Promoting Mastery Goal Orientation by developing and implementing a Mastery Focused Canvas Dashboard

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Promoting Mastery Goal Orientation by developing and implementing a Mastery Focused Canvas Dashboard

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K.B. Franken

in partial fulfillment of the requirements for the degree of

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Eindhoven University of Technology
Department of Industrial Engineering & Innovation Sciences

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Koen Franken

Abstract

This study focuses on learning analytic dashboards (LADs), which are becoming increasingly popular in education. While LADs offer a variety of benefits, existing research suggests that generic dashboard designs may not suit all students and could even demotivate students in ways such as decreasing mastery goal orientation. To address this, this thesis focuses on designing mastery goal-oriented dashboards using the TARGET framework and explores leveraging Canvas data for dashboard development. The study aims to identify dashboard features supporting mastery goal setting and assess the impact of engaging with a mastery goal-oriented dashboard on motivation, academic success, and self-control. Using a randomized 3x2 mixed experimental design, this master's thesis examined the effects of different dashboard types (mastery and normal) on goal orientation, motivation, and self-control among university students (N=29). Data collection involved online surveys with measures of goal orientation, motivation, self-control, and usability. The results indicated that the mastery dashboard did not significantly increase mastery goal orientation during the course. However, a small negative trend in the control group, absent in the treatment group, suggests that a mastery-focused dashboard mitigate the decline in mastery goal orientation. Notably, students with lower initial mastery goal orientation scores experienced a smaller increase in mastery goal orientation over time compared to those with higher initial scores. Additionally, the mastery dashboard significantly enhanced students' self-control in terms of academic persistence compared to the control group. However, no significant effects on motivation or academic achievement were observed. The implementation of a mastery dashboard based on the TARGET framework showed promise in mitigating the natural decline in students' mastery goal orientation over the course duration. However, the anticipated benefits related to enhanced motivation and self-control were limited or non-

existent in this study. Further research with a longer-term intervention may be necessary to investigate the potential for achieving these desired outcomes.

Keywords Goal orientation, Learning Analytics, Learning Dashboards, Motivation.

Table of contents

Acknowledgments....1
Abstract....2
1. Introduction....6
2. Previous work/ Theoretical Background....8
2.1 Learning Theory into Design....8
2.2 Achievement Goal Theory....10
2.3 Trait and State Goal Orientation....11
2.4 Practical Implications....12
2.5 Increasing Mastery Orientation....14
3 Dashboard design and development....19
3.1 Designing the Dashboard....21
3.1.1 Sessions per Day and History....22
3.1.2 Course Timeline....22
3.1.3 Material Links....23
3.1.4 To-do List per Assignment....23
3.1.5 Compliments for achievements....24
3.1.6 Link to discussion form....24
3.2 Data Model Development....25
3.3 Dashboard visualizations....27
3.4 Limitation of PowerBI....27
3.4.1 To-do List....27
3.4.2 Standardize Data Model....28
3.5 Privacy and Security....28
4 Methods....29
4.1 Design....29
4.2 Participants....29
4.3 Manipulation....30
4.4 Measures....30
4.5 Data Analysis....33
4.6 Data Preparation....33
4.7 Scale Analysis....34
4.8 Hypothesis Testing....35
5 Results....37
5.1 Descriptive Statistics....37

H1. A mastery dashboard will increase students' mastery orientation, during the span of a course. 41
H2. Mastery goal orientation will increase more for students who initially have a weaker mastery goal orientation than those with a stronger mastery orientation. 44
H3. Students using the mastery dashboard will have higher self-control compared to those using a normal untailored dashboard. 45
H4. Students using the mastery dashboard will have higher levels of intrinsic motivation to those using a normal untailored dashboard. 47
H5. Students using the mastery dashboard will perform higher academically compared to those using a normal untailored dashboard. 49
5.2 Dashboard Usability, Cognitive Load and Interaction 49
6 Discussion 51
6.1 Limitations 56
7 Conclusion 58
References 60
Appendix A: Information Sheet & Informed Consent 66
Appendix A.1: Information Sheet 66
Appendix A.2: Informed Consent 71
Appendix B: Survey Items 72
Appendix C: Data Model and Explanation Video 75
C.1 Data model 75
C.2 Explanation Video 75
Appendix D: Dashboard Views 76
D.1 Mastery Dashboard (treatment group) 76
D.2 Normal Dashboard (control group) 76
Appendix E: Extra Results Tables 77
E.1 Results of Usability, Cognitive load and Minutes as Covariates 77
E.2 Results of Self-reported Minutes on Dashboard 77

1. Introduction

Learning analytics applications have become increasingly popular in education (Zandvliet, 2020). A common example is a learning analytic dashboard (LAD). LADs allow students to track their progress, identify areas of weakness, and receive personalized feedback. Universities are collecting substantial amounts of data on their students' behaviour on a variety of online platforms which is translated into LADs. Despite the potential benefits, such as supporting self-regulated learning (SRL) techniques, there are still questions about their effectiveness in improving student outcomes (Teasley, 2017).

Multiple studies have shown that you cannot simply assume that presenting the accessible data will help all students. (Gašević, 2016; Teasley, 2017; 2018). In fact, Sedraykan et al. (2020) suggest that for example, performance-oriented dashboard designs may decrease students' mastery orientation, which means that students will focus more on external factors, such as grades and comparison to others, instead of focusing on the mastery of a task and desiring to acquire a new skill (Hsieh, 2011). Consequently, it becomes important to explore ways in which dashboards can be tailored to meet students' individual needs, potentially by enhancing mastery goal orientation. A literature review by Jivet et al. (2018, p38), provided recommendations on implementing learning analytics into education. I want to highlight the following:

"Do not assume the dashboard will have the same effect on all its users, but rather seek to determine which group of learners benefit the most and how to customise the dashboard to provide the same support to all its users."

This paper will use the achievement goal framework (Elliot & McGregor, 2001) to design dashboards with a mastery goal-oriented focus. Students who set and pursue mastery goal setting tend to perform better academically and engage more in self-regulated learning behaviours, such as setting goals and monitoring their progress (Lin, 2019; Wong, 2021). In

addition to this, they often have a long-term perspective on their goals which means that they are better at resisting immediate temptations and delaying gratification, showing better self-control than students with higher levels of performance goal orientation (Lee, 2021). This study aims to investigate how Canvas data can be used to design a mastery goal-oriented dashboard and increase mastery goal orientation, resulting in higher academic success, intrinsic motivation, and self-control.

Therefore, the following research (sub)questions will guide this study:

***RQ**: How can Canvas data be used to provide students with a mastery goal-oriented dashboard to increase mastery goal orientation, academic success, intrinsic motivation and self-control?*

***Sub-RQ1:** What dashboard features (e.g., timeline, to-do) that support mastery goal setting can be defined within specific courses?*

***Sub- RQ2:** How are motivation, academic success and self-control affected by engaging with this dashboard?*

2. Previous work/ Theoretical Background

This literature review will explore different theories of goal motivation, with a focus on mastery and performance goal orientation. Thereafter, various mastery goal intervention methods that have the potential to increase mastery orientation are examined. Finally, the review will conclude with suggestions on how to integrate these findings into dashboard design and other important considerations when developing a student-facing dashboard.

LADs give individuals the ability to track their activities to either self-analyse or compare with their peers. With the rise of online learning platforms and the increasing availability of data, there has been a significant increase in the use of LADs. More data can now be collected, analysed, and visualized, making it easier for learners and educators to gain insights into their performance and behaviour. This has led to a growing interest in LADs as a research topic, with many studies exploring the effectiveness of different dashboard designs and feedback mechanisms (Schwendimann et al., 2016).

2.1 Learning Theory into Design

To design effective learning dashboards, it is crucial to integrate learning theory into the design process (Teasley, 2018). By considering the principles of learning and motivation, designers can create dashboards that are tailored to meet the needs of learners. The inclusion of learning theory in dashboard design allows for a more nuanced understanding of how learners engage with the information provided and how it can effectively support their learning processes. Gašević (2016) emphasizes the importance of avoiding a ‘one size fits all’ approach in learning analytics. They discuss that the effects of instructional conditions can vary significantly among learners, and it is essential to acknowledge this variability in the design of dashboards. It is important to consider these instructional conditions, such as teaching methods, student engagement, and academic support when analysing student data. By doing so, this paper argues that learning analytics can be used to provide more

personalized feedback to students and educators. Although the term ‘learning’ is used in most research on LADs, learning analytics research has only recently started to incorporate learning theory. Therefore, there is a lack of literature on learning theory within LADs. Teasley (2018) discusses the combination of information and learning sciences in learning analytics. He highlights the importance of integrating learning theory into dashboard design. Learning analytics can benefit from the insights of learning sciences, for example in relation to self-regulation and motivational theory. By incorporating learning theory into the design and evaluation of student-facing dashboards, researchers from the learning sciences can contribute valuable expertise.

Self-regulation and motivational theories can provide insights into how learners engage with the dashboard, how they set goals, monitor progress, and adapt their learning strategies accordingly. Within the academic context, a considerable number of students encounter difficulties associated with performance-related stress (Deunk & Korpershoek, 2021). Within the academic context, it is common for students to enrol in courses primarily with the intention of achieving good grades and avoiding performing worse than their peers, rather than approaching them with the desire to maximize their learning potential. By focusing a learning dashboard on the achievement goal theory, it may be feasible to explain and potentially influence this behavior. A dashboard that prioritizes mastery-oriented goals over performance-oriented ones can support students in adopting a different approach to their courses, encouraging a focus on acquiring knowledge rather than merely attaining credits.

Although many claims suggest that integrating learning theories into Learning Analytics Dashboards (LADs) enhances their quality and usefulness, limited empirical research has been conducted in this area. Research has been done to address why students use LADs, explained by learning theories such as the self-regulated learning theory (Teasley et

al., 2021). However, there is a lack of research investigating the actual benefits of integrating learning theories into the design of LADs.

Teasley (2017) highlights the importance of understanding students' goals and motivations and tailoring dashboards to meet their specific needs. This paper suggests that personalized displays based on research examining how internal and external factors affect student motivation could be more effective in improving academic performance. The main reason for this is that dashboard designers often just display the available information to facilitate their students. Teasley suggests that dashboards should be designed with a focus on promoting student agency and self-regulation rather than simply presenting data. This is in line with his paper about the importance of integrating learning sciences into dashboard design, discussed earlier (Teasley, 2018). This paper shows the potential of integrating student information into algorithms to develop tailored and personal dashboards. By addressing the limitations of existing systems and displaying information on a personal level, these dashboards can help students to better understand their learning strategies and provide them with the necessary information to improve their academic performance.

2.2 Achievement Goal Theory

The goal orientation theory, also known as the achievement goal theory, describes how motivation and performance are related. This theory classifies goal orientations into four main categories: mastery-approach, mastery-avoidance, performance approach and performance-avoidance goals. This thesis concentrates on the investigation of mastery-approach and performance approach goals, which will henceforth be referred to as mastery goals and performance goals, respectively.

