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Student-Centred Blended Learning in a Flipped Classroom for a Pre-University Masterclass

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Flipped Classroom Approach, Blended Learning, Student-Centred, Engagement, Pre-University Education, Self-Regulated Learning

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Enjoy reading!

Eliza

Abstract

In the domain of education, enhancing student engagement is a continuous goal. This study explored the potential of implementing a student-centred blended learning approach within a flipped classroom setting to achieve this objective. The research question guiding this research is: Can the implementation of a student-centred, blended learning approach in a flipped classroom setting enhance student engagement in a Pre-University masterclass?

To address this question, the study adopted the Educational Design Research framework proposed by McKenney and Reeves (2018). This approach emphasizes iterative cycles of design, implementation, and evaluation, which aligns well with the multifaceted nature of the research problem. This research began with a comprehensive needs analysis, using data previously collected from surveys administered to participants of the masterclass in 2021. These survey results offered insights into participants' prior knowledge, expectations, and overall experience within the masterclass.

Following the needs analysis, the initial masterclass was redesigned following the guidelines of the flipped classroom approach (FLN, 2014). Then a pilot test of the redesigned masterclass was conducted. This phase aimed to evaluate the practicality and effectiveness of the proposed student-centred blended learning approach within the flipped classroom context. Through semi-structured interviews and systematic observations, the study explored how students engaged with the learning materials, activities, and their peers during the in-person sessions. Evaluation results revealed that students' ability to access learning materials at their own pace outside of class, coupled with interactive and collaborative in-class activities, significantly contributed to their engagement. These results are an indication that the masterclass design effectively fosters interaction, idea-sharing, and collaborative engagement among participants.

In conclusion, this research contributes to the existing body of literature, filling a gap in flipped classroom research within secondary education settings. By integrating a student-centred blended learning approach into a Pre-U masterclass, this study demonstrated the potential to enhance student engagement, ultimately improving the overall educational experience.

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Introduction

1.1. Problem Statement

This research is done in the context of a Pre-University masterclass. The current face-to-face set-up of the masterclasses that are given by Pre-University often includes students with varying levels of prior knowledge. Furthermore, the masterclasses often delve into topics where prior knowledge is lacking. Consequently, part of the collective class time is devoted to direct instruction. This often comes at the expense of valuable presence and social interaction with students. The general aim of the Pre-U masterclasses is to expose students to new topics that contribute to their understanding of potential future studies and to engage students in developing skills that are crucial for successful further education (Pre-U, 2023). This research aims to investigate the impact of a student-centred, blended learning approach in a flipped classroom for a Pre-University masterclass.

In recent years, there has been a growing interest in the use of blended learning in a flipped classroom to enhance student engagement (Lo & Hew, 2021). A flipped classroom is a form of blended learning in which the students prepare in their own time by watching short online videos and reading texts. In-class time is used to apply learning through problem-solving with peers (Smallhorn, 2017). This lets students take responsibility for their learning within environments that promote active engagement, critical thinking, problem-solving, collaborative work, and meaningful interactions. Many studies have been conducted to evaluate the effectiveness of the flipped classroom approach, particularly in higher education settings (Bishop & Verleger, 2013; Hew & Lo, 2018; Lage et al., 2000; McLaughlin et al. 2014; Strayer, 2012;). Several studies have shown that student-centred, blended learning in a flipped classroom can improve student engagement, motivation, and learning outcomes (Freeman et al., 2014; Hew & Lo, 2018; Shi et al., 2020; Strelan et al., 2020).

Although these approaches are effective in higher education and some K-12 settings, their implementation among secondary education students is still relatively new, and there is much to learn about how to effectively implement these approaches (Al-Harbi & Alshumaimeri, 2016; Lo & Hew, 2017). It is essential to conduct research to determine how this approach can be best implemented among secondary education students to improve student engagement. Specifically examining the different dimensions of engagement, including behavioural, cognitive, and emotional, to provide a comprehensive view of how students engage in flipped classrooms. The research design will involve designing and developing a masterclass based on the principles of a flipped classroom, implementing the intervention among secondary school students, and evaluating its effectiveness in enhancing student engagement.

1.2. Pre-University

This research is done in the context of Pre-University (Pre-U). Pre-U is an educational program offered by the University of Twente (UT), designed to provide secondary education students (Pre-University education or in Dutch VWO) with a glimpse into academic life and research (Pre-U, 2023). The program consists of a range of activities, including masterclasses, summer schools, workshops, and an honours programme, all geared towards fostering intellectual curiosity and academic potential among pre-university students.

Pre-U's culture is shaped by its emphasis on research-based learning and its commitment to fostering intellectual curiosity and academic potential. The program's values include a focus on critical thinking, creativity, and scientific inquiry. These values are reflected in the program's activities, which are designed to challenge pre-university students to engage in high-level thinking and problem-solving.

Stakeholders in the Pre-U program include Pre-U students, academic staff, students of the UT and the UT itself. The program is designed to provide pre-u students with a pathway to higher education. Pre-U operates within the broader context of the University of Twente, which is subject to policies and regulations governing research and education in the Netherlands. The program is also subject to its policies and regulations governing the management of activities, selecting participants, and evaluating the program's impact. Pre-U has access to research facilities and expertise at the University of Twente. The program also benefits from the expertise of academic staff and student assistants, who provide support for the program's activities.

Overall, Pre-U is an educational program that provides Pre-U students with a pathway to higher education and fosters intellectual curiosity and academic potential. Its organizational structure, culture, stakeholders, educational goals, policies and regulations, and resources are all geared towards achieving these objectives (Pre-U, 2023).

1.3. Research Questions

This study aims to analyse ways to enhance student engagement for secondary education students in a Pre-U masterclass. In particular, the study applies a student-centred, blended learning approach in a flipped classroom to promote student engagement. Based on the analysis and the wishes of Pre-U, a blended learning flipped classroom design for promoting engagement will be proposed and evaluated with students. Therefore, the main research question is:

RQ: Can the implementation of a student-centred, blended learning approach in a flipped classroom setting enhance student engagement in a Pre-University masterclass?

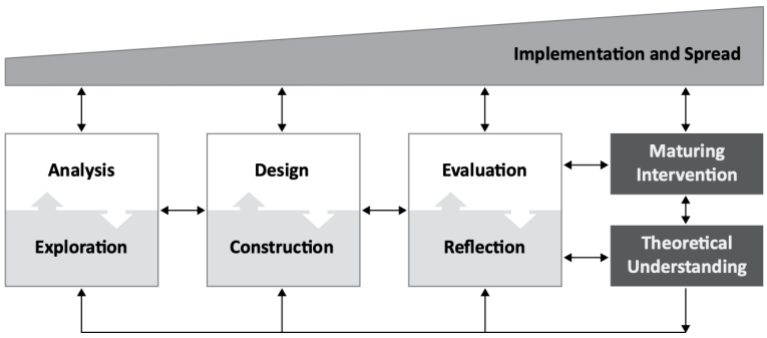
2

Design Approach

Design-based research was conducted to investigate the potential of student-centred, blended learning in a flipped classroom for student engagement. Design-based research aims to find a theoretical understanding of practical improvements (McKenney & Reeves, 2018). In this case, research was conducted on the Pre-U masterclass ‘Be Your Own Boss’ to make this more engaging and enhance learning outcomes regarding skills development. In this study, McKenney and Revees’ (2018) generic model for conducting educational design research (EDR) was used (Figure 1). This model follows three phases: analysis and exploration, design and construction, and evaluation and reflection (McKenney & Reeves, 2018). EDR is an approach to educational research that aims to develop and improve educational interventions in real-world settings through iterative cycles of design, implementation, and evaluation. The phases are explained in the following respective chapters.

Figure 1

A Generic Model for Conducting Design Research in Education (McKenney & Reeves, 2018)



3

Analysis & Exploration

The analysis and exploration phase aims to understand the student's experiences, needs, and wishes regarding engagement in the (initial) masterclass. A needs analysis was conducted to answer the question: How do the students currently experience the engagement of the masterclass? To answer this question, first, the initial masterclass will be described shortly; next, the evaluation of the masterclass will be described.

3.1. Initial Masterclass

The overall aim of the masterclass was to give students the experience of what it is like to run their own business. During the masterclass, they worked in groups and took on the role of a different company in the car industry. In each session, a bit of theory about entrepreneurship was alternated with policy choices and negotiations for their own business. The overall learning goals for the original masterclass were: 'the student understands the concept of entrepreneurship, 'the student knows what business opportunities are and how to capitalize on them', 'the student knows what a zero-sum game is', 'the student knows what the study International Business Administration entails'.

In four sessions lasting three hours each, all these topics were discussed in more detail. During the whole masterclass, the students had to use a simulation game in which they ran their company. In session one, the game was explained, and groups were formed. After this, the theory about entrepreneurship, partnerships and negotiating was covered. The students had to do group exercises about conducting market research, value propositions, and negotiating. Session two consisted of theory about the business model canvas, marketing, and financing. The group exercises were about making a marketing plan and making a pitch to prepare for the next session. In session three, the students had to pitch their business, and learn more about the different categories of the business model canvas, the lean start-up method, and pivoting. The last session was the finale. In the finale, the students continued working on their pivot and got time to reflect on the simulation game that they did throughout the masterclass. After this, the students got their certificates and were done with the masterclass.

3.2. Method

For the needs analysis, a previously collected evaluation of the masterclass was used. The evaluation material previously collected consisted of a survey which was administered to participants of the masterclass in 2021. This was the last time the masterclass was given in its original form, and thus the results from 2021 were used for the needs analysis. The survey results were discussed and analysed to get insights into the

current perceptions of the participants on the masterclass. The survey focused on the participants' prior knowledge, expectations, and experience in the masterclass. The responses to the questionnaire were organized, common themes were identified, and the perspectives were interpreted. The findings from the questionnaire contributed to a deeper understanding of participants' current perceptions of the masterclass and shed light on the strengths and weaknesses of the masterclass.

3.2.1. Participants

The participants included 20 VWO students from several schools in the Twente region. VWO (Voorbereidend Wetenschappelijk Onderwijs) is the highest level of secondary education in the Netherlands. VWO is characterized by its focus on academic and theoretical subjects, preparing students for higher education at universities. Because Pre-U is located at the campus of the University of Twente, this is the target group for the masterclasses. The participants were found using convenience sampling because they were already present in class during the masterclass. Participants voluntarily filled out the questionnaire.

In total, 20 students responded to the questionnaire, and they all answered all questions. The grades and specializations of the students can be found in Table 1. In the Dutch school system, students must choose a specialization in the 3rd year of VWO. This means students in years 5 and 6 of VWO have already chosen their specialization, which consists of specific courses that they follow. A list of the different specializations and the courses that are included can be found in Appendix A. Typically, students that are in 5 and 6 VWO are between the ages of 16 to 18 years old. Furthermore, all respondents were from the East part of the Netherlands; this is the focus area of the Pre-U activities.

Table 1

Characteristics of Participants' Evaluation

Baseline characteristics		
	n	%
Grade		
5 VWO	15	75
6 VWO	5	25
Specialization profile		
Nature &Technology	3	15
Nature & Health	1	5

Double specialisation Nature, technology & health	6	30
Economics & Management	8	40
Culture & Management	0	0
Double specialization Economics, management & culture	1	5
Double specialization Nature, technology, economics & management	1	5

3.2.2. Instrumentation

A five-minute survey was used to evaluate the masterclass. The full survey can be found in Appendix B and consisted of 23 questions. The first 7 questions were about prior knowledge and motivation, 9 questions focused more on the content of the masterclass, and the last 7 questions focused on general information. The survey started with general questions, focusing on the level of prior knowledge, motivation of the participants, what level and specialization they are studying, how they knew about the masterclass and if they had ever done any Pre-U activities before. The purpose of the second part of the questionnaire was to find out how the participants rated the content of the masterclass. Participants were asked to rate each session of the masterclass on a scale of 1 to 10, 1 being the worst, 10 being the best, whether they found the masterclass challenging enough and if they had any recommendations or comments. Other questions focused on the expectations and reality of their experience in the masterclass. The last part of the questionnaire focused on some general information again. The questions were about their current level, prior activities from Pre-U, from which school they came, and whether all the information they got was clear.

