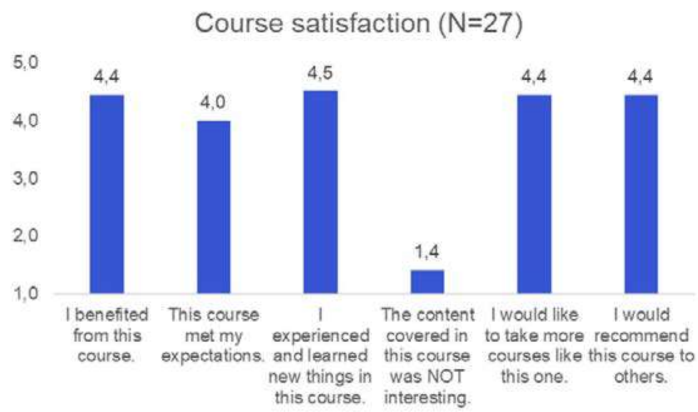
As shown in Tab. 2, whereas the success rate on the asynchronous elements does not differ between the onsite and the online qualifying students, the onsite students perform much better on the synchronous activities than the online ones. As activities that were not taken were also counted in the grades, the lower grades on the asynchronous elements for the online qualifying participants is also the result of a significantly lower participation on the synchronous activities other than the quizzes – see Tab. 1.

Nevertheless, most of the online qualifying participants (17 out of 19) got a grade larger than 50 points and thus passed the course, whereas all onsite participants (12) passed the course. The lower grades for the online qualifying participants are considered to be attributed to the LMS providing immediate update on the grades when an activity is completed. As it is believed that the online participants combine their synchronous participation with other duties (job, other studies, family, etc.), they most likely tend to simply pass the course, i.e., to get a grade of just 50 points. The onsite participants, on the other hand, by the nature of their onsite attendance, are more dedicated to the synchronous activities.

3.3 Analysis of the student satisfaction

As illustrated in Fig. 1, participants expressed very high satisfaction with the course on all items used in the course evaluation. All positively formulated statements reached an average agreement of 4 or more on a 5-point Likert scale, supplemented by the negative statement that had high disagreement (1.4).

Figure 1: Mean values of agreement with statements regarding course satisfaction (1…strongly disagree 5…strongly agree).



The thematic analysis of the participants answers to the open questions about what they liked and disliked about the course is presented in Tab. 3. Among the positive aspects of the course, the active learning activities and other course materials were particularly often mentioned, as evidenced through comments like:

"*The self-learning activities were great. All the handbook parts, videos and quizes brought lots of information and helped me to learn.*"

This was followed by the quality of the instructors and the course structure and organization, but the importance of interactions and support was also stressed in statements like:

"*Everybody (teachers and students) was eager to help when it was needed.*"

Among the negative aspects, participants were especially concerned about the amount of content that was covered in a relatively short period of time. Further, technical issues during the first run of the course were also often raised as an issue.

Table 3: Thematic analysis of course participants' answers to the questions about things they liked and disliked about the course (*N*=27, numbers in brackets indicate number of participants mentioning this theme).

Participants liked	*Participants did not like*
Practical Exercises / Tools / Codes / Software (16)	Time Constraints and Pace (17)
Course Materials / Handbooks / Slides / Sources (11)	Content and Instruction (13)
Well-explained Topics / Quality of Teachers (9)	Technical Issues and Software (11)
Organization / Course Structure / Preparation (9)	Course Structure (6)
Networking / Interactions with Students and Professionals (6)	Workload and Assignments (5)

Inclusive Atmosphere / Support from Teachers and Students (5)	Course Format and Recommendations (4)
Flipped Classroom / Teaching Methods (3)	Instructor-related Issues (3)
Flexibility / Pace / Online Learning (2)	
Real-world Applications / Industry Relevance (2)	
Multidisciplinary / Diverse Backgrounds (2)	

4 Discussion and Conclusions

Our results demonstrate that the flipped course, provided both as online and hybrid, has been successful in terms of participation, engagement, completion rates and learner satisfaction. An overwhelming large fraction of the participants who completed the preparatory work and were actively participating in the synchronous sessions successfully passed the course (100% for the onsite attendees and 89% for the online qualifying attendees). As result of the thematic analysis, we attribute this to the many activities and continuous formative feedback the participants received, so that they were able to understand their mistakes, learn from those, and successfully complete the various assignments. This was achieved by course design, as the asynchronous work followed by the synchronous quizzes gradually prepared the students for the more involved activities. Those activities also represented the core of the interactive sessions and, correspondingly, a large fraction of the graded activities. The successful completion of those activities was made possible via close supervision from the teachers of both the onsite and online students. Interactions between students and teachers occurred during the entire duration of the course, both during the asynchronous and the synchronous phases, through the various interaction channels that were implemented (chats, forums, messaging, quizzes with instant feedback, active quizzes, discussions, coding assignments, input deck writing and audio/video interactions). The continuous feedback the students receive on all learning activities through the LMS, beyond their formative nature, also allow the students to see their progression towards passing the course, adding an extra ingredient for motivating them to complete the tasks. This is clearly visible for the online students especially, as they work hard to obtain the necessary 50 points to pass the course. Thus, this study confirms the advocated learning benefits of the flipped classroom method and the online/hybrid learning design provided broader access for learners compared to traditional in-class teaching while keeping a high retention.

However, there were significant differences between onsite and online participants, indicating that online learners adopted a more strategic learning approach to keep up with the course content. Additionally, we saw from the thematic analysis that the high workload of the course may have made it challenging for learners to balance it with other duties. Thus, the proposed course format is best suited for learners who are mature enough to take responsibility for their learning, i.e., students at the master level and above with well-developed self-regulated learning skills (Stöhr et al., 2020).

Based on the positive outcomes observed in the course, we plan to reoffer the course during the next academic year, with potential modifications to better support the needs of online learners. For example, apart from eliminating the technical issues of the first run, additional scaffolding could be provided to help learners regulate their learning despite a high workload.

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