Students who have mastery goals are usually interested in learning for its own sake and derive satisfaction from the process of learning and understanding the material being taught. These students are motivated by the desire to master the material and to improve their

own understanding, without necessarily being concerned with how they compare to their peers. On the other hand, students with performance goal orientation are usually interested in learning as a means of demonstrating their competence and outperforming others (Dweck & Leggett, 1988). Research on goal orientation suggests that individuals' goal orientation is substantially determined by an individual's mindset, which can either be fixed or growth oriented (Dweck & Legget, 1988). The type of goals an individual sets can have a profound effect on their achievement motivation and behaviour. They found that individuals with a fixed mindset (entity theory) are more likely to adopt performance goals, seeking to validate their abilities and avoid negative judgments. In contrast, individuals with a growth mindset (incremental theory) are more inclined to adopt mastery goals, viewing challenges as opportunities for learning and development. This suggests that students who are more focused on performance beforehand are less likely to change their goal orientation.

2.3 Trait and State Goal Orientation

Dweck and Legget (1988) proposed an important distinction within goal orientations. They suggest that an individual has both a trait and a state goal orientation. This helps us understand how individuals approach their goals and respond to challenges. Trait goal orientation refers to a relatively stable, long-term attitude or belief about one's ability to achieve their goals and finish their tasks. It is grounded in the individual's mindset and how they perceive their abilities. On the other hand, state goal orientation refers to a temporary and context-specific mindset that influences how individuals approach a particular task or challenge. This orientation is situation-dependent and can be influenced by numerous factors, such as the specific goal, the perceived difficulty of the task, or the presence of others. In the context of Dweck's work, state goal orientation is related to the concept of 'growth mindset.' In a growth mindset, individuals believe that their abilities and intelligence can be developed through effort, learning, and perseverance. They see challenges as opportunities for growth

and view failure as a chance to learn and improve. Individuals who possess a growth mindset often exhibit a greater inclination towards mastery goal orientation.

In this thesis, the focus will be on state goal orientation. Within the time span of a single course, it will be exceedingly difficult to change an individual's trait goal orientation. Having an impact on an individual's state goal orientation is more achievable within the span of five weeks.

2.4 Practical Implications

Numerous researchers have explored the practical implications of goal differences. For instance, students exhibiting a mastery goal orientation tend to display higher intrinsic motivation and are often better at pursuing their goals (Lee et al., 2021). Lee also found that individuals with higher levels of mastery goals tend to have better self-control than those with higher levels of performance goals. Specifically, individuals with mastery goals were better able to resist immediate temptations and delay gratification in order to achieve their long-term goals. In contrast, performance orientation is associated with extrinsic motivation and high social comparison, since individuals tend to have the desire to demonstrate their competence to others (Sedrakyan, 2020). Because mastery goals are associated with higher levels of engagement, persistence, and intrinsic motivation, Zimmerman (2008) suggests that this is the most effective type of goal for academic achievement.

Goal setting is a prominent research topic within organizational psychology (Seijts et al., 2004). It suggests that having clear goals leads to higher performance. Zimmerman describes the process of goal setting, which involves setting specific, challenging, and realistic goals and developing strategies to achieve those goals. Zimmerman also suggests that students should monitor their progress and adjust their strategies when necessary to stay on track.

Mastery goals are often related to benefits such as higher academic performance, self-control, and enjoyment. Benefits that are useful for all types of students. However, over the duration of a course mastery orientation can actually decrease, resulting in a decline in academic performance (Lonn et al., 2015). Surprisingly, despite the measurement of mastery goal orientation in numerous studies, no research was found that specifically investigates the impact of manipulating mastery goal orientation through the design of student dashboards. Research has shown that mastery orientation tends to decrease when students have the ability to compare themselves to their peers (Aguilar et al., 2021). Which seems plausible since high social comparison is associated with performance goal orientation (Sedrakyan, 2020). Aguilar et al. suggests that incorporating learning analytics dashboards that actively promote mastery orientations could serve as a means to counteract the general decline in mastery orientation.

Therefore, the following research question is proposed:

RQ: *How can Canvas data be used to provide students with a mastery goal-oriented dashboard to increase mastery goal orientation, academic success, intrinsic motivation and self-control?*

This research question can be divided in the following two sub questions:

Sub-RQ1: *What features that support mastery goal setting can be defined with the course content and students' clickstream data?*

Sub- RQ2: *How are motivation, academic success and self-control affected by engaging with this dashboard?*

2.5 Increasing Mastery Orientation

To investigate these research questions, it is important to determine whether it is feasible to change an individual's level of mastery goals. This could possibly be achieved by implementing various goal-setting strategies, such as prioritizing mastery goals and developing tools to help achieve them. Zimmerman (2008) emphasizes the importance of goal setting as a proactive source of academic self-regulation. Zimmerman (2008) suggests that students and educators should prioritize mastery goals and focus on developing effective goal-setting strategies to improve academic achievement.

In their longitudinal study on 1680 secondary school students, Lüftenegger et al. (2014) investigated the effectiveness of a high school program designed to promote mastery goal orientations within the classroom. The researchers found that the implementation of their TARGET framework had a positive impact on student mastery goal orientations. The study, conducted with Austrian high school students, clearly demonstrated that the entire TARGET framework had significant effects on enhancing mastery goal orientation when compared to a control group. This is a promising outcome, and it is intriguing to consider the six TARGET dimensions into account while designing mastery goal-focused dashboards. It certainly demonstrates the potential to manipulate students' goal orientation. The TARGET framework includes six dimensions that support mastery goal orientation:

1. **Task**: This dimension focuses on the structure of classroom assignments, including the content, difficulty level, and materials needed. It aims to design tasks that help students learn and understand the subject matter.
2. **Authority**: In the classroom, the authority dimension looks at how decisions are made between teachers and students. It involves shared responsibilities, such as making choices, giving directions, monitoring progress, setting rules, providing rewards, and evaluating success.

3. **Recognition**: This dimension involves acknowledging students' efforts and accomplishments through rewards, incentives, and praise. It aims to positively reinforce and recognize their hard work. When students receive recognition for their hard work and dedication, it reinforces their intrinsic motivation and enhances their belief in their own competence (Ames, 1992).
4. **Grouping**: The grouping dimension considers how students with similar or different characteristics are brought together. It explores strategies for creating effective groups that encourage interaction and collaboration among students. A collaborative learning environment emphasizes the value of shared knowledge and the collective pursuit rather than individual competition (Johnson et al., 1998).
5. **Evaluation**: The evaluation dimension focuses on creating a fair and effective assessment system that helps students recognize their own progress and abilities. It emphasizes avoiding comparisons with others and encourages self-assessment.
6. **Time**: The time dimension involves managing the workload, pace of instruction, and allocation of time for learning tasks. It aims to provide students with sufficient time for learning and allows flexibility to accommodate their individual needs.

Valentini and Rudisill, (2006) provide practical examples of the importance of fostering a mastery climate. They show the use of the TARGET framework to create a mastery climate within a diverse set of settings, including education. Highlighting benefits such as developing positive attitudes toward learning. For example, Morgan and Carpenter (2002) focused on gym classes. Their longitudinal study on 153 high school students involved manipulation through a TARGET program. Results show that students' perceptions of a mastery climate were positively associated with significant improvements in their task orientation, preference for challenging tasks, satisfaction, and positive attitudes. These positive outcomes were observed as a direct result of their participation in the mastery

program. The review of Valentini and Rudisill, (2006) suggests that a mastery climate in the classroom is associated with mastery-oriented goal orientations, greater intrinsic motivation, and higher achievement. A mastery climate refers to the social and instructional environment that promotes mastery goal orientation among individuals. It is characterized by emphasizing learning, improvement, effort, and skill development rather than solely focusing on performance outcomes or social comparison. In a mastery climate, individuals are encouraged to adopt a growth mindset, embrace challenges, seek feedback, and view mistakes as opportunities for learning and growth. In contrast, a performance climate is associated with performance-oriented goal orientations, greater extrinsic motivation, and lower achievement.

While the TARGET framework is potentially an effective way to enhance mastery goal orientation, the existing research is focused on how to shape a course, so it fosters a mastery climate. Lüftenegger et al., (2014) suggest that more research is needed on the effectiveness in different educational contexts, for example in an online learning environment. Currently the TARGET framework is the most hand-on framework to promote mastery goal orientation. Therefore, in this thesis the TARGET framework will be translated and tested in an online dashboard. In the chapter titled 'Dashboard Design,' the six dimensions of the TARGET framework will be translated into specific and detailed features that can be used within online LADs.

Designing a dashboard with this TARGET Framework in mind should foster a mastery climate and increase students' mastery goal orientation. Therefore, I propose the following hypothesis:

H1. *A mastery dashboard will increase students' mastery orientation, during the span of a course.*

Students who possess lower levels of initial mastery goal levels have more room for improvement. Therefore, I hypothesize that students with weaker initial levels of mastery goal orientation would experience a greater increase in mastery goal orientation compared to those with a stronger initial mastery orientation. This is in-line with the recommendation from Jivet et al. (2018), that suggest designing a dashboard for the group that will benefit the most. Therefore, the following hypothesis is proposed:

H2. *Mastery goal orientation will increase more for students who initially have a weaker mastery goal orientation than those with a stronger mastery orientation.*

In conclusion, mastery goal orientation has been linked to numerous advantages. First of all, Lee et al. (2021) demonstrated that individuals exhibiting higher levels of mastery goal orientation tend to display enhanced self-control, showcasing their ability to resist immediate temptations and delay gratification in order to achieve their goals. Therefore, I propose the following hypothesis.

H3. *Students using the mastery dashboard will have higher self-control compared to those using a normal untailored dashboard (See Appendix D.2 for a dashboard mock-up).*

Furthermore, as evidenced by Lee (2021), individuals who exhibit high levels of mastery goal orientation tend to display greater intrinsic motivation. Additionally, fostering a mastery climate has been shown to enhance intrinsic motivation within the context of a course, as observed in the study by Valentini and Rudisill (2006). Whereas a performance climate was associated with higher levels of extrinsic motivation. Based on these findings, I propose the following hypothesis.

H4. *Students using the mastery dashboard will have higher levels of intrinsic motivation compared to those using a normal untailored dashboard.*

Finally, Teasley et al. (2017) suggest that incorporating factors that affect student motivation within dashboards is an effective way of improving academic performance.