3.2.3. Procedure

When the last session of the masterclass finished, the participants were asked to scan the QR code showing on the screen in class with their mobile phones. This QR code led them to the online survey, which they could fill in individually. After filling out the general information, more specific questions about the content of this masterclass were asked. Lastly, some more general information was asked about whether they already participated in a Pre-U activity before and from what school they came from. When all the questions were filled out, the survey was finished, and the participant was thanked for their participation.

3.2.4. Data Analysis

The raw data of the questionnaire was analysed by the Pre-U staff to ensure anonymity. The researcher received a report including visualizations for the relevant questions. To analyse the data to identify the needs of the target population first, the data was read and discussed. The middle part of the survey about the content of the masterclass was most relevant for the needs analysis of this design research. The level and specialization of the participants were also considered. Overall, this process enables a deeper understanding of the experiences and needs of the participants to identify areas for improvement. Because the students all have different specializations, in the analysis, this was the area of focus. Students' findings from different specialization profiles were compared to each other to see if this made a difference in their experience.

3.3. Results

The questionnaire was completed in December 2021. A total of 20 responses were recorded. The masterclass was rated with a 6.7 overall (SD = 1.6). Students with the N&T specialization rated the masterclass the highest, with a 7.3 on average. Students with an E&M or E&M and C&M specialization rated the masterclass with a 6.9 and a 7.0 on average. Students with an N&G or N&T and N&G specialization rated the masterclass with a 6.0 and a 6.1 on average. 50% of the respondents indicated that the masterclass was below their expectations, and one respondent with an E&M specialization commented.

> "It wasn't representative of any study program at the UT."

Some other comments from students with an E&M or C&M specialization.

> "At some point, I was bored because we didn't do much anymore."

> "Sometimes I didn't know what to do, the practical assignments were very educational though."

> "The quality of the sessions was mediocre."

Comments from students with an N&T or N&G specialization were.

> "The content was simple, not everything worked as it should've."

> "Sometimes it was not clear what the goal of the masterclass was. Because of this, I didn't know what to do. The practical assignments were very educational though.'"

> "I think it was a waste of time."

3.3.1. Ratings per session

The participants were asked to rate each session. An overview of the ratings per specialization can be seen in Table 2.

Table 2

Ratings per session

Variable	Session 1	Session 2	Session 3	Session 4
E&M (n=8)	5.5 (SD=2.3)	7.3 (SD=1.5)	7.4 (SD=1.2)	6.8 (SD=2.0)
E&M/C&M (n=1)	5.0	9.0	9.0	4.0
N&G (n=1)	7.0	8.0	6.0	10.0
N&T (n=3)	6.3 (SD=1.2)	7.3 (SD=1.6)	8.0 (SD=1.0)	7.0 (SD=0.0)
N&T/N&G (n=6)	6.3 (SD=1.6)	6.3 (SD=2.3)	5.5 (SD=1.8)	4.3 (SD=2.8)
Overall average (n=20)	**5.9 (SD=1.7)**	**7.2 (SD=1.7)**	**6.9 (SD=1.6)**	**6.3 (SD=2.6)**

Session 1 was rated with an overall average of 5.9 (SD= 1.7). Students with an E&M or E&M and C&M specialization scored this session the lowest, with a 5.5 on average. One student with this specialization rated the session with a 1 and commented that this was because.

> "In session one, we did not do anything because a lot still had to be arranged and set up."

Two students rated the session with an 8.0; they did not indicate why they gave this grade in a comment. The remaining students with an E&M or C&M specialization rated the session with grades between 5.0 and 6.0. Some comments were as follows.

> "Session one, I was thrown into the deep; some more info would have helped."

> "The introduction was not so interesting."

Students with an N&T and N&G specialization rated the session with both 6.3 on average. One student rated session one with a 4.0; they specified this with the comment.

> "I think it was not very well prepared overall."

Another student graded session 1 with a 5.0; this was not specified in a comment. The remaining students graded the session with a 7.0 or an 8.0.

Session 2 was rated with an overall average of 7.2 (SD=1.7). Students with an E&M and/or C&M specialization graded this session much higher, with a 7.3 (SD=1.5) and a 9.0 on average. One student graded the session with a 5.0; the comment was as follows.

> "The quality was mediocre."

The rest of the students graded the session with grades between 6.0 and 10. Students with an N&T and/or N&G specialization graded the session with 8.0, 7.3 (SD=1.5) and 6.3 (SD=2.3). One student rated the session with a 2; this was the same student who rated the first session with a 4.0. This grade brings the average down to 6.3, while the other grades were all between 6.0 and 8.0.

Session 3 was rated with an overall average of 6.9 (SD=1.6). Students with an E&M and/or C&M specialization rated this session with a 7.4 (SD=1.2) and a 9.0. One student rated the session with a 5.0, which was the same student who rated the rest of the sessions rather low. The rest of the students with this specialization rated the session with grades ranging from 7.0 to 9.0. Students with an N&T and/or an N&G specialization rated this session with a 6.0, an 8.0(SD=1.0) and a 5.5 (SD=1.8). Two students gave a 3.0 and a 4.0 for this session. One student found that.

> "The pitch was hard, and I did not know what to include."

The other students rated the other sessions low as well because they found the sessions not well prepared. The other students rated the session with a 6.0, a 7.0 and an 8.0. They did not explain why with a comment.

Session 4 was the final session and was rated with an average of 6.3 (SD=2.6). Students with an E&M and/or C&M specialization rated the session with a 6.8 (SD=2.0) and a 4.0. Some comments from these students were as follows.

> "In the last session, we did not do much."

> "The outro was not that interesting."

> "Session four did not have so much content, we could have done more."

These students rated the session with a 4.0 or a 5.0. One student graded the session with a 10 because he won the competition; the rest of the students rated the session with a 7.0 or an 8.0. Students with an N&G and/or an N&T specialization rated the session with a 10, a 7.0 (SD=0.0) and a 4.3 (SD=2.8). These ratings differ quite a lot from each other. Two students rated the last session with a 1.0; both students have low ratings for almost all the other sessions as well. All the remaining students rated the session with a 7.0.

3.3.2. Overall ratings

55% of the students found the masterclass useful, 60% found the masterclass educational, and 70% of the students found the masterclass fun. The students were very positive about the student assistants that taught the masterclass. 90% indicated that they were enthusiastic, and 75% said they were good at explaining the topic.

3.4. Discussion of results

Based on the evaluation results, we can conclude that there is a need to re-evaluate the design of the masterclass. In this section, the most important results will be discussed.

The evaluation questionnaire demonstrates the variety of participants that follow the masterclass. The students who participated in the masterclass all have different specializations (Nature, health, economics, management, culture and possibly a double specialization). The diverse range of specializations among the students highlights a need for a more nuanced and adaptable approach to the design of this masterclass. The current masterclass design is not adapted to the different learning styles of the students, this caused some students to feel bored and others to feel like they were thrown in the deep. Overall, the masterclass contained a substantial amount of direct instruction where the students had to sit and passively listen to the student assistants teaching the masterclass. The sessions that were rated best included more practical assignments that were authentic and involved active learning, for example, sessions two and three. The evaluation results also suggest that some students felt that the masterclass was not well organized. This can be because the software program of the simulation game did not always work. Despite some negative comments on the organization of the masterclass, 70% of the students indicated that the masterclass was fun.

Overall, the feedback from the evaluation suggests that there is room for improvement in the design and delivery of the masterclass. By incorporating even more engaging activities and interactive elements, the students will likely be more engaged with the material. For example, include more challenging activities and assignments that encourage students to apply what they have learned, as well as provide opportunities for

students to actively learn and take ownership of their learning. Having activities related to real-world cases can also encourage higher engagement levels.

4

Theoretical Framework

This chapter provides a framework for a comprehensive understanding of the relationship between the flipped classroom approach and student engagement in secondary education students. Specifically, this framework will explore the role of engagement in the context of the flipped classroom approach. To achieve this goal, this framework will draw on several relevant theories and concepts from educational psychology and instructional design, including the Flipped classroom approach, Self-Determination theory and Cognitive load theory.

These theories contribute to the understanding of student engagement in the flipped classroom approach. The flipped classroom approach emphasizes active learning, student autonomy, and meaningful interactions, aligning with the principles of self-determination theory. Promoting students' self-regulation engagement can be enhanced in a flipped classroom setting. Cognitive load theory offers insights into managing students' cognitive resources effectively, ensuring that learning content is presented in a way that minimizes cognitive overload. By looking at and connecting these theories, a comprehensive perspective is gained on how the flipped classroom approach can optimize student engagement and promotive effective learning experiences.

4.1 Engagement

Before exploring specific theories, it is important to establish a comprehensive understanding of student engagement and its significance. Student engagement takes many forms, and this maximizes the potential for positively impacting the quality of education and learning (Groccia, 2018). To achieve intellectual growth, the learner must engage with the learning process on behavioural, emotional, and cognitive levels (Appleton et al., 2008; Fredricks et al., 2004; Groccia, 2018). To engage on a behavioural level, a learner needs to actively participate and put in the effort, showing persistence throughout the learning process. On an emotional level, engagement involves having a genuine interest in the learning experience, which leads to increased motivation and enjoyment. This emotional investment establishes a sense of commitment to the learning experience. Lastly, cognitive engagement refers to the learner's mental activity and ability to process thoughts about the experience. It entails actively thinking, reflecting, and making connections with prior knowledge and experiences, allowing for deeper understanding and meaningful learning. It is possible to engage positively along one or more of these dimensions while also engaging negatively along others (Fredricks et al., 2004; Groccia, 2018).

According to Schlechty (2011), student engagement is not a black-and-white phenomenon. Students function at different levels of engagement. When students are *authentically engaged*, they actively participate in tasks that hold clear meaning and

immediate value for them. They are motivated intrinsically, finding personal relevance and a sense of purpose in what they are learning (Groccia, 2018). On the other hand, when students engage in *ritual engagement*, they perceive little or no inherent meaning or value in the assigned work. However, they still participate due to external factors, or the extrinsic rewards associated with the task. Their engagement is more driven by the desired outcomes or rewards rather than genuine interest or personal connection. *Passive compliance* occurs when students adopt a position of minimal effort and participation to avoid negative consequences. They may not see much value in the activities but comply with them to meet expectations or avoid punishment. At the *retreatant level of engagement*, students are disengaged and show little effort in their task performance. They lack motivation and interest in the learning activities, resulting in minimal involvement and limited learning outcomes. Lastly, *rebellious engagement* refers to students who actively resist participation in the assigned activities. They may disrupt others, refuse to engage, or try to substitute other activities for the assigned task (Groccia, 2018). These different levels of engagement demonstrate the varying degrees to which students are invested in their learning and highlight the importance of fostering authentic engagement to promote meaningful and effective learning experiences (Groccia, 2018).

Research by Fredricks et al. (2004) supports the multidimensional nature of engagement and its significance in secondary education. Several factors influence student engagement in secondary education. Individual characteristics, including self-efficacy and goal orientation, play a role, as well as classroom factors like teacher-student relationships, instructional strategies, and the overall school environment (Fredricks et al., 2004). Creating supportive learning environments, providing opportunities for autonomy and meaningful learning experiences, and offering personalized instruction are strategies that have been found effective in promoting student engagement (Fredricks et al., 2004; Groccia, 2018). By recognizing and addressing the behavioural, emotional, and cognitive dimensions, educators can foster authentic engagement, leading to enhanced academic performance and meaningful learning experiences.

4.2. Flipped Classroom Approach

Next, the flipped classroom approach is explored. According to the Flipped Learning Network (2014) flipping a classroom does not necessarily lead to flipped learning. To engage in flipped learning, the following four pillars (FLIP) must be incorporated 1) Flexible environment, 2) Learning culture, 3) Intentional content, and 4) Professional educator. Incorporating these leads to the successful integration of the flipped classroom into learning and facilitates the development of self-regulated learning strategies. Over the last decade,

the flipped classroom approach has gained significant attention as an innovative teaching and learning model that has the potential to transform traditional classroom instruction (Strelan et al., 2020; Wagner et al., 2021). In a flipped classroom, traditional roles of teacher-led lectures and student-led homework are reversed. Students learn the theoretical concepts before class through various online resources, such as videos, podcasts, and readings. During class time, students engage in activities that reinforce and apply the learned concepts (Låg & Sæle, 2019). This definition implies that the flipped classroom is just a re-ordering of classroom and at-home activities; however, in practice, this is not the case. The flipped classroom is an expansion of the curriculum because it consists of two parts: interactive group learning activities inside the classroom and direct computer-based individual instruction outside the classroom (Bishop & Verleger, 2013; FLN, 2014).

The flipped classroom approach is based on the principles of active learning and student-centeredness, which have been shown to improve learning outcomes (Freeman et al., 2014). In a student-centred approach, the learning experiences, strategies, and curriculum are designed to meet the unique needs, interests, abilities, and learning styles of each student (Mahendra et al., 2005; McLaughlin et al., 2014). Active learning is an approach that emphasizes student engagement and participation in the learning process. Numerous studies have shown that active learning can have significant benefits for student learning outcomes (Freeman et al., 2014). Active learning can be implemented in many ways, for example, with group discussions, problem-based learning, and peer instruction.

The flipped classroom approach is a type of blended learning and thus this approach typically involves the use of technology, such as pre-recorded video lectures, interactive online quizzes, and other digital resources, to deliver content to students outside of class (FLN, 2014; Lo et al., 2017). This allows students to review the material at their own pace and in their own time. Meanwhile, classroom time is used for more interactive and collaborative activities, such as group discussions, problem-solving activities, and projects (FLN, 2014).

4.2.1. Benefits and challenges of a flipped classroom

Many studies have shown that the flipped classroom approach can have positive effects on student engagement (Freeman et al., 2014; Hew & Lo, 2018). These studies showed that the flipped classroom is associated with higher student achievement, engagement and satisfaction compared to traditional lecture-based instruction. A reason for the positive student perception of the flipped classroom approach is that it provides students with the opportunity to engage in self-directed learning and develop critical thinking and problem-solving skills (Hew & Lo, 2018). By completing the initial learning at home, students

can work at their own pace and have more control over their learning. During class time, students can collaborate with peers and receive immediate feedback from the teacher, leading to a more interactive and engaging learning experience (Lage et al., 2000). When implemented effectively, the flipped classroom can promote more engaging and effective learning experiences for students while also providing teachers with greater flexibility and opportunities for creativity in their teaching practice (McLaughlin et al., 2014).

While the flipped classroom approach offers a promising alternative to traditional classroom teaching, it requires careful consideration and planning to be implemented effectively. One of the main challenges of the flipped classroom approach is the development of high-quality video content for students to learn from at home. Teachers must ensure that the videos are engaging, clear, and effective in conveying the necessary information (Brame, 2016). Additionally, students may not have access to reliable technology or may not complete pre-class work, leading to potential knowledge gaps during class time (Hew & Lo, 2018; Strayer, 2012). A way to minimize this potential knowledge gap is to include quizzes at the start of the face-to-face class. This can help the students recall the knowledge learned before the class, and it helps the instructor identify potential misconceptions about the learned materials (Hew & Lo, 2018). Another challenge is the need for effective classroom management strategies. The flipped classroom approach requires a more active role for the teacher in facilitating student discussions and providing feedback (FLN, 2014). This can be challenging for some teachers who may be more accustomed to a lecture-based approach (Boevé et al., 2016).

4.3. Self-determination Theory

Additionally, self-determination theory (SDT) provides a framework for understanding the psychological factors that influence student engagement. SDT proposes that learners are inherently motivated to seek out activities that satisfy their basic psychological needs for autonomy, competence, and relatedness (Persky & McLaughlin 2017). Autonomy refers to the need to have control over one's own life and decisions, competence refers to the need to feel capable and effective in one's actions, and relatedness refers to the need to feel connected to and cared for by others (Ryan & Deci, 2000). When these three basic needs are met, individuals will experience greater intrinsic motivation; when these needs are not met, feelings of frustration or demotivation can be experienced.

In the flipped classroom, students are given the autonomy to learn at their own pace and in their own way (Bond, 2020; Persky & McLaughlin, 2017). This can increase their sense of control and ownership over their learning. Students can build their competence by including self-assessments that allow students to determine their strengths and weaknesses.

Also, incorporating assessments that allow students to demonstrate progress towards achievement of desired outcomes is a way of promoting competence (Persky & McLaughlin, 2017). Relatedness among students can be promoted through collaborative learning activities and discussions. This way, students can feel connected and foster enhanced motivation and engagement (Bond, 2020; Persky & McLaughlin, 2017).

4.4. Cognitive Load Theory

In the context of student engagement, cognitive load theory (CLT) provides insights into how the design of learning materials and instructional strategies can impact learners' cognitive resources. In Educational Psychology, the CLT posits that working memory has a limited capacity (Sweller 1988). When learners are presented with too much information at once, they can experience cognitive overload, which can negatively impact learning outcomes (Sweller, 1994). CLT suggest that working memory, the part of the mind responsible for processing and manipulating information, has limited capacity. When this working memory becomes overloaded, it becomes difficult for the learner to process new information, leading to difficulties in learning and problem-solving (Sweller, 1988; Sweller, 1994). Cognitive load is the number of cognitive resources that are required to complete a task, and there are three types: intrinsic, extrinsic, and germane load.

Intrinsic cognitive load is the cognitive load that is inherent in the task itself (Sweller, 1994). It is directly related to the complexity of the material being learned. More complex tasks require more working memory capacity and have a higher intrinsic cognitive load. Extrinsic cognitive load is the load that is introduced by the delivery of the material (Sweller, 1994). For example, poor instructional design or a lack of organization confuses and thus causes a higher extrinsic cognitive load (Kirschner et al., 2006). Finally, germane cognitive load is necessary for learning and is related to the development of schemas or mental models (Sweller, 1994). When the learner can construct a mental model of the material being learned, they are better able to process and retain the information, as well as transfer it to a new context. Effective instructional design can help manage cognitive load, including germane cognitive load (Sweller, 1988). By presenting information in a way that allows learners to construct mental models and make connections between new and existing knowledge, more effective learning outcomes can be promoted. By managing extraneous cognitive load by providing clear and organized instructional materials, learners can devote more cognitive resources to germane cognitive load, further facilitating effective learning (Van Merriënboer & Sweller, 2005).

For example, cognitive load can be managed by incorporating the flipped classroom approach. In the context of the flipped classroom approach, the CLT is relevant in two ways,

1) because students are expected to engage in independent learning before class, which can impact their cognitive load during class time, and 2) in designing the online learning materials the cognitive load needs to be taken into account. For example, videos should be no longer than 6 minutes because the working memory will become exhausted (Senali et al., 2022) The flipped classroom approach can help to reduce cognitive load by allowing students to learn at their own pace and review difficult concepts before class (Hew & Lo, 2018). This can free up working memory during class time, allowing more effective use of cognitive resources (van Merriënboer & Sweller, 2005).

4.5. Design Implications & Content

Based on the results of the participant evaluation of the initial masterclass, the theoretical framework and Pre-U's wishes, several design implications were developed. Table 3 shows an overview of the design implications and its connected theory. While some of these implications were derived directly from the participant feedback, others were focused on areas that were outside the scope of the questionnaire. These implications primarily centred on improving the overall student engagement of the initial masterclass. Some of the design implications were already present in the original masterclass to some extent, such as incorporating interactive activities and providing clear and concise learning objectives for each session. The evaluation showed that in the areas where these features were included in the design, the students were more satisfied with the session.

Table 3

Design implications

Design implications	Connected theory
D1: Incorporate challenging tasks related to real-world cases	Evaluation
D2: Chunk the learning content	CLT
D3: Incorporate interactive activities	SDT + evaluation + flipped classroom approach
D4: Use multimedia sources effectively	CLT
D5: Provide feedback	SDT
D6: Provide clear and concise learning	CLT + Evaluation

objectives for each session	
D7: Provide opportunities for self-regulated learning	SDT

Design implications that are important to include, according to several educational theories, are chunking the learning content (Miller, 1956), using multimedia sources effectively (Mayer, 2014), providing feedback (Hattie & Timperley, 2007) and providing opportunities for self-regulated learning (Zimmerman, 2000). According to previous research, these design implications have been effective in increasing student engagement and motivation in learning. The first design implication based on the needs analysis is.

D1: The flipped masterclass should incorporate challenging tasks related to real-world cases.

Students reported a need for more challenging tasks. Additionally, research shows that challenging tasks that are situated in real-world context engages students and promotes critical thinking and problem-solving skills (Lo & Hew, 2021; Newmann & Wehlage, 1993; Senali et al., 2022; Vygotsky, 1980).

D2: The flipped masterclass should include chunked learning content.

The initial masterclass already consists of four sessions as this fits with the normal format of the Pre-U masterclasses. The learning content of the flipped masterclass should also be chunked into manageable units. This can improve learning efficiency and engagement (Mayer, 2014; Sweller, 1994).

D3: The flipped masterclass should incorporate interactive activities.

Next, the flipped masterclass should incorporate interactive activities, such as group discussions, collaborative problem-solving, or role-playing. This allows students to engage with their peers and co-construct knowledge together (Lo & Hew, 2021; Vygotsky, 1980). Interactive activities also promote deeper understanding and higher levels of engagement (Hancock et al., 2010).

D4: The flipped masterclass should use multimedia sources effectively.

A flipped classroom is a type of blended learning and typically makes use of an online component before the in-person sessions. When using multimedia in a flipped classroom, it is crucial to manage the cognitive load by effectively presenting information (Mayer, 2014).

To achieve this minimizing extraneous cognitive load in the presented information is essential (Sweller et al., 2011). This can, for example, be done by paying attention to the length of the videos that are used, these should be less than 6 minutes (Senali et al., 2022)

D5: The masterclass should include feedback moments for the students.

Additionally, feedback plays a crucial role in helping students assess their progress, identify areas for improvement, and facilitate learning (Lo & Hew, 2021; Zimmerman, 2000). These feedback moments can consist of immediate feedback in the online component or feedback from the teacher during the in-person sessions.

D6: The masterclass should include clear and concise learning objectives for each session.

Furthermore, clearly defined learning objectives provide a clear focus on what students should be able to do at the end of a session. It can help students to identify and organize new knowledge and skills they are expected to acquire. (Sweller et al., 2011). Clearly defined learning objectives are already present in the initial masterclass, these should be updated and adapted to the redesigned masterclass content.

D7: The masterclass should include opportunities for self-regulated learning.

Lastly, self-determination theory suggests that individuals are motivated when their psychological needs for autonomy, competence, and relatedness are fulfilled (Ryan & Deci, 2000). Providing opportunities for self-regulated learning can enhance learners' autonomy and intrinsic motivation. Learning experiences that promote self-regulated learning can also help learners to manage their cognitive load effectively (Sweller et al., 2011). All these design implications together build a strong base to start the design & construction phase.

Next to the design implications, certain learning goals of the masterclass should be included in the new masterclass design. Pre-U's goal with the masterclass is to provide students with opportunities to discover their talents and interests while practising 21st-century skills that are essential for further studies. Therefore, the overall learning goals for the initial masterclass were revised and updated using the SMART framework (Conzemius & O'Neill, 2009) to: 'the student understands the lean start-up method and knows how to apply it in developing a business idea', 'the student has done market research, customer interviews, and created a minimum viable product', 'the student has pitched their business idea to others', 'the student knows if entrepreneurship fits them'. Additionally, the content of the masterclass was revised and updated. The revised content and learning goals aim to provide students with practical experiences, 21st-century skills, and self-awareness in the context of

entrepreneurship, preparing them to navigate the real-world challenges of starting and developing a business.