Furthermore, a mastery climate is associated with higher levels of academic achievements, compared to a performance climate (Valentini & Rudisill, 2006). Zimmerman (2008) further emphasizes that prioritizing mastery goals and focus on developing effective goal-setting strategies will eventually improve academic achievement. Therefore, I propose the following hypothesis:

H5. *Students using the mastery dashboard will perform higher academically compared to those using a normal untailored dashboard.*

3 Dashboard design and development

While the TARGET framework seems to be a way to improve students' mastery goal orientation it has not been tested in an online environment. Therefore, I have investigated the six different facets of this framework and evaluated whether they can be used in an online setting, to be able to evaluate this within a learning dashboard. Note that for within this master thesis there is no collaboration with the responsible lecturer before the course, therefore the course content cannot be tailored to fit with the TARGET dimensions. Integrating features that support the six TARGET dimensions will help developing a 'mastery climate.' Table 1 shows how the different TARGET components are used as a feature to support mastery goal orientation.

Table 1

Implementation of TARGET dimensions

Component	How to implement?	Why does it support mastery goal?
Task	• Set achievable deadlines for students and provide resources to help them succeed. • Clearly communicate what materials are needed to complete assignments.	By clearly communicating the material and showing that the deadlines are achievable students are more likely to develop a mastery goal orientation. Because they feel more competent and confident in their ability to succeed (Patrick, Ryan, & Kaplan, 2007).

Table 2 continued

Authority	• Provide opportunities for students to set their own goals and track their progress towards them. • Implement a system for monitoring student progress and providing constructive feedback. • Provide resources and tools for students to self-manage their learning, such as study guides or time management apps.	Letting students create achievable goals for themselves creates a sense of autonomy. By having a sense of autonomy, students are more likely to develop intrinsic motivation, which is closely linked to a mastery goal orientation (Deci & Ryan, 2000).
Recognition	• Compliment students when a test is done, or an assignment is handed in. Make sure they are personal.	Praise the student efforts: feedback, focused on their efforts and progress and not just grade, can make students less performance focused.
Grouping	*Students can be grouped, e.g., based on their expected/desired grade like in Peter's thesis (Peters, 2023). However, this does contain social comparison and is therefore outside the scope of this master thesis.*	*n/a*
Evaluation	• Make sure there is no social comparison. • Let students compare themselves to their previous performance (Svinicki, 2010).	*"Goal orientation theory holds that performance orientation is a manifestation of normative. performance, i.e., how one compares to others." (Svinicki, 2010)*
Time	*To implement this the course set-up has to be changed.*	*n/a*

3.1 Designing the Dashboard

Two dashboards were designed: one that serves as a treatment condition, and includes mastery focused functions, and one that serves as a control condition, which includes data that is also directly reachable through the general Canvas page. The features per dashboard are shown in Table 2.

Table 3

Dashboard Features

Normal Dashboard	Normal & Mastery Dashboard	Mastery Dashboard
• Latest grades	• Sessions per day • Upcoming assignments & Tests	• Session history (Evaluation) • Course timeline (Task and Authority) • Direct links to material per assignment and/or test (Task) • Compliments for achievements (Recognition) • Link to discussion form + prompt to use this (Mastery Climate) • Possibility to create to-dos per assignment and/or test (Authority)

The remainder of this chapter focuses on designing and implementing a mastery-focused dashboard using the TARGET framework. Firstly, the design of unique features within the dashboard and how they promote mastery goal orientation is discussed. Then, the development process, which involves building a Power BI data model for the dashboard is described. Finally, I will discuss how visualizations are created within the limitations of the Power BI platform.

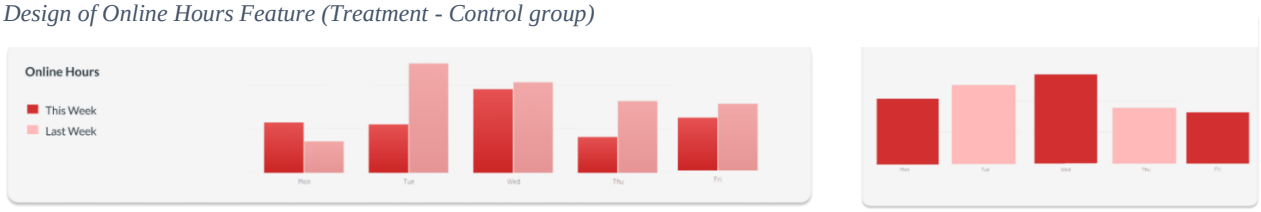
3.1.1 Sessions per Day and History

This feature is included in both the control as treatment condition. However, in the treatment condition student have the ability to check their progress from previous weeks.

Through the dashboard students will be able to see their online behavior (hours online) compared to last week (supporting the Evaluation structure). This feature (Figure 1) differs from the control group in that they will see the online hours of this week and previous week. Where the control group will only see this week's online hours. Because the treatment group can see their history, they can compare themselves to their previous performance, which potentially increases mastery goal orientation (Svinicki, 2010).

Figure 1

Design of Online Hours Feature (Treatment - Control group)

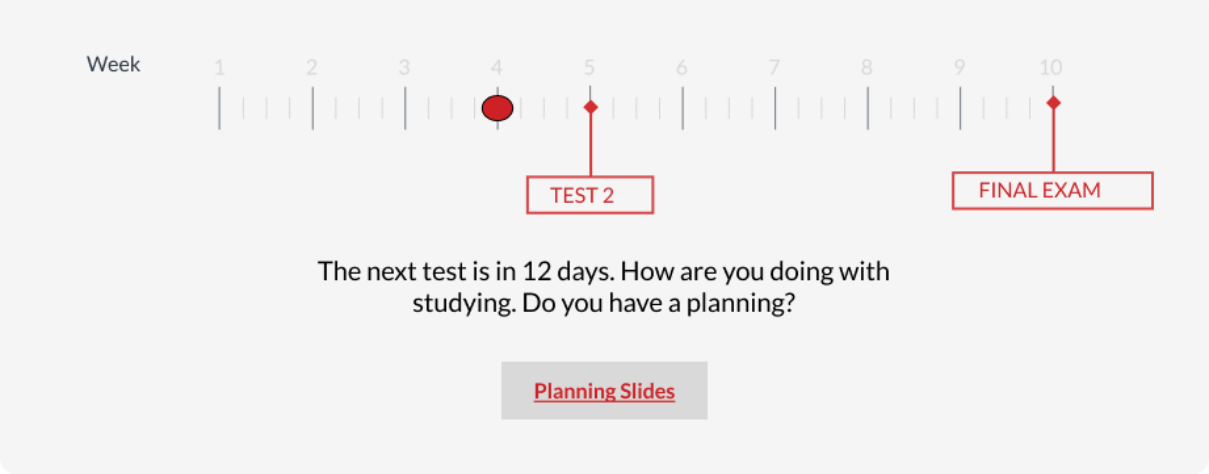


3.1.2 Course Timeline

This feature shows the progress of students within the course on a timeline that covers the complete course planning (Figure 2). Prompts are used to give some tips and feedback, with actionable buttons to support self monitoring. Such as "The next assignment is due in a week, how are you doing? Did you make a planning?". Also links are added to specific course content such as the the slides about how to make an edit your planning (0HV40) or to the general course planning (0SAB0-SD). This features supports the Task dimension of the TARGET framework since it shows that the deadlines are achievable with the course material. In addtion to this it also supports the Authorithy dimension, since it prompts students to set and manage their own goals. By incorporating these elements, the feature encourages a sense of responsibility and self-regulation among students, fostering a more autonomous and mastery goal oriented learning environment.

Figure 2

Design of course timeline feature



3.1.3 Material Links

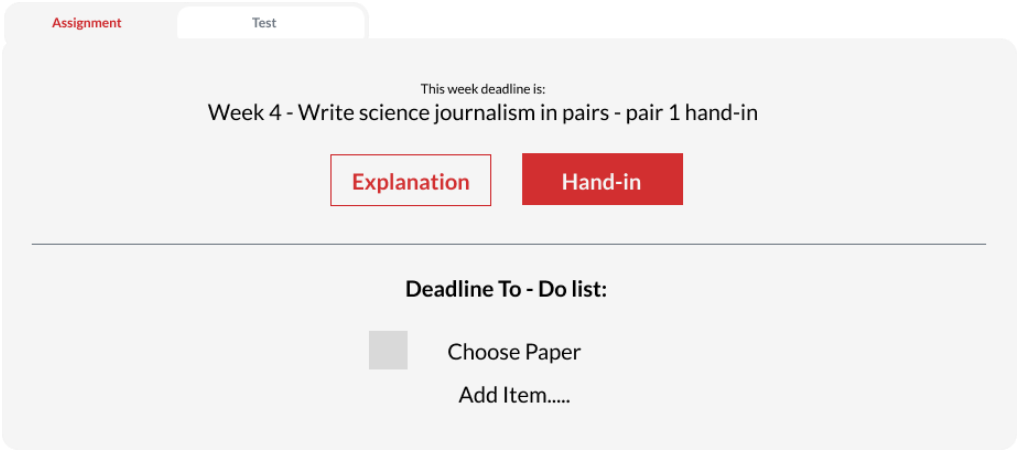
This feature clearly shows which materials are needed to complete the upcoming assignments (supporting the Task structure), it gives easy acces to the explanation of assignments and where to hand it in (Figure 3). These links differ per assignment but they usually link to the dedicated assignment page with instructions and materials for the specific assignment. This feature shows what is needed to complete assingments, making students feel more competent and confident in their ability to succeed and potentially increasing mastery goal levels (Patrick, Ryan, & Kaplan, 2007).

3.1.4 To-do List per Assignment

A feature will be implemented that allows students to create specific goals, in the form of to-do's, towards assignments and/or tests (Figure 3). This gives students the sense of autonomy (supporting the Authority structure) eventually increasing intrinsic motivation, which is closely linked to a mastery goal orientation (Deci & Ryan, 2000).

Figure 3

Design upcoming assignment feature including specific material links and to-do list.

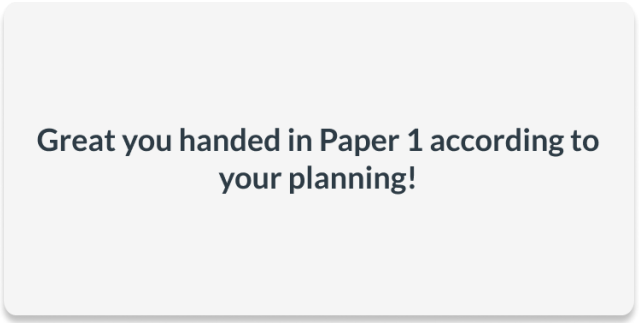


3.1.5 Compliments for achievements

After an assignment or paper is handed in an appreciation in the form of a text box will be displayed on the dashboard (Figure 4), supporting the Recognition structure. After an assignment or paper is handed in a compliment will be displayed on the dashboard (supporting the Recognition structure). If possible in Power BI the name of the student will be displayed making the comment personal. Feedback focused on students' efforts and progress, and not just their grades, can make students less performance focused.

Figure 4

Design Handed in assignment feature.