5

Design & Construction

The design implications and learning goals for enhancing student engagement were translated into a design during the design and construction phase. The main aim of this design was to decrease the gaps between the current design and the learners' needs. This phase encompassed curriculum re-design, instructional resource development and technology integration, resulting in the construction of a comprehensive and effective learning experience. The e-learning activities of the redesign were constructed with the software program Xerte. The main design choices are discussed below.

5.1. Method

In the initial phase of the design and construction process, the existing course was carefully evaluated to determine which aspects should be retained and which needed to be changed. The researcher engaged in multiple brainstorming sessions with different experts in the field of entrepreneurship and start-ups, as well as educational experts at Pre-U. After these meetings, the researcher considered the different elements of the existing masterclass, generating alternatives and seeking feedback until a core set of ideas emerged. Existing literature (Lo & Hew, 2017; Schlechty, 2011; Hew & Lo, 2018) was reviewed to identify and refine the design requirements and propositions. The literature provided valuable insights and guidelines in addressing the challenges related to student engagement. These findings, combined with the previously generated ideas, formed the foundation for creating a design. The design included a course overview outlining the learning goals, required materials, a manual for the student assistant, logistics for face-to-face meetings, topics, brief activity outlines, online and offline tasks, and assignments for each week.

5.2. Design

The masterclass is designed as a flipped classroom with blended learning aspects. This means that the masterclass design provides the student with e-learning activities that they can complete at their own pace and time before the in-person sessions. This provides an opportunity for self-regulated learning (D7). The initial masterclass content was updated and converted into a flipped design. In the section below, every session will be discussed in more detail, followed by a description of the most important changes made from the original masterclass.

5.2.1. Description of the Design

Session 1

E-learning activity

Every e-learning activity started with the date of the next face-to-face session for which this e-learning activity was a preparation. After this, the student indicated their name and which specialization they have. They had to do this at the beginning of every e-learning activity because then their data was registered under the correct name.

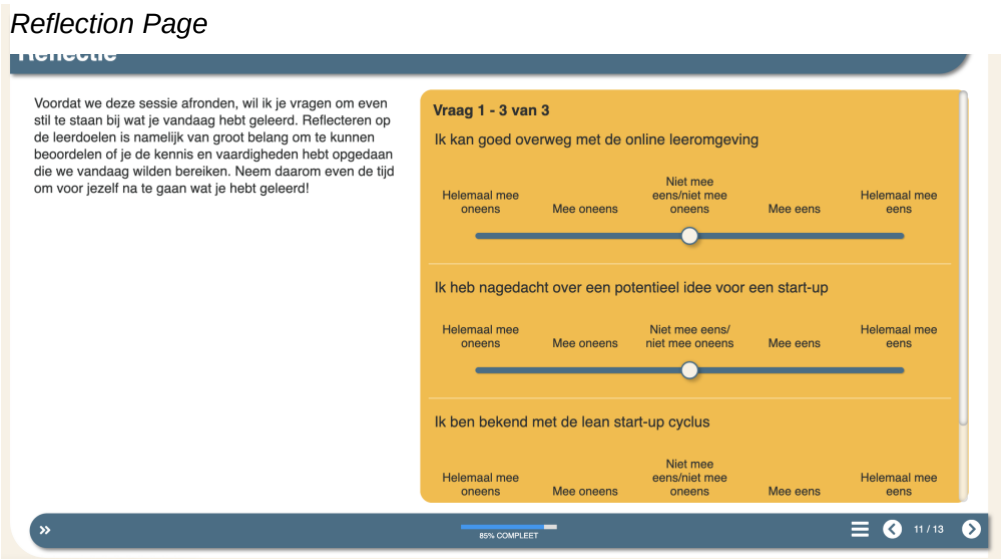
Next, the learning goals for the whole masterclass were stated, and the students now know what to expect for the coming sessions (D6). The student was then asked to introduce themselves a bit more, indicate why they decided to participate and what they were expecting from the masterclass. Next, a bite-size video (D4) that explains more about the online environment and how you can use it to prepare for the face-to-face sessions was presented.

After the general information was provided, the actual first session started. The learning goals for this first e-learning activity (D6) were stated, and an indication was given of how long the student would approximately need to complete it. First, the student was asked to think about a potential start-up idea and elaborate on it on the form presented. Next, a text about the lean start-up cycle (D2) was presented. This cycle came back throughout the whole masterclass. Following, there was a short video (D4) that provided more information about the lean start-up cycle. This was all the theory for this session.

Next, the students were asked to reflect on their learning in this e-learning activity (see Figure 2) (D7). The three learning goals that were stated at the beginning were repeated and the students were asked to rate how well they have reached each of them on a scale from 'I completely do not agree' to 'I completely agree'. Finally, the contact information of the student assistants who taught the masterclass and practical information about

Figure 2

Reflection Page



the upcoming face-to-face session were presented. The students were also asked what they were interested in learning more about (D7). This was the end of e-learning activity one.

In-class session

The learning goals for the face-to-face sessions are focused on 21st-century skills (D6). In the first face-to-face session, the students learned about their role in a team, what brainstorming methods exist and how to use them, and they came up with a start-up idea with which they worked the rest of the masterclass. All these topics are crucial in the process of starting up a business according to experts in the field. The first learning activity consisted of a teambuilding activity in which they got to know their fellow students and had to build a structure together (D3). After this activity, they got instructions about the different roles that exist within a team, and they had to analyse which role fitted them best. After the teams had been formed, a guest speaker talked about their experience of beginning their start-up (D1). The lean start-up method was also mentioned, which they had learned about in the first e-learning activity. After this inspirational talk, the students got to work. Several brainstorming techniques were explained, aligning with the goal of learning 21st-century skills, and the students had to apply them and come up with start-up ideas (D3). They had to fill out the problem statement of their idea to determine the target group and their goal. After this, the students briefly pitched their ideas to the group and reflected on what they had learned (D7). The session ended by explaining the learning goals and activities for the next session (D6).

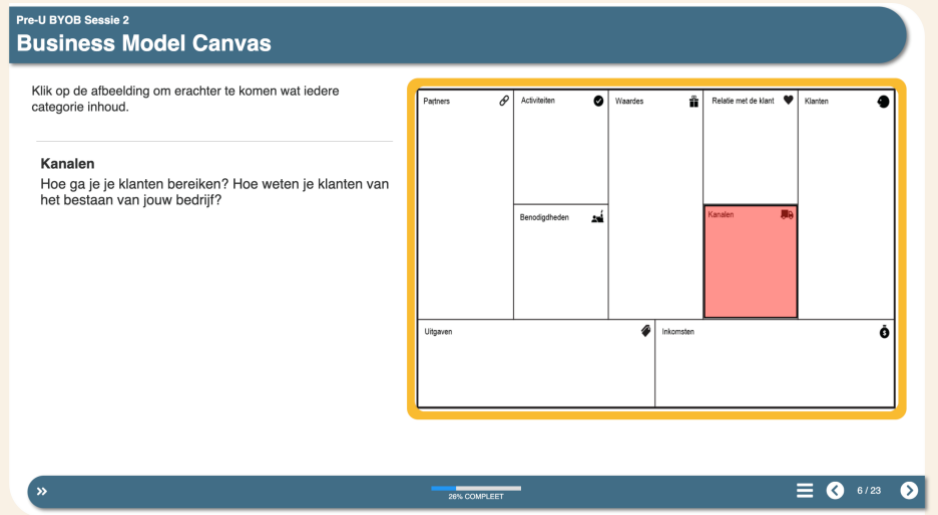
Session 2

E-learning activity

After the general welcome and the questions about specialization and name were answered, the learning goals of this e-learning activity were stated (D6). The e-learning activity started with a video (D4) to introduce the business model canvas (D2). Next, an interactive image of the business model canvas was presented. Students could click on the different

Figure 3

Interactive Image



categories to see what they were about (see Figure 3). After this, a video with more in-depth information about the business model canvas was presented (D4). Now that the students learned the general theory of the business model canvas, a real-world case study was introduced with some text (D1). After this, a video on this real-world case was presented (D1, D4). After having watched the video, an empty business model canvas was presented and students had to drag and drop the right concepts into the right categories (D3). When they made a mistake, they got immediate feedback and got a chance to try again (D5).

Next, a text with theoretical information about sustainable entrepreneurship was presented. After that, the students watched a video about the sustainable development goals of the United Nations (D2). Following this, the students were asked three open questions about sustainable entrepreneurship (D3). After the student had filled in an answer, they could check their answer with the template answer that was then provided (D5). The next theoretical topic of market research was introduced with a short text, then there was a video about this topic (D4).

Another video about the relevance of getting feedback was presented (D4). The student then had to ask for feedback on their start-up idea to ChatGPT; a possible prompt was already provided (D5). They had to upload a screenshot of the conversation in the online environment so the instructor could provide feedback (D5).

This was the end of the second e-learning activity. The learning goals were provided again, and the student was asked to reflect on each learning goal (D7). The next screen contained the contact information of the student assistants and practical information about the upcoming face-to-face session. The students were again asked what they were interested in learning more about. This is the end of e-learning activity two.

In-class session

The second face-to-face session started with a reflection on what the students learned last week (D7). Then an overview of the learning goals for this session (D6) and a short knowledge check on what they learned in the second e-learning activity were presented. The students got an example of the business model canvas (BMC), and together with the whole group, they filled it in for a known Dutch company (D1). After this example, the students had to fill in the BMC for their start-up ideas in the groups that they formed earlier (D3). After a short break, the customer and value proposition were discussed in more detail. These are parts of the BMC that are further elaborated upon in the value proposition canvas (VPC). Before the students got into the VPC, they had to analyse their potential clients and create an interview scheme. They practised with this in a role-play activity (D3). All these topics were included because of their relevance in the real world according to experts in the

field of start-ups. After this, an example of the VPC was filled in with the whole group of the same Dutch company. Next, the students had to fill in the VPC in their groups. The session was concluded with a reflection on what was learned (D7), and the learning goals and activities for the next session were explained. Before the next face-to-face session, students were expected to interview one person from their potential customer group.

Session 3

E-learning activity

After the general welcome and the questions about specialization and name were answered, the learning goals of this e-learning activity were stated (D6). The e-learning activity started with a video about the minimum viable product (D4) and why this is important in the lean start-up cycle. Next, a text with ideas on how a minimum viable product can be made was presented. The topic ended with an open question and a template answer after the student had answered (D3, D5).

The next topic, pitching, was introduced with an open question that asked the student to think about three important factors in the process of making a pitch (D3). Then a short text was presented to introduce the next video. After the short video about pitching, a video about giving constructive feedback was presented (D2, D4).

This was the theory of e-learning activity three. The learning goals were presented again for the student to reflect upon (D7). The student assistants' contact information and practical information about the upcoming face-to-face session were presented. The students were again asked what they were interested in learning more about. This was the end of e-learning activity three.

In-class session

Session three started with a reflection on what the students had learned last week. Extra attention was paid to their experience with interviewing a potential client. Next, the learning goals and activities for this session were mentioned (D6). Some theory about the minimum viable product (MVP) was explained, and immediately the students got to work on their MVP (D3). Most of the session was dedicated to being creative and building the MVP. The students also got time to work on their pitch, and a peer-to-peer feedback exercise was done (D3, D5). If there was enough time, students could also work on their company name, logo and slogan. The session ended with a reflection (D7) and the learning goals for the next session. As a take-home assignment, the students had to go back to their potential customers and ask for feedback on their MVP.

Session 4

E-learning activity

After the general welcome and the questions about specialization and name were answered, the learning goals of this e-learning activity were stated (D6). The e-learning activity started with a video about investing and financing a start-up (D4). After this, a multiple-choice quiz with 5 questions asked the students about the different investing possibilities for a start-up. The students saw their scores after they completed all 5 questions (D3, D5).

This was all the theory for the fourth e-learning activity. The learning goals were stated again, and the student was asked to reflect on them (D7). There was again the open question where they could fill in what they were interested in learning more about; on this page, there was also contact information and practical information about the last face-to-face session.

Because this was the last e-learning activity in the masterclass the students got five questions to reflect on the e-learning component experience. The five statements were: 'I was motivated to participate in the online part of this masterclass', 'The online activities suited my way of learning', 'The online materials helped me to understand the theory better', 'I have the feeling I accomplished the learning goals of the masterclass', and 'I would recommend this masterclass to fellow students'. Next, there was an open question where the students could leave comments or tips for the masterclass. This was the end of e-learning activity four. This last part was included for the general evaluation of the masterclass for Pre-U.

In-class session

Session four started again with a reflection on the last session. This time extra attention was paid to the evaluation of the MVP with the potential customer. The learning goals and activities for this session were explained (D6), and the students immediately got time to improve their MVP based on the feedback they got. After this, the students had to come up with a crowdfunding action to finance their start-up (D1, D3). Then the finale of the masterclass began. The students got to pitch their business plans to real entrepreneurs at the universities' Incubase. Incubase is the incubator at the University of Twente. It offers working facilities and an international community to accelerate student start-ups. The entrepreneurs gave the students feedback on their ideas and more information on what Incubase entails (D1, D5). This way they got an idea of what the University of Twente facilitates for young entrepreneurs like them. The masterclass was concluded with a

reflection on the overall learning goals and a short evaluation (D7). The students all received a certificate of participation, and the masterclass ended.

5.2.2. Changes Made

The redesign of this masterclass focused on improving student engagement. The content of the masterclass was updated, and the sessions were restructured. The most important changes are discussed below.

The initial masterclass consisted of four in-class sessions with no preparation. In the new design, a flipped classroom approach was used in which the students had a maximum of 30 minutes of preparation before each in-class session. Thus, four e-learning tasks were developed in the software program Xerte. One week before the face-to-face session, the students were given access to the e-learning activity for this session. This change was made because it was a wish of Pre-U to implement blended learning in a flipped classroom. The flipped classroom approach allows for a more personalized learning experience. Students can access instructional materials at their own pace. During in-class sessions, there is more time to engage in discussions and participate in collaborative activities. This aligns with the goals of Pre-U and the need to enhance student engagement in this masterclass.

The learning goals of the masterclass were also revised and changed. The overall learning goals for the initial masterclass were: ‘the student understands the concept of entrepreneurship, ‘the student knows what business opportunities are and how to capitalize on them’, ‘the student knows what a zero-sum game is’, ‘the student knows what the study International Business Administration entails’. These were changed to: ‘the student understands the lean start-up method and knows how to apply it in developing a business idea’, ‘the student has done market research, customer interviews, and created a minimum viable product’, ‘the student has pitched their business idea to others’, ‘the student knows if entrepreneurship fits them’. The revised learning goals were formulated according to the SMART framework (Conzemius & O’Neill, 2009) and aim to provide students with practical experiences, skills, and self-awareness in the context of entrepreneurship, preparing them to navigate the real-world challenges of starting and developing a business. The learning goals were formulated together with experts in the field of student start-ups at the universities’ Incubase.

The content of the masterclass was revised and updated. The new masterclass content focused more on the initial phases of starting up a business instead of experiencing what it is like to have a business in the car industry. Overall, the shift from a simulation game to a process-oriented approach centred around starting a business provides students with a more relevant learning experience related to real-world cases (Freeman et al., 2014). It

aligns with their interests, facilitates the development of essential skills, and prepares them if they ever want to start up their own business (Ryan & Deci, 2000). In this way, the masterclass can enhance intrinsic motivation and engagement. The masterclass also has broader applicability across different sectors and industries with the new design. This allows students to explore their interests and talents, but also to get familiar with the facilities that the university provides for student start-ups.

Several parts of the initial masterclass remained relevant for the new design. Certain theoretical parts in the initial masterclass were still relevant, such as the theory about the lean start-up method, conducting market research, value propositions, business model canvas, pivoting and financing. All these theory components were now relevant to the student's start-up ideas. The pitch originally in session three was moved to session four to function as the finale of the masterclass series. The theoretical parts were mostly covered in the e-learning activities preceding the in-class sessions.

5.3. Design Implications

Based on the needs analysis and the literature review, the design implications were made. These design implications include several practical manifestations which can be found in Table 4. The practical manifestations are based on a combination of educational theories from the theoretical framework and best practices in instructional design aimed at optimizing the educational experience for learners.

Table 4

Design Implications & Manifestations

Design Implications	Specific manifestations			
D1: Incorporate challenging tasks related to real-world	Real-world case studies	Invite guest speaker	Problem-solving activities	Role-playing exercises
D2: Chunk the learning content	Modular lessons	Bite-sized video lectures		
D3: Incorporate interactive activities	Group discussions	Collaborative projects or presentations	Peer-to-peer feedback	
D4: Use multimedia sources effectively	Video lectures	Visual aids		

D5: Provide feedback	Immediate feedback through quizzes	Personalized feedback from instructors
D6: Provide clear and concise learning objectives for each session	Clearly stated learning objectives	Expected outcomes and competencies
D7: Provide opportunities for self-regulated learning	Self-paced learning resources	Moments of Reflection on one's own learning

First, the design implication 'incorporate challenging tasks related to real-world cases' can be brought into practice by implementing real-world case studies, inviting a guest speaker, and including problem-solving activities or role-playing exercises. These exercises are chosen to align with experiential learning theory (Kolb, 1984). Research highlights the value of real-world applications for a deeper understanding of knowledge (Vygotsky, 1980), additionally, these exercises foster critical thinking and practical problem-solving skills which aligns with Pre-U's wishes. The role-playing exercise was included upon recommendation of experts in the field of student start-ups.

Chunking the learning content can be realized by making modular lessons and bite-sized video lectures. The modular lessons were kept the same as in the original design since this aligns with Pre-U's usual format of a masterclass. The bite-sized video lectures were used since this is in line with the principles of blended learning in a flipped classroom. There are a lot of criteria for making engaging video lectures (Wang et al., 2023), however, this is beyond the scope of this research. The only criterium for videos in the e-learning activities in this research was that they were no longer than six minutes each (Senali et al., 2022).

Incorporating interactive activities can be brought into practice by including group discussion exercises, collaborative projects or presentations and moments for peer-to-peer feedback. These exercises align with the principles of active learning and thus aim to enhance engagement and promote a deeper understanding of concepts (Freeman et al., 2014). Next is the design implication of using multimedia sources effectively. This can be incorporated by including video lectures and visual aids in the design. The video lectures and visual aids are based on principles of multimedia learning (Mayer, 2014) which emphasizes the significance of these elements in instructional materials for enhancing learning outcomes. In this masterclass, the video lectures fit well with the blended flipped classroom approach.

The visual aids during in-person sessions were already part of the standard format of Pre-U masterclasses. The design should include moments for feedback, and this can be implemented by providing students with immediate feedback through quizzes of personalized feedback from the instructors. These two forms of feedback fit well with the flipped structure of the masterclass. Constructive feedback is critical for student learning and improvement (Hattie & Timperley, 2007).

Providing clear and concise learning objectives for each session can be done by clearly stating the learning objectives and expected outcomes and competencies. This is essential for aligning instructional content with learning goals, which is a fundamental principle of instructional design. Lastly, the design implication ‘providing opportunities for self-regulated learning’, can be implemented by providing the students with self-paced learning resources and opportunities to reflect on their learning process. Both of these were implemented into the e-learning activities. Research by Zimmerman (2000) emphasizes the role of metacognition and self-reflection in enhancing learning autonomy.

6

Evaluation of the Design

In the evaluation and reflection phase data was gathered to assess the effectiveness of the educational design. This phase aims to reflect on the design's strengths and weaknesses, identify areas for improvement, and gain a deeper understanding of how the blended flipped classroom design functions in the intended educational context. In particular, the focus was on the different dimensions of student engagement.

6.1. Method

Qualitative research was conducted to evaluate the design. The evaluation consisted of a pilot test of the full masterclass and a semi-structured interview about the participants' experience. During the pilot test, learning analytics were collected from the e-learning activities, and in-class activities were systematically observed by the researcher. From this pilot, areas for improvement could be identified, and recommendations were formulated.

6.1.1. Participants

The participant group for the pilot and the interviews consisted of five secondary school students (VWO) from the Twente region. This participant group is similar to the one on which the needs analysis was based. In Table 5 the participant profiles are displayed.

Table 5

Participant Profiles

	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Gender	Male	Female	Male	Female	Female
Grade	5VWO	5VWO	5VWO	5VWO	4VWO
Educational specialization	Economics & management	Nature, technology & health	Nature & health	Nature, technology & health	Nature & health
Attendance f2f sessions	4/4	4/4	4/4	3/4 Missed session 4	3/4 Missed session 1
Notes		Pre-U honours student	Pre-U honours student	Pre-U honours student	

Since the design implications were based on this needs analysis, and this represents the general population that the masterclasses are meant for, the pilot test was done with a similar participant group. Ethics approval by the BMS ethics committee was obtained before recruiting participants, the informed consent form can be found in Appendix C. Participants were recruited using the network of Pre-U by contacting partner schools and asking the students who were currently following the Pre-U Honours Programme.

The teacher of the masterclass, in line with the common practice in Pre-U programs, was a student assistant. While this student has received some training in didactics, it is essential to acknowledge that they cannot be seen as a professional educator in the traditional sense. Their role primarily involved facilitating the learning process, offering guidance, and moderating class activities. This student assistant played a crucial role in creating an interactive and engaging classroom environment, aligning with the principles of the flipped classroom approach and contributing to the overall success of the masterclass.

6.1.2. Instrumentation

During the pilot, learning analytics were collected in the online environment to get insights into the online learning behaviour of the students. A data plan was made to communicate what learning analytics were relevant to this research. The data plan can be found in Appendix D. From this data plan, four dashboards were created, one for each session, and shared with the researcher.

To get further insights into engagement in the face-to-face sessions, the researcher observed the participants and the teacher during these sessions (the observation scheme can be found in Appendix E). The observation focused on the behavioural engagement of the participants, for example asking questions, commenting, and engaging in a discussion. After all four sessions were completed, the participants were interviewed individually. These interviews addressed three main topics: cognitive engagement, behavioural engagement, and emotional engagement. Based on the prior literature and the specific context of the research the interview questions were developed by the researcher. Interview questions asked were for example: ‘Can you describe a skill that you learned during the masterclass that you found particularly valuable?’, ‘In what environment did you complete the e-learning activities?’, and ‘What did you enjoy most about the masterclass?’ The full interview scheme can be found in Appendix F.

6.1.3. Procedure

Participants of the pilot were told that the masterclass was part of a master thesis research and that the insights were used to improve the Pre-U masterclasses. They were informed that the e-learning component would register learning analytics, and they were also informed that the interview would take place after the pilot had ended and that this would take a maximum of 30 minutes. Informed consent was obtained before the start of the first e-learning component.

One week before the first face-to-face session, the participants received the information to start with the first e-learning activity that prepared them for the first face-to-face session of the masterclass. The participants completed all four sessions in six weeks. After the last session, the individual interviews were conducted via MS Teams. The interview started with a repeated explanation of the aim of the research and the evaluation procedure. Then the interview questions were asked following the prepared interview scheme. When needed, follow-up questions were asked to get sufficient information about the participant's experience. After the interview was finished the participants were thanked for their participation.

6.1.4. Data analysis

All answers to the interview questions were transcribed and translated into English. A deductive thematic analysis was conducted. The interview outcomes were coded, and three themes were created following the structure of the interview scheme: cognitive, behavioural, and emotional engagement. The coding scheme and the frequency that codes were mentioned in the interviews can be found in Table 6. The same researcher coded all data, so no inter-coder reliability was calculated. The in-class observations were structured and summarized per session.