3.1.6 Link to discussion form

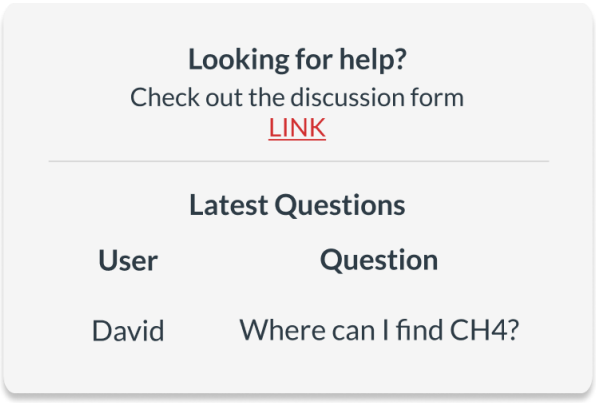
Help seeking behavior is positively predicted by mastery goals (Karabenick, 2004) and closely related to a mastery climate (Valentini & Rudisill, 2006) . Students who are performance oriented tend to avoid help seeking. Therefore a feature is created that remind

students of the possibilty of seeking help, containing a direct link to the discussion page (Figure 5).

Help seeking behavior is positively predicted by mastery goals (Karabenick, 2004) and closely related to a mastery climate (Valentini & Rudisill, 2006). Students who are performance oriented tend to avoid help seeking. Therefore I integrate this feature to make sure students know the possibilty of seeking help and in this way promoting this behavior.

Figure 5

Design Discussion Form feature



3.2 Data Model Development

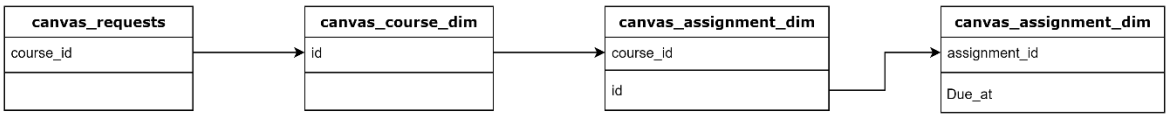
In collaboration with the TU/e Information Management Services-team (IMS), the data model and learning dashboards were developed. In this study Microsoft PowerBI is utilized to develop a data model and create the visualizations for the dashboard. PowerBI is a data visualization tool in which reports, and interactive dashboards can be developed based on various data sources, in this case Canvas Data. Student Canvas data is stored on a secured Databricks server, pseudonymized and then loaded into Power BI.

To be able to use the data in Power BI for creating a dashboard, a data model has been developed. Within this data model relationships between tables are established and data transformations are performed to be able to create the dashboard functionality. Since there is no universal data model this had to be created manually based on the Canvas data dictionary (Canvas Data Portal, n.d.).

For this data model the table ‘canvas requests’ serves as the central component. All tables that are associated with either the specific student or the specific course (0HV40 or 0SAB0-SD) are connected to this table. In this way visuals can be created, from data extracted from multiple tables. An instance of this scenario arises when presenting the submission time of a specific assignment for this the following connections have been created and is displayed in Figure 6.

Figure 6

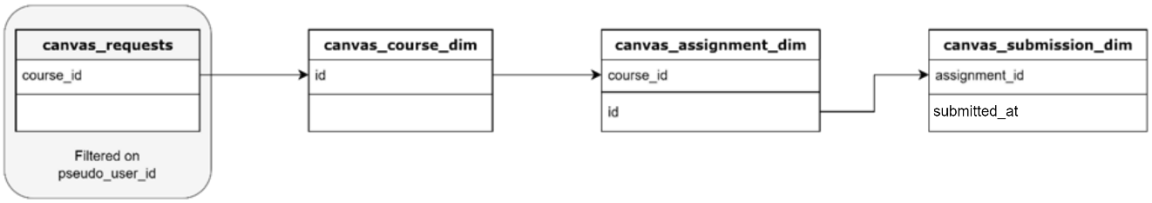
Data connection for showing submission time.



Another example is the ability to display personal submitted assignments, and their submission date. To be able to do this a similar approach as above was used. Instead of the assignment_dim the submission_dim is used. Finally, the canvas requests table had to be filtered by students’ personal pseudo_user_id. This is displayed in Figure 7.

Figure 7

Data connection for showing personal submitted assignments.



3.2.1 Transformations and New Variables

Transformations had to be done to be able to display data from different tables in one visualization. An example of a transformation that was performed was to combine the assignment and quiz tables to be able to show deadlines of both assignments and quizzes in a single timeline view.

Lastly some new tables were created examples of this are:

Learning_goals was created to display a summary of the learning objectives of each course. These objectives had to be manually added to this newly created table using HTML code.

url_deadlines were created to link url's to certain assignments to be able to display these together with their associated assignment. This has been connected to the assignment table to be able to show links to each specific assignment.

The full data model and an explanation video can be found in appendix C.

3.3 Dashboard visualizations

To create visualizations based on the constructed data model in Power BI, the rich array of visualization options available within the PowerBI environment are used. Because the data model was constructed, visualizations could easily be dragged and dropped onto the canvas to create visual representations of student data. An example of this is the timeline that could be created by dragging the assignment titles, quiz titles and deadlines into the timeline visualization option. A mock-up of both the mastery and control dashboard can be found in appendix D.1 and D.2.

3.4 Limitation of PowerBI

While using the Power BI platform for building the dashboard, it is important to consider the associated limitations. Certain features discussed in 3.1 may not be fully configurable within the Power BI environment.

3.4.1 To-do List

Power BI is primarily designed for generating reports and visualizations to analyse data and create reports. Therefore, it does not provide built-in features for creating interactive to-do lists. Power BI does not allow direct user input or manipulation of data within the platform. To address this limitation, the Power Apps add-on, which is a separate Microsoft

platform, can be integrated with Power BI. Power Apps offers the possibility to build custom applications, including interactive to-do lists. By combining Power Apps with Power BI, it potentially becomes possible to create and manage dynamic to-do lists connected to the underlying data model. While it seems feasible to create to-do list with the Power Apps add-on there is no subscription for this within the TU/e. Within the timeframe of this project, it was not feasible to receive the needed subscription. For future project it is advised to start get this Power Apps subscription to be able to create more interactive dashboards.

3.4.2 Standardize Data Model

For this project, a new data model had to be created. Creating a data model takes time and is vulnerable for bug. When creating a wrong link between tables it will not be possible to publish the dashboard, resulting in extra time to find these broken links. For future projects it would be greatly beneficial to create a standardized canvas data model in advance. By adopting such an approach, data models for dashboards become less susceptible to errors, and it would be possible to develop standardized dashboards even before the arrival of student data.

3.5 Privacy and Security

The TU/e IMS team pseudonymized both the Canvas-data and dashboard interaction data for this study. The researcher had exclusive access to the pseudonymized data, while the IMS team only had access to the student number and email, excluding any survey data. To ensure the careful handling and integrity of the data, a Data Protection Impact Assessment (DPIA) was conducted to evaluate the study. Moreover, all research conducted within the Human-Technology Interaction Group adheres to the Code of Ethics established by the NIP (Nederlands Instituut voor Psychologen – Dutch Institute for Psychologists). Furthermore, the Ethical Review Board of Eindhoven University of Technology has granted approval for this study.

4 Methods

4.1 Design

The study followed a randomized 3x2 mixed experimental design, which involved manipulating the independent variable between subjects: dashboard type. Dashboard type had two levels: Mastery and Normal. Measurement moment had three within subjects' levels: before, during and after using the dashboard. Participants were randomly allocated to either the mastery or a normal untailored dashboard. Participants were divided into two equal groups. Each student (participant) participated in three surveys to measure changes in goal orientation, motivation and self-control. In addition to this, the researchers had access to their grades. For both courses, there were at least 3 grades in total over the duration of the experiment (including both assignments and tests).

4.2 Participants

Participants were recruited through two different courses: 0HV040 Brain, Body, and Behavior and 0SAB0-SD USE Basic Theme: Society and Digitalization at the Eindhoven University of Technology. An overview of the study was provided during the introductory lecture, and interested students were invited to participate via email. Participation was voluntary, and participants received €12 compensation if they completed the full experiment. All the participants read the information sheet and signed the informed consent (Appendix A) before partaking in the study. The final sample consisted of 29 students (N=29), who were randomly assigned to either the Mastery or Normal dashboard condition. The sample size distribution is displayed in Table 3) It is important to note that the sample size fell below what was initially expected and determined through a power analysis considering the anticipated effects of the dashboard intervention on performance and motivation levels (Fleur et al., 2020). This discrepancy was primarily due to a smaller initial number of participants

and a significant dropout rate, resulting in a sample size that is smaller than what was anticipated based on a sensitivity analysis (N=52).

Table 4

Sample Distribution

	0HV40	**0SAB0-SD**	**Total**
Control Dashboard	11	5	16
Mastery Dashboard	10	3	13
Total	21	8	29

4.3 Manipulation

The participants were divided into two equal groups, with one group receiving the Mastery Dashboard and the other group receiving the Normal Dashboard. The drop-out rate caused slightly unequal groups.

4.4 Measures

The study was run online, which is where the date is acquired. Canvas clickstream data and grades of students were collected for the span of a semester. In addition to this survey data is collected at three moments during the experiment. Students received links for the surveys in their mailbox.

The surveys contained the following measures:

Goal orientation

Survey 1, 2 and 3 included the Achievement Goal Questionnaire-Revised (AGQ-R) (Elliot et al., 2008). Through this survey student's goal orientation was measured before, during and after using the dashboard.

Motivation

To measure motivation a subset of the Motivated Strategies for Learning Questionnaire (MSLQ) is used (Guay, 2000). The MSLQ was developed to measure learning strategies and academic motivation amongst college students. A subset of 5 questions that can be answered on a course-level is used. This subset covers students intrinsic and extrinsic motivation, in the form of external regulation, within a certain course. The questions consisted of 7-point Likert scale questions where respondents are asked to rate how much they agree with statements such as 'I participate in this course because I think this course is pleasant.'.

Self-control

To measure self-control two measures are used. First of all, the persistence scale from the Online Self-Regulated Learning Questionnaire (OSLQ) (Jansen et al., 2017) is used. A subset of 7 Likert type scale questions covers topics such as how students dealt with studying in challenging times. This set includes statements such as "When I was feeling bored studying for this online course, I forced myself to pay attention."

The second scale to measure self-control is the Online Homework Distraction Scale (Xu, 2020). This scale measures how students deal with distraction on two levels: conventional and tech related distraction.

Usability

In Survey 2 and Survey 3, usability measures were performed. Usability was measured using: the System Usability Scale (SUS) (Brooke, 1996) it was enhanced by extra questions relative to the learning dashboard.

The SUS scale, commonly used to evaluate perceived usability of websites or applications, was chosen for its adaptability to specific contexts. The scale was reduced to 7

questions measured on a 7-point Likert scale to rate agreement with statements such as " I found the various functions in this dashboard were well integrated."

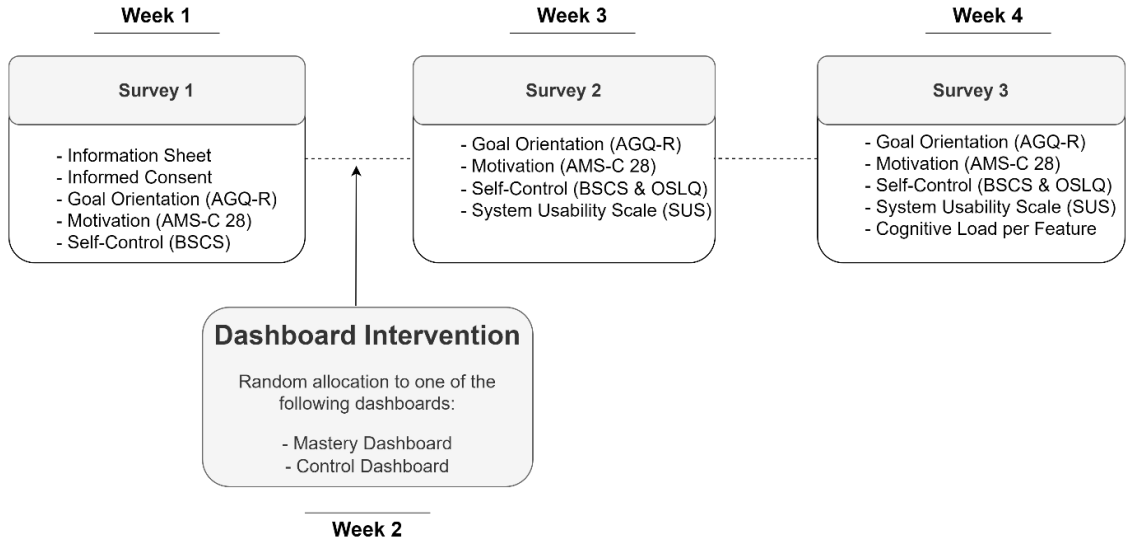
Cognitive Load

Survey 3 contained questions about the cognitive load of the different features. These questions were used since a previous study on Canvas dashboard (Peters, 2023) found that this can play a crucial role in testing the effectiveness of these types of dashboards. This measure contained questions such as “The dashboard covered concepts and definitions that I perceived as very complex.”

Figure 8 displays the planning of the experiment. The complete survey measures can be found in Appendix B.

Figure 8

Experiment Planning



4.5 Data Analysis

The hypotheses were evaluated using a repeated-measures ANOVA. The independent variable for all hypotheses was the type of dashboard used, which interacted with two dummy variables indicating the measurement moment (1, 2, or 3). The dependent variable differed for each hypothesis, specifically mastery goal orientation, self-control, intrinsic motivation, or performance (grades). Time was the within-subjects factor, measured at three different points. To specifically test the hypothesis at specific times of the experiment (during or after) regression analyses were used.

4.6 Data Preparation

Before conducting hypothesis testing, the datasets from all surveys were combined. The following steps were performed to explore and translate the data:

1. Missing Values: Missing values were checked to ensure data completeness and to determine if exclusion was necessary.
2. Translation of Scales: Scales with categorical responses were translated into numerical values. For example, the scale "Corresponds not at all" to "Corresponds exactly" was translated to -3, -2, -1, 0, 1, 2, 3, respectively.
3. Combination of Scale Scores: (e.g., items related to intrinsic motivation were combined into a single variable called ‘intrinsic motivation’ by summing up the scores and dividing these by the number of questions).
4. Combining the surveys by a common identifier (student_id)
5. Transformation to Long Format: To facilitate hypothesis testing for repeated measures, the data was transformed from wide format to long format.

4.7 Scale Analysis

To assess the reliability of the scales a scale analysis was performed. The outcomes of the scale analysis for all three surveys are presented in Table 4. The findings indicate that most scales used are reliable measures. However, the self-control measure has a low reliability coefficient. So, conclusions based on this scale should be made very carefully. Potentially only the persistence scales can be used to address self-control. The low coefficient in mastery goal orientation is unpleasant since the main hypothesis is based on this measure. This analysis showcases that measuring mastery goal orientation is difficult, and the available self-reported measures are not perfect.

Table 5

Summary Scale Analysis

Measure	Survey 1		Survey 2		Survey 3	
	Items	*SRC*	*Items*	*SRC*	*Items*	*SRC*
Mastery goal	3	.51	3	.78	3	.54
Performance goal	3	.85	3	.82	3	.90
Self-control	6	.49	6	.44	6	.50
Persistence	7	.86	7	.85	7	.86
Intrinsic motivation	3	.85	3	.91	3	.91
Extrinsic motivation	2	.84	2	.82	2	.76
Usability			11	.91	11	.92

Note: SRC = Scale Reliability Coefficient

4.8 Hypothesis Testing

The hypotheses evaluated in this study are presented below, along with the corresponding statistical analyses conducted.

H1. A mastery dashboard will increase students' mastery orientation, during the span of a course.

To examine the effect of the mastery dashboard on students' mastery orientation during the course, a mixed repeated measures ANOVA was performed. The dependent variable was 'mastery goal orientation,' and the independent variables were 'group' (treatment vs. control) and 'time' (before, during, after).

H2. Mastery goal orientation will increase more for students who initially have a weaker mastery goal orientation than those with a stronger mastery orientation.

To examine this hypothesis a mixed repeated measures ANOVA was used, similar to H1. For this analysis, a new variable of low initial mastery goal level will be created. This value will be based on the median of the mastery goal scale of the 'before' survey. 'Low mastery" will be 1 if the score is above the median, which is 2.

H3. Students using the mastery dashboard will have higher self-control compared to those using a normal untailored dashboard.

To compare self-control between students using the mastery dashboard and those using the normal untailored dashboard, a t-test followed by two repeated measures were performed. The t-test served as a way to compare the self-control levels between the control group (using the normal dashboard) and the treatment group (using the mastery dashboard) in general. This is followed up by two regressions, for the during and after phase, each with initial self-control levels as a covariate.

H4. Students using the mastery dashboard will have higher levels of intrinsic motivation compared to those using a normal untailored dashboard.

Similar to Hypothesis 3, a t-test followed by two regression analysis were conducted.

H5. Students using the mastery dashboard will perform higher academically compared to those using a normal untailored dashboard.

Similar to Hypothesis 3 & 4, a t-test followed by two regression analysis were conducted.

5 Results

The following section presents the results of the study, aimed at investigating the effects of a mastery dashboard on students' mastery orientation, self-control, intrinsic motivation, and academic performance.

5.1 Descriptive Statistics

The descriptive statistics for the first phase of the experiment are shown in Table 5. Most of the skewness values for the variables ranged from .00 to .39, indicating a slight right skewness. This suggest that the degree of skewness observed was relatively small. However, the variable ‘extrinsic motivation’ for the 0HV40 course has a significant skewness value of 0.94, which is positive, indicating a right-skewed distribution. This suggests that there may be some students with particularly high levels of extrinsic motivation in the 0HV40 course.

Similarly, the kurtosis values for the variables ranged from .01 to .97, suggesting that the distributions exhibited slightly heavier tails and sharper peaks compared to a normal distribution. Since these kurtosis ratings are in the range of -1 and +1 they can be seen as acceptable.

Overall, based on the obtained skewness and kurtosis values, the findings indicate that the variables' distributions display slight right skewness and have slightly heavier tails and sharper peaks compared to a normal distribution. Nevertheless, it is important to note that these deviations from normality are relatively minor.

Table 6

Descriptive Statistics per course

Variable	Course	N	Mean	Std. dev.	Min	Max	*Skewness*	*Kurtosis*
persistence	0HV40	21	.40	.47	-.86	1.29	0.07	0.97
	0SAB0-SD	8	.10	.60	-1.43	1.14	0.32	0.46
mastery goal	0HV40	21	.69	.78	-1	2	0.32	0.25
	0SAB0-SD	8	.46	.60	-1	1.67	0.30	0.36
performance goal	0HV40	21	.33	.80	-1.33	1.67	0.10	0.07
	0SAB0-SD	8	-.06	.96	-2	1.33	0.19	0.29
extrinsic motivation	0HV40	21	-.29	1.63	-3	2.5	0.94*	0.01*
	0SAB0-SD	8	1.90	1.17	-1.5	3	0.00	0.06
intrinsic motivation	0HV40	21	1.79	1.36	-1.33	4.333	0.11	0.54
	0SAB0-SD	8	-1.44	2.17	-5	4	0.14	0.19
Self-control	0HV40	21	-.18	.47	-1.17	1.33	0.39	0.10
	0SAB0-SD	8	-.06	.52	-1	1.33	0.09	0.10

$^{*}p < .05$

From the initial scores on the different variables, it is evident that scores differ significantly between courses. Due to this finding, multiple t-tests were conducted to examine the differences in mean scores for the variables intrinsic and extrinsic motivation between two course conditions (Table 6). The results in the pre-course measurement shows that for intrinsic motivation, a statistically significant difference in mean scores between the two course conditions was found ($t(27) = -2.39$, $p < .05$), where 0HV40 (mean = 1.94, SE = .28) displayed higher mean scores compared to 0SAB0 (mean = -.46, SE = 1.03). Similarly, for extrinsic motivation, a statistically significant difference in mean scores between the two course conditions ($t(27) = 1.79$, $p = .01$) was observed. 0SAB0-SD (mean = 1.44, SE = .38)

exhibited significantly higher mean scores than 0HV40 (mean = -.36, SE = .36). The results from the pre-course measurement indicate that participants in the 0SAB0-SD course exhibited higher levels of intrinsic motivation but lower levels of extrinsic motivation compared to those in the 0HV40 course. However, no significant differences were found between the two course conditions for the other variables, including goal orientation.

Analysing the during and after phases of the experiment through additional t-tests revealed consistent findings regarding intrinsic and extrinsic motivation. Once again, significant differences were observed between the two courses in terms of intrinsic and extrinsic motivation. However, similar to the pre-course measurement, no statistically significant differences in mean scores were found for the other variables between the two course conditions in both the during and after phases of the experiment.

The significant differences found in both intrinsic and extrinsic motivation between the two course conditions are crucial findings with important implications for the study. As a result, the need to include the ‘course’ variable as a covariate in subsequent analyses when investigating both intrinsic and extrinsic motivation is recognized. By using ‘course’ as a covariate, potential confounding effects can be controlled, allowing for a more robust examination of the relationships between intrinsic and extrinsic motivation and other relevant variables.