Table 6

Coding Scheme

Theme	Code	Description	Frequency
Cognitive engagement	Challenge/interest	Participant mentioned challenging or interesting aspect	9
	Critical thinking	Participant discussed development of critical thinking skills or application	4

	Self-paced video learning	Participant referred to self-paced video learning component	7
	Teacher	Participant mentioned role of the teacher	5
	Usefulness e-learning activities	Participant mentioned overall usefulness of e-learning activities	15
	Valuable activity	Participant pointed out valuable activity	6
	Valuable concept	Participant pointed out valuable concept	4
	Valuable skill	Participant pointed out valuable skills	5
Behavioural engagement	Effort	Participant discussed effort they put into preparing for masterclass	5
	Look up extra info	Participant mentioned seeking extra information outside of provided material	5
	In-class participation	Participant discussed active participation during in-class sessions	2
	Learning environment (online)	Participant discussed aspects related to the online learning environment	6
	Learning strategies	Participant talked about strategies used to engage with materials	6
	Time spent on e-learning activities	Participant mentioned amount of time dedicated to e-learning activities	7
Emotional engagement	Enthusiasm	Participant expressed enthusiasm, motivation, or excitement about masterclass	8
	Group activities	Participant discussed emotional engagement with group activities/interactions	7
	Learning environment (f2f)	Participant discussed impact of f2f learning environment	6

Less enjoyable	Participant mentioned any aspects that they found less enjoyable/engaging	5

6.2. Evaluation Outcomes

The evaluation aimed to gain a deeper understanding of the impact of implementing a student-centred, blended learning approach in a flipped classroom setting on student engagement in the Pre-U masterclass. The analysis of the interviews focused on the cognitive, behavioural, and emotional engagement of the students in the masterclass. The analysis of the in-class observations and the learning analytics focused on behavioural engagement. This chapter presents a summary of the results based on the interview results, learning analytics and the results of the in-class observations.

6.2.1. Cognitive Engagement

In the following section, the most important insights gathered from the interviews focusing on cognitive engagement will be discussed. As previously defined, cognitive engagement includes the mental activity and thoughtful processing that learners invest in their educational experiences (Groccia, 2018). In exploring cognitive engagement, the focus was on understanding participants' perceptions of challenging aspects, valuable concepts, and skills learned during the masterclass, as well as the role of online materials, pre-class activities, and in-class group activities in their learning experience.

Participants found the assignments challenging. P1 and P3 found the pitching exercises the most challenging, P2 found the exercises with the BMC most challenging, and P5 and P4 indicated that the whole economic way of thinking was challenging for them because they did not learn this at school. All participants valued the connection to real-life scenarios. This alignment between the masterclass and real-world application sparked their interest and engagement.

> "It is mainly that I could relate it to the real world, it wasn't something abstract that you did not do much with, but something that you could elaborate upon and maybe even execute after the masterclass." [Participant 1]

Several participants highlighted specific concepts and skills they found particularly valuable. P2, P4 and P5 found that using the BMC was valuable because they had never done it before. It helped P5 to help structure her thoughts and put them to practice. P1 and P3 did not mention specific concepts they found valuable.

> "Filling in the BMC was very useful for me; it gave me clarity about how the idea was taking form. Everything that was first in my head was now on paper, that gave me clarity." [Participant 5]

Skills that were found valuable consisted of pitching (P3, P5), problem-solving (P2), learning how to interview a potential customer (P2), and learning to collaborate in a group (P1). P4 did not know what skills she found most valuable. Furthermore, cognitive engagement was displayed by the participants via the e-learning activities. All participants, except P1, appreciated the e-learning activities as preparation for the f2f sessions. This way they felt prepared and were able to understand the concepts and learned theory during the f2f sessions. This gave them the idea that they were ready and better able to complete the assignments, and actively engage during in-class discussions.

> "I felt prepared because it was not new anymore during the face-to-face session. I had already read or heard about it, so I knew better what we were talking about." [Participant 3]

However, not all feedback was positive.

> "The e-learning activities were quite easy; I knew many things from school already. For me, it would also be okay without the online part" [Participant 1]

For P1 the e-learning activities did not have added value because a lot of the theories were already known to him, this could have been due to his specialization. However, the e-learning activities also included exercises related to the theories which he could have completed with his prior knowledge. Looking at his completion times in Table 7 he did not complete the exercises as intended, so it would have been hard for him to judge if the e-learning activities were too easy. P4 indicated that some of the content was redundant because the e-learning activities contained information on the same topic that was talked about during the f2f session. This could have led to lower engagement levels.

The group activities during the f2f sessions were found valuable by all participants. P3 indicated that there was a lot of interaction which was useful for their learning process. P4 explained how she handled the group discussion when a new member joined their group in the second f2f session. She said this discussion was valuable because this helped her to develop her collaborative skills. P2 said that the small group size was helpful during in-class discussions, peer feedback from the other group was valuable and it helped her develop important skills.

> "The group activities during class helped me develop those critical thinking and problem-solving skills." [Participant 2]

In summary, the cognitive engagement of participants in the masterclass was characterized by their readiness to tackle challenging assignments, their recognition of the course's alignment with real-world scenarios, and their appreciation of valuable concepts and skills. Participants indicated cognitive engagement through their interaction with the online materials. Despite some redundancy in the content, the online component contributed to the participants' sense of preparedness for the in-class sessions, fostering active engagement and understanding of the course content.

6.2.2. Behavioural Engagement

Next, the most important evaluation findings on behavioural engagement will be discussed. Behavioural engagement refers to the visible behaviour and active involvement that participants show in their educational activities (Groccia, 2018). First, the interview findings on behavioural engagement will be discussed, and later the in-class observations will be explained. The data collected in the e-learning environment was not as reliable since this was also a pilot for using Xerte. Therefore only the completion times are used as results.

Three out of five participants were present at all f2f sessions. P5 missed the first f2f session, and P4 missed the last f2f session. Both times the reason for missing the session was out of the participants' hands so this should not be seen as an indication of low behavioural engagement. In general, three participants (P2, P4, P5) indicated to have put effort in their free time to be prepared for the masterclass f2f sessions.

> "I did my best in the masterclass with the online activities I did my best to come prepared." [Participant 2]

P1 and P3 indicated to have rushed through the e-learning activities. In Table 6 it is visible that P1 and P3 spent significantly less time in the e-learning components than the other three participants. P1 indicated that he knew most concepts already and the e-learning activities were not useful for him. When looking at the completion times in Table 7 for Participant 1, it is impossible that he looked through all the learning materials and made the conclusion that he knew all the materials. Additionally, the e-learning activity did not only consist of theoretical knowledge, in each e-learning activity there were interactive exercises which are useful for participants with every level of prior knowledge. Therefore, it can be concluded that P1 did not participate in the e-learning activities, he will be seen as an outlier.

In general, the most time was spent on the e-learning activities a day before the next f2f session. P2 indicated to have spent the most time on the e-learning activity of session 2,

this aligns with the length of this activity. P3 said to have spent the least time on the last e-learning activity and that in general, he rushed through the online component, this is an indication of lower behavioural engagement levels.

> "I think I spent the least time on the last e-learning activity of session 4. In general, I rushed through the online preparation parts a bit." [Participant 3]

P4 and P5 said to have used the time they needed to complete the e-learning activities; this is also represented by the times in Table 7. These findings show that P2, P4 and P5 were most behaviourally engaged with the e-learning activities.

Table 7

Completion times e-learning activities

Estimated time needed	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Average
Session 1: *10:00 min*	2:52 min	12:33 min	1:53 min	10:12 min	7:48 min	7:03 min
Session 2: *30:00 min*	1:42 min	41:15 min	13:36 min	36:38 min	11:01 min	20:50 min
Session 3: *12:00 min*	2:30 min	14:17 min	3:51 min	9:02 min	4:54 min	6:54 min
Session 4: *6:00 min*	unknown	5:31 min	unknown	14:28 min	8:23 min	9:27 min
Total time: 58:00 min	7:04 min	73:36 min	19:20 min	70:20 min	32:06 min	

P2, P4 and P5 all spend around the estimated time needed on the e-learning activity for session one. P1 and P3 did not participate. This e-learning activity consisted of a welcome video and a video on how to use the e-learning activities for the rest of the masterclass. This preparation did not include much theoretical knowledge, it was mainly to introduce the topic and manage students' expectations. The e-learning activity for session two was by far the longest, the estimated time needed was 30 minutes. P2 and P4 both spend more time on this than expected. This could have been because of the interactive activities in the e-learning activity. They could have needed more than one try to get it right,

or they could have rewatched parts of the videos to get a better understanding before proceeding. The online preparation for session three was completed around the expected time by P2 and P4. P3 and P5 spend significantly less time on this activity. The e-learning task consisted of multiple videos and open questions related to the videos. The participants might have skipped the videos or skipped to the part with the necessary knowledge. If they were already familiar with certain theories and concepts this is not a problem. It was expected that students with more prior knowledge would skip certain parts. The e-learning activity for the last session was completed within the expected time by P2. P4 and P5 needed more time than expected for this. The video in this e-learning activity contained quite a lot of information. They might have rewatched the video multiple times to fill in the questions afterwards correctly. In general, P2, P4 and P5 participated in most e-learning activities. The differences in completion times can be explained by different learning strategies the students may have used, or the difference in prior knowledge. However, the completion times for the e-learning analytics in Table 7 cannot be linked directly to the actual time students spend studying the materials. While they opened the e-learning activity on their browser they could also have done things unrelated to studying, this still adds to the completion time the learning analytics collected.

When asked about the participants' learning strategies, P1 found it hard to explain what strategies he used to understand and remember the information presented in the masterclass, for the e-learning activities this could have been because he did not participate in most e-learning activities. P2 explained that she did all the exercises and made notes on the difficult topics, later she would look at the notes again if needed. This was similar for P3 and P5. P4 indicated that she had rewatched some of the videos offered online if she did not understand certain things at once, doing the exercises also helped her to understand and remember information.

Behavioural engagement was also displayed by the participants by looking up extra information about the topic of the masterclass. P1 talked to some friends outside the masterclass about the topic, he brainstormed with them about creative ideas. P2 said she used some information from previous educational activities to understand the content better. P3 indicated to have looked for extra information regarding a certain topic he learned in the e-learning activity.

> "I did look online for the BMC and the other model and also how some companies applied it." [Participant 3]

And P4 and P5 said to have looked up some terms they did not understand at first. All these activities outside of class time display a high level of behavioural engagement with the masterclass.

In addition to the participant interviews, in-class observations were done with the help of the observation scheme that can be found in Appendix E. The observations focused on participants' behavioural engagement during the masterclass f2f sessions. Together with the participant interviews, these observations give valuable insights into how students actively engage with provided materials, collaborate with peers, and interact with the learning environment. Table 8 presents specific observations per session.

Table 8

Observations f2f sessions

	Session 1	Session 2	Session 3	Session 4
Verbal engagement				
- Turn taking	7 turn taking	5 turn taking	2 turn taking	-
- Asking a question	12 questions	1 question	No questions	2 questions
Collaboration				
- Talking in pairs - Discussion	During all group assignments	During all group assignments	During all group assignments	During group assignments
Focus & attention				
- Distraction - Disruptive behaviour	P1 looked at phone once	4 people looked at phone One pair discussing holidays	- One pair discussing holidays	3 people looked at phone One pair discussing holidays
Comments	P1 asked more than half of the questions, he	More discussion than first session in group of three	Group of three seemed to neglect one	All participants seemed very engaged when we changed

	was very engaged P4 was the quietest of the group, P2 the most outgoing and confident	member during discussions	location & pitched to a professional

During the first f2f session, the group consisted of three people who already knew each other and one new member (P1). Their interactions and behaviours provided insights into behavioural engagement. P1, who was new to the group, showed a high degree of behavioural engagement by actively participating and asking the most questions. P3 and P4 also engaged by asking questions. Overall, P4 was relatively quieter, while P2 displayed outgoing and confident behaviour. Both groups demonstrated collaboration, discussion, teamwork, and the exchange of ideas.