Table 7

T-test result differences per course

Measure		Before		During		After	
	Course	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
persistence	0HV40	.37	.54	.41	.42	.44	.46
	0SAB0-SD	.02	.77	.07	.47	.20	.60
mastery goal	0HV40	.87	.66	.48	.92	.71	.74
	0SAB0-SD	.58	.39	.33	.89	.46	.47
performance goal	0HV40	.56	.82	.19	.83	.24	.75
	0SAB0-SD	.13	.89	-.17	.91	-.13	1.17
extrinsic motivation	0HV40	-.36*	1.64	-.26*	1.69	-.26*	1.64
	0SAB0-SD	1.44*	1.08	2.31*	.84	1.94*	1.47
intrinsic motivation	0HV40	1.94*	1.30	1.79*	1.36	1.65*	1.49
	0SAB0-SD	-.46*	2.91	-1.96*	1.44	-1.92*	1.81
self-control	0HV40	-.16	.49	-.23	.47	-.15	.46
	0SAB0-SD	.00	.30	-.15	.63	-.04	.63

$^{*}p < .05$

Table 7 presents the relationships between study variables in the form of a correlation matrix. The results revealed several significant correlations among the variables. Firstly, a positive and significant correlation was found between ‘Persistence’ and ‘Mastery Goal’ ($r = 0.23$, $p < 0.05$), suggesting that students who have a higher mastery goal orientation tend to demonstrate higher levels of academic persistence. Additionally, a positive and significant correlation was observed between ‘Persistence’ and ‘Performance Goal’ ($r = 0.29$, $p < 0.05$), indicating that students who have a performance goal orientation also exhibit increased levels of persistence. On the other hand, ‘Extrinsic Motivation’ displayed a negative and significant correlation with ‘Persistence’ ($r = -0.28$, $p < 0.05$), suggesting that students with higher levels of extrinsic motivation tend to demonstrate lower levels of persistence. Both ‘Mastery Goal’ and ‘Performance Goal’ orientation showed a positive significant correlation with Intrinsic

motivation ($r = 0.28$, $p < 0.05$), suggesting that students with higher intrinsic motivation also tend to both a higher mastery and performance goal orientation.

The correlation matrix presented in Table 7 serves as an important reference point for guiding the following analyses in this study. It provides valuable information about the relationships between the study variables, which can help with making decision and interpreting future analyses.

Table 8

Correlations for Study Variables

Variable	1	2	3	4	5	6	7
1. Persistence	—						
2. Mastery Goal	.23*	—					
3. Performance Goal	.29*	.19	—				
4. Extrinsic Motivation	-.28*	−.20	-.19	—			
5. Intrinsic Motivation	.17	.28*	.28*	-.53*	—		
6. Self-Control	−.14	−.10	.20	.07	-.18	—	
7. Usability	-.17	-.02	-.05	.29*	-.12	.06	-

*$p < .05$

H1. A mastery dashboard will increase students' mastery orientation, during the span of a course.

A mixed analysis for repeated measures was conducted to examine the changes in mastery goal orientation over the duration of the experiment, specifically from the 'before' to the 'during' and 'after' time points, for both the treatment and control group (Table 8). The analysis included the variables 'before,' 'during,' and 'after' as well as the interaction terms between each time point and the group variable. For the control group, the results revealed a significant decrease in mastery goal orientation from both the 'during' as the 'after' measurement compared to the before stage.

However, in the treatment group there was no significant change in mastery goal orientation in either the ‘during’ or the ‘after’ measurement.

Table 9

Mixed ANOVA group and measure effects on Mastery Goal orientation (Dependent Variable)

Fixed Effect	Coefficient	Std. Error	z	p-value	95% Conf. Interval
during	-0.35	0.14	-2.47	0.013	-0.63 - -0.07
after	-0.29	0.14	-2.04	0.042	-0.57 - 0.01
treatment before	0.19	0.26	0.72	0.471	-0.32 - 0.70
treatment during	0.18	0.26	0.70	0.482	-0.33 - 0.70
treatment after	0.51	0.26	1.93	0.053	-0.01 – 1.02
_cons	0.71	0.18	4.04	<0.001	0.36 – 1.05

LR test vs. linear model: chibar2(01) = 39.26 Prob >= chibar2 < 0.001

Although the interaction term ‘treatment after’ was not statistically significant, it is interesting to note that there was a small increase in mastery goal orientation (c = 0.51) and it approaches a significant p-value (.053) for the treatment group from the ‘during’ to the ‘after’ measurement, which suggests a potential trend that might become significant with a larger sample size or in a different context. The effect size (η^2) for the variable ‘treatment after’ was found to be 0.01, indicating a small effect according to Cohen's guidelines.

In summary, the results do not provide evidence to support the hypothesis that a mastery dashboard increases students' mastery orientation during the span of a course. The mastery dashboard does not have a statistically significant effect on mastery orientation, as indicated by the non-significant coefficient and the confidence intervals that include zero in both the during and after stage. However, a significant decrease in mastery goal orientation is present in the control group. This finding is not completely in line with the main hypothesis. Instead of showing significant higher mastery goal values the treatment condition does not show significant negative values.

To specifically analyse the result between groups (treatment and control) both in the during and after phase of the experiment two regression analysis were performed. The two analyses investigate the relationship between the variables during*mastery and after*mastery, with predictors group and initial mastery goal. The results are presented in Table 9.

Table 10

Results regression analysis Mastery Goal Orientation

	Mastery Goal During		**Mastery Goal After**	
	Coefficient	**P-value**	**Coefficient**	**P-value**
Treatment	-.01	0.980	.37	<.05
Initial Mastery Levels	1.01	<.001	0.75	<.001
_cons	-0.6	.007	.09	.21

The model ($F(2, 26) = 10.50$, $p < 0.001$), explains approximately 44.68% of the variance in the dependent variable. Among the predictors, initialmasterygoal shows a statistically significant positive association with duringmastery ($\beta = 1.01$, $p < 0.001$), indicating that higher levels of initial mastery goal orientation are linked to increased during mastery. However, the group variable does not exhibit a statistically significant relationship with during mastery ($\beta = -0.01$, $p = 0.964$), meaning no significant differences between the control and treatment group was present at the during phase of the experiment, when initial mastery levels was added as a predictor.

For the after mastery regression model: The model $(2, 26) = 16.47$, $p < 0.001$), explains approximately 55.89% of the variance in the dependent variable. Similar to the during mastery model, initial mastery goal demonstrates a statistically significant positive relationship with after mastery ($\beta = 0.75$, $p < 0.001$), indicating that higher initial mastery goal orientation is associated with increased after mastery. Additionally, the predictor group shows a statistically significant positive association with after mastery ($\beta = 0.37$, $p < 0.05$),

suggesting that being part of the treatment group is associated with a positive increase on mastery goal levels in the after phase of the experiment.

H2. Mastery goal orientation will increase more for students who initially have a weaker mastery goal orientation than those with a stronger mastery orientation.

To evaluate this hypothesis an interaction effect of group (control or treatment), measure (survey 1 or 2) and low mastery orientation, which is true (low mastery=1) when the mastery goal orientation was below the median. Results are shown in Table 10.

The variable 'low mastery' had a significant negative effect ($F = -0.89$, $p < .001$), indicating that students with lower initial mastery goal orientation scores experienced a smaller increase in mastery goal orientation over time compared to those with higher initial scores. While the findings are significant they are contrary to the initial hypothesis, which hypothesized that a significant positive effect of low mastery was present.

Table 11

Summary of Significant Results for Factors Influencing Mastery Goal Orientation

Fixed Effect	Coefficient	Std. Error	z	p-value	95% Conf. Interval
during	-0.35	0.14	-2.47	0.01	-0.63 - -0.07
after	-0.29	0.14	-2.04	0.04	-0.57 - -0.01
Treatment before	-0.01	0.21	-0.05	0.96	-0.43 - 0.40
Treatment during	-0.02	0.21	-0.08	0.94	-0.43 - 0.40
Treatment after	0.31	0.21	1.44	0.15	-0.11 - 0.72
Low mastery	-0.89	0.17	-5.10	<0.001	-1.23 - -0.55
_cons	1.32	0.18	7.17	<0.001	0.96 - 1.68

H3. Students using the mastery dashboard will have higher self-control compared to those using a normal untailored dashboard.

Persistence scale: The t-test for the variable 'after persistence' between control and treatment group showed a significant difference ($t = -2.57$, $p < .05$). The mean score for the control group (1.75) was significantly lower than the mean score for the treatment group (3.62). Thus, the treatment group demonstrated higher persistence in the 'after' period compared to the control group. The results of this t-test are displayed in Table 11.

Table 12

Results T-test effect of group on persistence (after phase)

Group	N	Mean	Std. Error	Std. Deviation	95% Conf. Interval
Control	48	.25	.07	.46	.12 - .38
Treatment	39	.52	.08	.51	.35 - .68
Combined	87	.37	.05	.50	.35 - .68
diff		-.27	.10		-.47 - -.06

$Pr(T < t) = 0.006$ $Pr(|T| > |t|) = 0.012$

A plausible explanation for the observed variations in persistence could be attributed to potential differences that might have existed during the initial measurement (before phase). Consequently, two separate regression analyses were conducted to investigate the differences between the during or after phase and the before phase of the experiment.

To better understand the relationships between the different measurement times and persistence (the dependent variable), two regression analyses were performed (Table 12).

Persistence during the experiment. The treatment group has a regression coefficient of .04, indicating that being in this group is associated with a positive increase in persistence during the experiment compared to before. However, the p-value of .53 implies that this relationship is not statistically significant ($\alpha = .05$).

‘Before Persistence’ has a coefficient of .52, indicating that a higher level of persistence before the experiment is associated with a high persistence score during the experiment. The p-value of <.001 indicates that this relationship is statistically significant, suggesting that the level of persistence before the experiment is the only significant predictor of persistence in the during phase of the experiment.

Persistence after the experiment. The treatment group has a coefficient of 2.12, indicating that being in this group is associated with a positive increase in persistence after the experiment. The p-value of .001 suggests that this relationship is statistically significant, providing convincing evidence that the treatment condition has a significant impact on the level of persistence after the experiment.

‘Before Persistence’ has a coefficient of .48, indicating that a higher level of persistence before the experiment is associated with a positive increase in persistence after the experiment. Similar to the ‘Persistence during’ regression, the p-value of <.001 indicates that this relationship is statistically significant.

Table 13

Regression results persistence during and after the experiment

	Persistence during		**Persistence After**	
	Coefficient	**P-value**	**Coefficient**	**P-value**
Group 1	.04	.530	0.30	.001
Before Persistence	.52	<.001	.48	<.001
_cons	0.16	.002	.11	.079

Overall, these results suggest that both the group and the initial level of persistence, as a covariate, have a significant impact on the persistence levels after the experiment. However, the group does not have a significant effect on the persistence levels during the experiment , while the initial covariate remains significant in predicting this.

Online Homework Distraction Scale: The Online Homework Distraction Scale was not used for the analysis. The scale analysis (chapter 4.7) indicated a low Scale Reliability Coefficients in all three phases. Adding this measure to the analysis did not change any of the other effects.

H4. Students using the mastery dashboard will have higher levels of intrinsic motivation to those using a normal untailored dashboard.