During session two the group consisted of five participants, one newcomer joined the group (P5). This change in group dynamics promoted additional discussions within that smaller group. Overall, the collaboration within the groups went well. During the general part, four out of five participants took a turn in answering questions from the student assistant, showing active participation. However, toward the end of the session, participants seemed to have lost their focus and were distracted by their phones or started talking about something other than the assignment. This shows a decline in engagement.

The third session predominantly involved group collaboration work. The absence of questions suggested a shift in behavioural engagement from individual questions to collaborative effort. In the group of three, two of them shared more ideas and seemed to exclude the third person slightly. From the interviews, it can be concluded that this was mainly due to the difference in interest among the people in that group.

In the fourth and final session, the group consisted of four participants again, P4 was absent. This session primarily focused on group work, presentations, and feedback moments. The group collaboration went well, and ongoing behavioural engagement was displayed. In the middle of the session, P2 and P3 got distracted and started talking about their holiday plans. During the last part of the session, all participants showed high levels of engagement and interest in the activities. This part of the masterclass took part in a different location which added novelty and relevance to the topic of the masterclass.

In conclusion, the in-class observations together with the participant interviews give a valuable perspective on behavioural engagement within the masterclass. The observations show consistent patterns of interaction, collaboration, and participation, reflecting the behavioural engagement supported by the masterclass. The findings from the observations are similar to the findings of the interviews and show that the design facilitates an environment for interaction, idea sharing and collaboration.

6.2.3. Emotional Engagement

This section will dive into the findings from the interviews focusing on the emotional engagement of the participants. As previously discussed, emotional engagement is the genuine interest, motivation, and enthusiasm that learners develop during their educational activities. All participants expressed high levels of emotional engagement, indicating to have been motivated and excited for the f2f sessions. The emotional engagement set a positive tone for their overall experience. P5 who missed the first f2f session experienced initial discomfort during the second f2f session but showed enthusiasm as she eventually felt more at ease with the group.

> "I was new or like newer than the rest, so I was a bit uncomfortable in the beginning. But everyone was nice so I could easily talk along." [Participant 5]

Because the participant group was small, P2 had the feeling that they understood each other's ideas and could give more valuable peer feedback. The group assignments and the guest speaker were the main events that made the participants enthusiastic and caused high emotional engagement levels.

> "The group assignments made the masterclass fun, but also the guest speaker in the first f2f session made me enthusiastic to get started with the project." [Participant 3]

P4 explained that the teambuilding exercise in the first f2f session was fun and useful to get to know everyone. P1, P3 and P5 all indicated there was a lot of interaction within the group which was valuable.

The most exciting part for P1, P2, P3, and P5 was the last session. Here they got feedback from a real young entrepreneur which made the connection to the real world very tangible. P4 expressed enthusiasm for the fact that they had to create a start-up idea themselves and that it wasn't about a company that already exists.

> "By far the most exciting part was that we had to pitch our result to a real professional. It also gave me the idea it really had potential." [Participant 2]

Also, the student assistant who taught the f2f sessions of the masterclass was appreciated by all participants. They were enthusiastic about her and indicated that she could explain clearly and had an accessible attitude.

> "She explained very well and indicated clearly what we had to do during the class and in the assignments. And she also always asked what we did afterwards and what we thought of it which I found very nice." [Participant 2]

When asking the participants about the least exciting part of the masterclass P3, P4 and P5 could not name something. P1 said that he would have found it nice if the group was more diverse, or bigger so that there were more people with similar interests as him. P2 found the exercise of filling in the BMC too long, this could be shortened next time.

In conclusion, the multifaceted evaluation of behavioural engagement within the masterclass, through interviews and in-class observations, shows the participants' active involvement and commitment to the learning process. While the variations in e-learning activity preparation times indicate differing degrees of behavioural engagement, the participants' strategies for understanding and remembering the material reflect their individualized approaches to learning. Their efforts to seek additional information and discussions outside of class hours underscore their deep behavioural engagement with the topic. The in-class observations align with the interview findings, reinforcing the view that the masterclass design effectively fosters interaction, idea sharing, and collaborative engagement among the participants.

7

Discussion & Conclusion

Educational design research was conducted to answer the question *'Can the implementation of a student-centred, blended learning approach in a flipped classroom setting enhance student engagement in a pre-University masterclass?'*. This question can only be answered to a certain extent. Substantial evidence confirms that the implementation of a student-centred, blended learning approach in a flipped classroom may have a positive impact on student engagement in the Pre-U masterclass.

Participants generally responded favourably to the approach, appreciating the relation to real-world practices, interactive activities, and the use of multimedia. They demonstrated motivation and effort. After discussing the most important findings in terms of engagement, design implications for a flipped classroom in a Pre-U masterclass are formulated. Consequently, the study's limitations and recommendations for further research and development of the design will be provided.

7.1. Discussion

The findings of this study underscore the significance of student engagement in the flipped classroom setting. Engagement is a multifaceted construct that consists of behavioural, emotional, and cognitive dimensions (Appleton et al., 2008; Fredricks et al., 2004; Groccia, 2018). This study effectively captured the cognitive engagement of participants. The detailed descriptions of the participants' experiences, their perceptions of challenging assignments, valuable concepts, and skills learned during the masterclass provide a rich understanding of their cognitive engagement (Ryan & Deci, 2000). The masterclass' alignment with real-world scenarios appears to have been a significant driver of cognitive engagement, and this finding underscores the importance of practical relevance in education. Through both interviews, learning analytics and in-class observations the research offers a clear picture of students' behavioural engagement. The varying degrees of engagement with the e-learning activities, indicated by the time spent on them, show that different students interact differently with the online materials. The flipped classroom approach's asynchronous learning component allows students to manage their cognitive load by reviewing materials at their own pace, there is an indication that this reduces extrinsic cognitive load (Sweller, 1994). This indication of the reduction in cognitive load during in-class activities may have allowed students to use more cognitive resources to germane cognitive load, enhancing learning outcomes (van Merriënboer & Sweller, 2005). The behavioural engagement exhibited by looking up additional information and discussing the topic outside of class hours demonstrates a proactive approach to learning among the participants. This aligns with the essence of self-directed learning integral to the flipped classroom model (Freeman et al., 2014). The benefits of the flipped classroom approach were evident in the positive student perception of the approach. The participants' positive

reactions to certain activities like the group activities and the guest speaker, are an indication that the masterclass was successful in promoting emotional engagement (Hew & Lo, 2018). The connection to real-world scenarios seems to have played a significant role in fostering emotional engagement.

From these findings, it can be concluded that there is an indication that a student-centred blended learning approach in a flipped classroom was successful in engaging students. The students actively participated and indicated that the tasks had value for them. According to Schlechty (2011), there was thus an indication that the participants were authentically engaged which is the desired level of student engagement.

On a critical note, the effect of courtesy bias might have influenced the results, potentially threatening the research's validity. Courtesy bias is the participants' tendency to not fully state their unhappiness with the masterclass as an attempt to be polite toward the researcher (Clarke, 2022). The interviews were conducted by the researcher themselves and thus the participants may have provided feedback that they believed the researcher wanted to hear. This could have led to exaggerated positive responses, and thus to overestimation of their engagement levels and positive experiences. To limit this potential bias the participants were informed about anonymous data processing and their right to withdraw from the pilot test. Furthermore, the interview consisted of open questions with a natural tone, thus did not direct students to positive or negative answers.

7.2. Implications

From a theoretical perspective, this qualitative study contributes to the literature of the flipped classroom approach in secondary education by adding richness and gaining a deeper understanding of the factors that influence students' engagement in a flipped classroom. Quantitative research is the most commonly employed method in flipped classroom studies (Senali et al., 2022), this qualitative study adds richness by adopting a qualitative method in the form of interviews and in-class observations. Also, the learning analytics presented enrich the understanding of students' learning through the online learning environment. Furthermore, the study adds to the body of literature on engagement in a flipped classroom because it investigates the different dimensions of engagement (Fredricks et al., 2004). Rather than solely focusing on a single aspect of engagement, it gives a holistic view of all dimensions of student engagement. This gives a better understanding of how students interact with the flipped classroom model, enriching the existing literature (Appleton et al., 2008). Lastly, this study's emphasis on secondary education distinguishes it from the predominant focus on higher education settings in most related research (Al-Harbi & Alshumaimeri, 2016). By incorporating secondary education, this research gives a broader

understanding of the applicability and impact of the flipped classroom approach across different educational levels (Wagner et al., 2021).

From a practical perspective, this research enables instructors and institutions to improve their teaching methods. The findings on cognitive, behavioural, and emotional engagement (Fredricks et al., 2004) show factors that influence student engagement, this information can help design curricula that are more engaging and aligned with students' needs and expectations (Lo et al., 2017). By highlighting the importance of practical relevance, this study emphasizes the need for real-world application in education settings. Instructors and Pre-U can use this information to design activities and assignments that connect classroom learning to practical scenarios, enhancing students' motivation and engagement. The feedback of students on e-learning activities can be used to refine online materials, ensuring that they are engaging and aligned with students' needs.

7.3. Recommendations

For the next iteration of the masterclass redesign, it is suggested to continue enhancing the quality and accessibility of the materials (Brame, 2016). For the online component, it is essential to recognize the diverse backgrounds and prior knowledge of the students. Tailoring the online component to accommodate students with various levels of prior knowledge ensures that every student finds the pre-class learning activities valuable (Hew & Lo, 2018). Additionally, minimizing redundancy is key, especially for students who are already familiar with certain topics. Identifying these students and providing them, with alternative, more advanced materials or activities can foster deeper engagement (Strelan et al., 2020).

Furthermore, videos have emerged as a valuable resource in the e-learning activities in the masterclass. However, it is essential to have a balance between different types of learning materials (Mayer, 2014). Recognizing the diversity in learning styles among students and thus providing written resources alongside video content is necessary (Brame, 2016).

Another critical aspect of improvement lies in optimizing the functionality of the online learning tool. In this case, ensuring that Xerte operates smoothly is crucial. More testing and continuous optimization of this platform can lessen technical issues, resulting in a seamless learning experience for all students (McKenney & Reeves, 2018).

During the in-person sessions, it is important to allow for group formations based on shared interest can significantly enhance engagement (Freeman et al., 2014). Stimulating students to express their preferences fosters a sense of autonomy and ownership over their learning (Ryan & Deci, 2000). Moreover, forming groups based on shared interests can

create a supportive and engaging learning environment. During the in-person sessions, the role of the educator is essential. Since all Pre-U masterclasses are taught by student assistants, the last pillar of flipped learning (professional educator) is not implemented in this masterclass. Since in a flipped classroom, the role of an educator is even more important and demanding than in a traditional one, it is important to consider how the absence of a professional educator might impact the effectiveness of this teaching approach (Hew & Lo, 2018).

Finally, maintaining an environment that continually motivates and excites students about their learning journey is important. This can be achieved by regularly updating content to keep it relevant and by periodically introducing new guest speakers or case studies that connect the masterclass to real-world applications. Such dynamic elements can spark enthusiasm and engagement among students, ensuring that the masterclass remains an impactful learning experience (Brame, 2016).

7.4. Limitations

While the study has provided valuable insights into the impact of implementing a student-centred, blended learning approach in a flipped classroom setting on student engagement in a Pre-University masterclass, it is essential to acknowledge certain limitations that may have influenced the findings. The first limitation is the generalizability of the results. Since the recruitment of participants was rather difficult only the minimum number of participants took part in the implementation of the design. In this case, the study may not have captured the full range of diverse perspectives, experiences, and engagement levels that could be seen in a larger sample of students. The experiences and feedback from these five participants may not adequately represent the variability that may be present in a more extensive and diverse group of students who might enrol in similar Pre-U masterclasses. Because of the context-specific nature of this study, it is hard to generalize the findings to a broader educational context. Piloting with a larger group of students with differences in specialization would increase the generalisability of the results for the Pre-U masterclass.