The t-test for intrinsic motivation measured after the experiment between the control and treatment group revealed a significant difference ($t = -1.02$, $p < .001$). The mean score for the control group (-.25) was significantly lower than the mean score for treatment group (.77). This indicates that students in treatment group exhibited higher intrinsic motivation after the intervention compared to the control group. Results are shown in Table 13.

Table 14

Results T-test effect of group on intrinsic motivation (after phase)

Group	N	Mean	Std. Error	Std. Deviation	95% Conf. Interval
Control	48	-.25	.23	1.56	-.70 - 0.20
Treatment	39	.77	.21	1.33	.34 - 1.20
Combined	87	.21	.16	1.54	-.12 - 0.53
diff		-1.02	.31		-1.65 - -.39
		Pr(T < t) < 0.001		Pr(|T| > |t|) = 0.002	

To better understand the relationships between the different measurement times and intrinsic motivation, two regression analyses were performed (Table 14).

The regression model examined the impact of the treatment group and the initial level of intrinsic motivation (before intrinsic) on the during- and after-experiment intrinsic motivation values. The overall model was found to be statistically significant, indicating that the predictors had a significant impact on the outcome variable. However, the results revealed that there was no significant difference in after intrinsic scores between the treatment group

and the control group in both the during (c = -.74, p = .424) and after (c = -.22, p = .819) stage of the experiment. This suggests that the treatment did not have a significant effect on increasing persistence levels measured after the experiment. However, the before intrinsic score was a significant predictor in both the during (c = -.80, p <.001) and after (c = .76, p <.001) stage of the experiment, meaning that the explanation for the t-test would be that intrinsic motivation significantly different because the treatment group started with higher levels.

Table 15

Regression results intrinsic motivation during and after the experiment.

	Intrinsic motivation during		**Intrinsic motivation after**	
	Coefficient	**P-value**	**Coefficient**	**P-value**
Treatment group	-0.25	.424	-.07	.819
Before Intrinsic	.80	<.001	.76	<.001
_cons	-.19	.272	-.33	.067

Since the t-test per course (Table 6) matrix showed a significant result for course on intrinsic motivation this was also added to the regression model. The results in Table 15 show that both initial intrinsic motivation and course significantly predict intrinsic motivation levels in both the during and after phase of the experiment.

Table 16
Regression results intrinsic motivation with initial levels and course as covariates.

	Intrinsic motivation during		**Intrinsic motivation after**	
	Coefficient	**P-value**	**Coefficient**	**P-value**
Treatment group	.18	.454	.30	.266
Before Intrinsic	.39	<.001	.40	.001
Course	1.97	<.001	1.77	<.001
_cons	-1.50	<.001	-1.51	<.001

Overall, this analysis suggests that the initial level of intrinsic motivation and the course that student participate in, as covariates, have a significant impact on the intrinsic motivation at both the during and after phase of the experiment. However, the group does not have a significant effect in both these phases, while the initial covariates remain significant in predicting this.

H5. Students using the mastery dashboard will perform higher academically compared to those using a normal untailored dashboard.

Within the timeframe of this project, I was unable to retrieve the student grades. Therefore, no analysis has been done.

5.2 Dashboard Usability, Cognitive Load and Interaction

Dashboard usability, cognitive load and interaction, in the form of minutes spent on the dashboard, were examined since these were potential confounding factors (Appendix E).

To ensure the robustness of the analyses, cognitive load was included as a covariate in various statistical analyses. However, the results indicated that cognitive load had minimal influence, as evidenced by small coefficients and p-values well above the significance threshold of 0.05.

For dashboard usability, similar to cognitive load, analyses to investigate its potential impact on the study outcomes were conducted. The aim was to assess whether incorporating dashboard usability as a covariate in the different analyses might have played a significant role in influencing the results. However, similar to cognitive load, the inclusion of dashboard usability as a covariate did not yield any effects, with small coefficients and p-values exceeding 0.05.

In a similar way minutes spent on the dashboard was measured in both the during and after phase of the experiment, by using self-reported data. However, the results indicated minimal impact, as evidenced by the small coefficients and p-values not below 0.24. The data

suggest that self-reported minutes spent on the dashboard did not significantly influence mastery goal orientation, self-control, or intrinsic motivation in any phase of the experiment.

These findings indicate that dashboard usability, cognitive load or minutes spent on the dashboard may not have substantially influenced the observed outcomes in this study.

6 Discussion

H1. A mastery dashboard will increase students' mastery orientation, during the span of a course. The primary aim of this study was to investigate whether the implementation of a mastery dashboard would lead to an increase in students' mastery goal orientation during the course. The results of the mixed analysis for repeated measures provided valuable insights into the changes in mastery goal orientation over time in a treatment and control condition.

Recapping the results, for the control group the analysis revealed a significant decrease in mastery goal orientation from both the 'during' and 'after' measurements compared to the initial 'before' stage. This decline in mastery goal orientation is consistent with previous research, which suggests that as students' progress through a course, their mastery goal orientation decreases.

Contrasting with the hypothesis the results indicate that the introduction of a mastery dashboard did not lead to a statistically significant increase in students' mastery orientation during the course. It is worth noting that, although it was not significant, there was a slight increase in mastery goal orientation observed in the treatment group from the 'during' to the 'after' measurement. The p-value approached significance ($p = 0.053$), indicating a potential trend that might become significant with a larger sample size or in a different educational context. Furthermore, the additional regression analysis showed that when looking solely at the after phase compared to the before phase, there is a small significant increase in mastery goal orientation.

The most interesting finding is when looking at this difference in increase and decrease in mastery goal orientation between the control and treatment condition. While mastery goal orientation decreases in the control group it does not, and potentially increases,

in the treatment condition. The mastery dashboard seemed to mitigate the natural decrease in mastery goal orientation that was observed in the control group.

H2. Mastery goal orientation will increase more for students who initially have a weaker mastery goal orientation than those with a stronger mastery orientation.

The second hypothesis of this study aimed to explore whether students who initially have a weaker mastery goal orientation would experience a greater increase in mastery goal orientation when exposed to the mastery dashboard intervention, compared to those who already possess a stronger mastery orientation. The results of the analysis, which included an interaction effect of group (control or treatment), measure (survey 1 or 2), and low mastery orientation (below the median), showed some valuable insight on the impact of the intervention for students with various levels of initial mastery orientation.

Contrary to the initial hypothesis, the variable ‘low mastery’ had a significant negative effect on the increase in mastery goal orientation over time ($F = -0.89$, $p < 0.001$). This finding indicates that students with lower initial mastery goal orientation scores experienced a smaller increase in mastery goal orientation over time compared to those with higher initial scores. Although the findings are contrary to the initial hypothesis, they highlight the significance of considering the initial levels of mastery goal orientation when examining the effects of interventions on students' mastery orientation.

I argue that having a growth mindset could potentially explain this result. Given the positive association between mastery goal orientation and a growth mindset (Dweck & Legget, 1988), it is plausible to argue that students with higher initial mastery goal orientation levels might already possess a stronger belief in their capacity to improve and learn from challenges. Consequently, these students may approach the mastery dashboard intervention with greater openness to embrace learning opportunities to enhance their mastery-oriented behaviors.

The results of this hypothesis showed that students with lower initial mastery goal orientation scores experienced a smaller increase in mastery goal orientation over time. Though this is the group that potentially need help increasing their mastery goal orientation the most. The results suggest that students' initial levels of mastery goal orientation play a crucial role on the impact of interventions. Further research should explore how to tailor dashboard to specifically meet certain subgroup's needs in order to help students that need these types of interventions the most.

H3. Students using the mastery dashboard will have higher self-control compared to those using a normal untailored dashboard. The third hypothesis of this study aimed to investigate whether students using the mastery dashboard would demonstrate higher self-control, specifically measured through the persistence scale, compared to those using a normal untailored dashboard (control group). The results of the t-test conducted on the variable 'after persistence' provided insights into the differences in persistence levels between the treatment and control groups at the after measurement.

The t-test revealed a significant difference between the control and treatment groups ($t = -2.57$, $p < 0.01$). The treatment group exhibited a significantly higher mean score (3.62) on the persistence scale in the after phase compared to the control group (1.75). These results indicate that students using the mastery dashboard demonstrated higher levels of persistence after the experiment compared to those using the normal untailored dashboard.

To further explore the observed variations in persistence, two separate regression analyses were conducted. These investigated the impact of the initial score on the persistence scale (before phase) on the impact of the intervention.

The regression results indicate that both group (treatment versus control) and the initial level of persistence play significant roles in predicting students' persistence levels for the after phase of the experiment. However, it is worth noting that the group did not have a

significant effect on persistence levels at the second measurement (during phase) of the experiment. This implies that while the mastery dashboard intervention had an impact on students' persistence after the experiment, its effects during the course might be more nuanced and the dashboard did not increase self-control within this timespan.

These results provide valuable insights into the potential of mastery dashboards to enhance students' self-control and persistence in educational settings. Understanding the impact of such interventions and the role of initial self-control levels can help in the development on future interventions, specifically targeted at increasing students' self-control and persistence.

H4. Students using the mastery dashboard will have higher levels of intrinsic motivation compared to those using a normal untailored dashboard. The fourth hypothesis of this study aimed to explore whether students using the mastery dashboard would show higher levels of intrinsic motivation compared to those using a normal untailored dashboard (control group). The results of the t-test conducted on intrinsic motivation measured after the experiment provided insights into the differences in intrinsic motivation levels between the treatment and control groups.

The first t-test revealed a significant difference between the control and treatment groups ($t = -1.02$, $p < 0.001$). The treatment group displayed a significantly higher mean score (0.77) on intrinsic motivation after the intervention, while the control group had a significantly lower mean score (-0.25). This finding indicates that students in the treatment group exhibited higher levels of intrinsic motivation compared to the control group.

As with H3 two regression analysis were conducted to explore the role of initial intrinsic motivation levels and which course student participated in on the t-test outcomes. The regression model examined the impact of the treatment group, the initial level of intrinsic

motivation (before intrinsic) and course on intrinsic motivation values at the during and after stage of the experiment.

The overall regression model was found to be statistically significant, indicating that the predictors (treatment group and before intrinsic) had a significant impact on the outcome variable, intrinsic motivation. However, the specific results revealed that there was no significant effect for treatment in after intrinsic scores in both the during and after stages of the experiment. This implies that the treatment did not have a significant effect on increasing intrinsic motivation levels measured during and after the experiment and that it was solely predicted by the initial levels of intrinsic motivation and the course students participated in. Regardless of whether students were in the treatment or control condition they seem to maintain their levels of intrinsic motivation.

These findings suggest that within the chosen courses intrinsic motivation is not significantly influenced by the use of a dashboard, neither a tailored nor a mastery-focused dashboard.