Additionally, this study primarily made use of qualitative methods. This offers the tools and flexibility needed to explore the dynamics of engagement in the flipped classroom. However, qualitative research relies on interpretation, and the researcher's subjectivity could have influenced the findings. To limit this bias in the future, intercoder reliability checks should be done.

Furthermore, it's worth noting that the use of learning analytics was limited in this study. Given the relatively short duration of the course and the small number of participants, the full potential of learning analytics in tracking and analyzing student engagement

trajectories over time may not have been realized. In longer courses with larger student populations, the application of learning analytics could offer a more comprehensive understanding of how engagement evolves throughout the learning process.

7.5. Conclusion

This research aimed to explore the relationship between the flipped classroom approach and student engagement in a Pre-U masterclass. Several key insights have emerged, showing the multifaceted nature of student engagement within the context of the flipped classroom. Analysis and exploration revealed the diverse backgrounds and learning styles of masterclass participants, underscoring the need for a more adaptable approach to design. While some aspects, particularly practical and active learning components, received positive feedback, there were opportunities for improvement in terms of organization and engagement. Seven design implications were formulated based on the outcomes of the student evaluation surveys, several educational design theories, and Pre-U's wishes.

These implications together with the basic principles of the flipped classroom approach yielded a new design for the Pre-U masterclass. Evaluation of the pilot test of the new masterclass revealed that students' ability to access learning materials at their own pace outside of class, coupled with interactive and collaborative in-class activities, significantly contributed to their engagement. This thesis has provided valuable insights into the relationship between the flipped classroom approach and student engagement in a Pre-U masterclass. While it has shown the potential of this pedagogical model to enhance engagement, it has also highlighted the need for careful implementation and ongoing refinement. The findings and recommendations from this research can serve as a guiding framework, for educators striving to create engaging and effective learning environments that support students in their learning experience.

8

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Appendices

Appendix A. Specializations Dutch VWO

Obligatory courses for everyone

- Dutch language and literature
- English language and literature
- Social studies
- Cultural Artistic Education (CKV) (not at the gymnasium)
- Physical education
- Second foreign language, at gymnasium this is Latin or Greek

Specialization	Obligatory courses	Obligatory free choice courses	Possible dubble specialization
Nature & technology (N&T)	- Maths B - Phycics - Chemistry	- Biology - Informatics - Math D and nature - Life and technology - Research and design	N&T + N&G N&T + E&M
Nature & health (N&G)	- Maths A or Maths B - Biology - Chemistry	- Geography - Physics and nature - Life and technology - Research and design	N&G + N&T N&G + E&M
Economics & society (E&M)	- History - Maths A or Maths B - Economics	- Geography - Business economics - German - French - Social sciences	E&M + C&M
Culture & society (C&M)	- Maths A or Maths B or Maths C - History	- Geography - Economics - German - French - Latin language and culture - Greek language and culture - Art - Philosophy	C&M + N&G C&M + N&T

Appendix B. Evaluation Questionnaire

This questionnaire was used to evaluate the initial masterclass. The needs analysis was based on the results of this questionnaire.

1. What level masterclass did you follow?
- 1-2 VWO
- 3-4 VWO
- 5-6 VWO
2. Did you ever participate in a Pre-U activity before?
- Yes, namely…
- No
3. What masterclass did you follow?
- List of all masterclasses
4. Are you a participant in the Pre-U Honoursprogramme?
- Yes
- No
5. How did you hear about the masterclass? (multiple answers possible)
- Teacher
- Pre-U coordinator
- Teamleader
- Parents
- Instagram
- Facebook
- Friends or fellow students
- Pre-U website
- I don't know
- Other ..
6. To what degree do you agree with the following statements about your registration for the masterclass?
- The topic interests me
- I want to learn something about the topic
- I want to discover if this topic fits me
- I am looking for an extra challenge besides my schoolwork
- A fellow student asked if I wanted to join
7. Next to this masterclass, are you going to do another Pre-U activity?
- Yes, namely..
- No
8. On a scale of 1 to 10 how satisfied were you with the masterclass?
9. Did the masterclass meet your expectations?
- Yes
- No
10. Can you rate each session with a number from 1 to 10?
11. Can you explain the numbers you have given?
- Open question
12. How easy or hard did you find the masterclass?
- Scale from very easy to very hard
13. If your found it hard, can you explain why?
14. Can you give a number from 1 to 10 about how satisfied you were with the student assistants of this masterclass?
15. To which degree do you agree with the following statements
- The student assistants could explain the topic well
- The student assistants were enthousiastic

- The student assistants gave clear instructions when needed
- The student assistants had a feasible time planning

16. Do you have any additional tips for the student assistants?
17. In what year are you currently?

- 1 VWO
- 2 VWO
- Etc.

18. To which extent do you agree with the following statements?

- I have experienced whether this topic suits me or not
- I have learned new things about the topic of the masterclass
- The masterclass has challenged me besides my courses in school
- I have discovered what scientific research means
- I have gotten an impression of what it is like to study at a university
- I have gotten insights into what study direction would fit me best

19. To which extent do you agree with the following statements?

- The information on the website was clear
- I got the information about the masterclass in time
- The information in the informationletter was clear

20. What did you find good about this masterclass?
21. What could be improved about this masterclass?
22. What specialization do you follow?

- Specializations listed

23. At what school do you study?

- List of parterschools

Thanks for filling out the questionnaire, we have received your response.

Appendix C. Informed Consent Form

Toestemmingsformulier voor onderzoek blended masterclass Be Your Own Boss

Beste leerling,

Leuk dat je meedoet met de masterclass Be Your Own Boss. Dit is een blended masterclass, wat betekent dat je een (klein) deel van het lesmateriaal online volgt en de overige 4 lessen klassikaal op de UT plaatsvinden. De masterclass is dit jaar vernieuwd en onderdeel van een afstudeeronderzoek naar de invloed van blended onderwijs op onze masterclasses. Wij bieden deze masterclass gratis aan. In ruil daarvoor geef je een interview waarin je jouw ervaringen deelt.

Het interview zal worden opgenomen zodat het kan worden uitgewerkt. De opname en de uitwerking van het interview zal na het onderzoek verwijderd worden. Citaten uit de interviews kunnen -altijd anoniem- gebruikt worden in het onderzoeksverslag. Ook zal er data worden verzameld in de korte online lessen van de masterclass over hoe jij je door de online les beweegt. Bijvoorbeeld of een filmpje volledig bekeken wordt of hoe vaak ergens op geklikt wordt. Deze data worden – altijd anoniem- gebruikt om de kwaliteit van de masterclass te kunnen verbeteren en kan verwerkt worden in het onderzoeksverslag. Je mag op ieder moment stoppen met jouw deelname aan dit onderzoek. Deelnemen aan dit onderzoek brengt geen risico's met zich mee. Alle gegevens zullen anoniem verwerkt worden. Je hebt verder een informatiebrief ontvangen met praktische informatie en wat er van je verwacht wordt.

Om deel te kunnen nemen aan dit onderzoek en de masterclass hebben we jouw toestemming nodig. Daarom sturen we jou dit toestemmingsformulier. We ontvangen graag uiterlijk 22 mei het ingevulde formulier terug als je wilt deelnemen. Je mag het digitaal opsturen of het thuis printen en er een foto van opsturen.

Mocht jij (of jouw ouders/verzorgers) vragen hebben dan kun je contact opnemen met Eliza Vermare van de Universiteit Twente via e.g.vermare@student.utwente.nl of met Maschja Baas, opdrachtgever van dit onderzoek bij Pre-U via m.i.a.baas@utwente.nl

Met vriendelijke groet,
Eliza Vermare
Onderzoeker

Via deze weg geef ik toestemming dat ik deelneem aan het onderzoek naar de blended masterclass Be Your Own Boss.

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Naam leerling	Handtekening	Datum van ondertekening

Appendix D. Data Plan

Goal

At Pre-U, we are redeveloping the existing masterclass Be Your Own Boss which we also immediately turn into a blended masterclass. This is because we want to gain experience in the development and use of blended education and learning analytics to increase the learning outcome within our education. The subject of the masterclass is entrepreneurship. The target groups are students from 5 and 6 VWO. The masterclass will consist of four three-hour classroom lessons and an e-learning activity of up to one hour prior to the four classroom lessons. Within the four e-learning tasks, we want to collect learning analytics in order to continuously improve our education. This document contains an overview of exactly which data points we want to collect within e-learning as learning analytics. We mainly focus on data about the engagement/involvement of students and the learning outcomes of the short assignments. These are important for this research.

Data

Engagement/Involvement

- What % of the students have logged into the Xerte environment each week? & maybe at what time? (just before the f2f sessions or throughout the week?)
    - If there are few logins, the students are not properly engaged with the platform
- What % of the students go through the entire e-learning?
    - Little participation can indicate less commitment
- Which lessons/parts of lessons are most attended?
- How often do students return to this?
    - For example, are certain videos viewed more often?
- Are certain lessons/lesson components visited by students with a certain profile more often?
- How long does it take students to complete a lesson?
    - Less time spent can be an indication of less engagement
- Videos:
    - How many unique and total clicks are there per video?
    - Do students watch the whole video or just parts? So, are they engaged in “searching behavior”?

This data provides insight into which lessons and which lesson components are visited the most and in what order. This can help optimize the content and learning experience.

Learning outcomes:

- What % of the students with a certain profile choice (E&M, C&M, N&T or N&T, possibly double profiles) have completed what % of the exercises correctly? Do you see a difference between the students with different profiles, or is this negligible?
    - Students with lower performance may be less engaged
- Do students try the question again when they fill in an incorrect answer?
- How much time do the students take to complete the exercises? And is there a relationship between the speed with which the students answer the questions and whether they answer the questions correctly or incorrectly?

This data can help assess students' prior knowledge, whether the assignments are feasible, and whether students are engaged.

Why these data?

My research is about student engagement in the master class because engagement is important in achieving higher-order thinking skills (HOTS) such as critical thinking, creative thinking and problem-solving. All these data could give an indication of the involvement of the students.

Visualizations

For most of this data, visualizations would help to understand the differences between the different specializations of the students.

Appendix E. Observation Scheme

Observable behavior	**St1:**	**St2:**	**St3:**	**St4:**	**St5:**
Verbal engagement Turn taking (how many times did the person speak) Asking a question Commenting					
Collaboration Talking in pairs (write down the groups) Asking questions in group Lively discussion Sharing ideas					
Focus & attention Distractions (looking at phone) Loss of attention (looking at window) Talking to each other about something other than assignment (disruptive behavior)					

Comments:					

Appendix F. Interview Scheme

Cognitive Engagement

1. What did you find most challenging or interesting about the masterclass? [Domain/Skill]
2. Can you describe a concept that you found valuable? [Domain]
3. Can you describe a skill that you learned during the masterclass that you found particularly valuable? [Skill]
    a. Can you describe a specific activity or exercise that you found interesting/engaging during the masterclass?
4. Did you find the online materials helpful in understanding the content? Why or why not? [Domain]
    a. Did the pre-class activities help you to enhance your class participation?
5. Did the in-class group activities help you to develop critical thinking skills (e.g. problem-solving) and communication skills [Skill]
    a. Why did you choose to participate or not participate?
6. Did class activities with the teacher promote creativity and enable new ways of critical thinking? [Skill]

Behavioural Engagement

1. How much effort did you put into the masterclass?
2. How often did you participate in group discussions or activities during the masterclass?
3. What strategies did you use to help you understand and remember the information presented in the masterclass?
4. Did you print anything?
5. Did you look up any other information?
6. What device did you use? Same for all sessions?
7. In what environment did you complete the e-learning activities? (session, 1, 2, 3, 4?)
    a. At dinner table

   b. In your room

   c. At school in between classes

   d. Etc.

8. When did you spend the most time on e-learning? Why?

Emotional Engagement

1. What did you enjoy most about the masterclass?
2. What did you enjoy least?
3. Did you feel comfortable or invited to participate in the course activities?
4. Were you satisfied by the group activities?