H5. Students using the mastery dashboard will perform higher academically compared to those using a normal untailored dashboard. The fifth hypothesis of this study aimed to investigate whether students using the mastery dashboard would achieve higher academic performance compared to those using a normal untailored dashboard (control group). However, due to limitations within the timeframe of the project, the researcher was unable to retrieve the student grades, and consequently, no analysis was conducted to evaluate this hypothesis.

6.1 Limitations

This study explored the development and implementation of a dashboard based on Canvas data to enhance the learning experience in higher education courses. While the findings provide valuable insights, several limitations were identified during the research process, which should be considered when interpreting the results and planning future studies.

Lack of Academic Performance Data. While the lack of data on academic performance is a limitation of the study, it is important to acknowledge the importance of this metric to evaluate dashboard success. Although it is important to create an inspiring learning environment, academic performance directly reflects students' learning outcomes and academic achievement. Especially in future research designs, which should have a longer time span, academic performance is an important metric to evaluate dashboard success.

Despite this limitation, the study still provides valuable insights into the impact of the mastery dashboard on students' motivation, self-control, and persistence, which can guide educational practitioners in designing interventions to support students' learning experiences.

Dropout Rate and Dashboard Timing. One of the limitations of this study was the relatively high dropout rate observed among participants. Due to delay in the development of the dashboard, regarding privacy policies and data availability, the dashboard could only be published five weeks into the course. I would argue that this makes the dashboard less valuable for students, making it more likely to quit the experiment before completion. Future studies should try to use the course data from previous years to make sure the dashboard can be developed before the course start. This way students can start a new course with the new dashboard, not having to switch in the middle of a course.

Interaction with Responsible Lecturers. To foster a complete mastery environment and align with all pillars of the TARGET framework, it is essential for the dashboard designers to collaborate closely with the responsible lecturers of the courses. In this study, such direct collaboration was not feasible, limiting the dashboard's full potential. For future implementations, it is recommended that dashboard designers and course instructors work together to modify the course set-up where possible, ensuring better alignment between the dashboard's features and the course objectives.

Course Participation and Dashboard Relevance. The 0SAB-SD course had a considerable smaller participation rate. I would suggest that because this course involves more group work and does not have an exam. Therefore, a personal Canvas dashboard is less relevant compared to the 0HV40 course. Group work happens more in self-created environments, such as OneDrive or Google Drive. To enhance the effectiveness of dashboard implementations, future research should carefully consider the types of courses where students are likely to benefit the most from utilizing a Canvas data dashboard.

Measurement of Growth Mindset. While the current study focused on dashboard usage and its impact on student mastery goal orientation, it did not directly measure growth mindset, which is known to be closely related to trait goal orientation, as theorized by Dweck and Legget (1988). Incorporating a measure for growth mindset in future studies could provide valuable insights into their interactions with dashboard usage and mastery goal orientation.

While this master's thesis contributes valuable findings regarding the development and implementation of a Canvas data dashboard in higher education courses, it is essential to acknowledge the limitations outlined above. Addressing these limitations in future research can enhance the effectiveness and applicability of such dashboards and their potential to positively impact student learning experiences, such as increasing mastery goal orientation.

7 Conclusion

This master thesis aimed to develop and investigate the effectiveness of a student dashboard promoting mastery goal orientation in a specific course. The literature review highlighted the benefits of creating a mastery climate, including increased intrinsic motivation and self-control. Therefore, the research question was as follows:

RQ: How can Canvas data be used to provide students with a mastery goal-oriented dashboard to increase mastery goal orientation, academic success, intrinsic motivation and self-control?

It was hypothesized that a dashboard developed according to the TARGET framework would increase individuals' mastery goal orientation and eventually lead to the aforementioned benefits. The experiment involved developing the dashboard using Power BI, by building a data model accompanied with the build-in visualizations. Thereafter participants were randomly assigned to either the mastery-focused dashboard group (treatment) or a control group using a regular untailored dashboard.

The results of the mixed analysis for repeated measures yielded valuable insights. First of all, the mastery dashboard mitigated the natural decline in mastery goal orientation observed in the control group. Additionally, participants' initial levels of mastery goal orientation played a crucial role in predicting their levels at the end of the experiment. Notably, individuals with higher initial mastery goal orientation experienced a more substantial increase during the study. In the five week timespan of the experiment participants did not show any differences in intrinsic motivation. The intrinsic motivation scores after the experiment were explained by the initial intrinsic motivation levels and the course students participated in. For self-control measures, specifically the persistence scale, the results show significant findings for the group variable in the after phase. Implying that a mastery focused dashboard increased student academic persistence in this experiment.

Despite certain limitations, such as a high drop-out rate, the research demonstrated the impact of a mastery-focused dashboard on students' motivation, self-control, and persistence. The effects, while small, highlight the importance of further investigating the relationship between learning dashboards and mastery goal orientation. Future research should explore the identification of subgroups to tailor interventions for diverse types of students. This knowledge will be valuable for educational practitioners in designing effective interventions to support students' learning experiences.

References

Aguilar, S. J., Karabenick, S. A., Teasley, S. D., & Baek, C. (2021). Associations between learning analytics dashboard exposure and motivation and self-regulated learning. *Computers & Education*, *162*, 104085.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, *84*(3), 261.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology*, *80*(3), 260–267. https://doi.org/10.1037/0022-0663.80.3.260

Bandura, A. (1997). Self-efficacy: The exercise of control. *W.H. Freeman and Company.* 79-116

Barzegar, M. (2012). The Relationship between Goal Orientation and Academic Achievement--The Mediation Role of Self Regulated Learning Strategies--A Path Analysis. *Online Submission*.

Broadbent, J. (2017). Comparing online and blended learner's self-regulated learning strategies and academic performance. *Internet and Higher Education, 33, 24- 32.* https://doi.org/10.1016/j.iheduc.2017.01.004

Brooke, J. (1996). SUS-A quick and dirty usability scale. *Usability evaluation in industry*, *189*(194), 4-7.

Canvas Data Portal. (n.d.). *Canvas Data Portal*. https://portal.inshosteddata.com/docs

Conde Gafaro, B. (2022). First steps towards self-regulated learning. *Setting goals in MOOCs*, 63-75.

Deci, E. L., & Ryan, R. M. (2000). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227-268.

Deunk, M., & Korpershoek, H. (2021). Studentenwelzijn in het hoger onderwijs: Een overzichtsstudie van veelbelovende aanpakken voor docenten(teams), opleidingen en instellingen. *Rijksuniversiteit Groningen.*

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological review*, *95*(2), 256.

Elliot, A. J., & McGregor, H. A. (2001). A 2 X 2 achievement goal framework. *Journal of personality and social psychology*, *80*(3), 501–519. https://doi.org/10.1037/0022-3514.80.3.501

Elliot, A. J., & Murayama, K. (2008). On the measurement of achievement goals: Critique, illustration, and application. *Journal of Educational Psychology, 100 (3),* 613-628.

Fleur, D. S., van den Bos, W., & Bredeweg, B. (2020). Learning analytics dashboard for motivation and performance. In *Intelligent Tutoring Systems: 16th International Conference, ITS 2020, Athens, Greece, June 8–12, 2020, Proceedings 16* (pp. 411-419). Springer International Publishing.

Gašević, D., Dawson, S., Rogers, T., & Gasevic, D. (2016). Learning analytics should not promote one size fits all: The effects of instructional conditions in predicting academic success. *The Internet and Highe r Education, 28,* 68-84.

Guay, F., Vallerand, R. J., & Blanchard, C. (2000). On the assessment of situational intrinsic and extrinsic motivation: The Situational Motivation Scale (SIMS). *Motivation and emotion*, *24,* 175-213.

Hsieh, P. H. (2011). Mastery Orientation, *Encyclopedia of Child Behavior and Development (915–916).*

Jansen, R. S., Van Leeuwen, A., Janssen, J., Kester, L., & Kalz, M. (2017). Validation of the self-regulated online learning questionnaire. *Journal of computing in higher education*, *29*(1), 6-27.

Jivet, I., Scheffel, M., Specht, M., & Drachsler, H. (2018). License to evaluate: Preparing learning analytics dashboards for educational practice. *In Proceedings of the 8th international conference on learning analytics and knowledge* 31-40.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Cooperative learning returns to college what evidence is there that it works?. *Change: the magazine of higher learning*, *30*(4), 26-35.

Karabenick, S. A. (2004). Perceived achievement goal structure and college student help seeking. *Journal of educational psychology*, *96*(3), 569

Lee, M., Bong, M., & Kim, S. I. (2021). Effects of achievement goals on self-control. *Contemporary Educational Psychology, 67, 102000.*

Lin, X. (2019). Achievement Goal Orientations as Predictors of Self-Regulated Learning Strategies of International ESL Students. *International Journal of Teaching and Learning in Higher Education, 31(2), 214-223.*

Lonn, S., Aguilar, S. J., & Teasley, S. D. (2015). Investigating student motivation in the context of a learning analytics intervention during a summer bridge program. *Computers in Human Behavior*, *47*, 90-97.

Lüftenegger, M., Van de Schoot, R., Schober, B., Finsterwald, M., & Spiel, C. (2014). Promotion of students' mastery goal orientations: Does TARGET work?. Educational Psychology, 34(4), 451-469.

Morgan, K., & Carpenter, P. (2002). Effects of manipulating the motivational climate in physical education lessons. *European Physical Education Review*, *8*(3), 207-229.

Narciss, S., Proske, A., & Koerndle, H. (2007). Promoting self-regulated learning in web-based learning environments. *Computers in human behavior*, *23*(3), 1126-1144.

Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of educational psychology*, *99*(1), 83.

Peters, B. A. (2023). Design and Evaluation of a Student-Facing Learning Dashboard Using Self-Regulated Learning Theory.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp. 451-502). Academic Press.

Schwendimann, B. A., Rodriguez-Triana, M. J., Vozniuk, A., Prieto, L. P., Boroujeni, M. S., Holzer, A., ... & Dillenbourg, P. (2016). Perceiving learning at a glance: A systematic literature review of learning dashboard research. *IEEE Transactions on Learning Technologies, 10(1)*, 30-41.

Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. *Computers in Human Behavior*, 107, 105512.

Seijts, G. H., Latham, G. P., Tasa, K., & Latham, B. W. (2004). Goal setting and goal orientation: An integration of two different yet related literatures. *Academy of management journal*, *47*(2), 227-239

Svinicki, M. D. (2010). Fostering a mastery goal orientation in the classroom. *Essays from excellence in teaching*, *9*, 25-28.

Tangney, J.P., Baumeister, R.F. and Boone, A.L. (2004), High Self-Control Predicts Good Adjustment, Less Pathology, Better Grades, and Interpersonal Success. *Journal of Personality, 72:* 271-324. https://doi.org/10.1111/j.0022-3506.2004.00263.x

Teasley, S. D. (2017). Student facing dashboards: One size fits all?. Technology, Knowledge and Learning, 22(3), 377-384.

Teasley, S. D. (2019). Learning analytics: Where information science and the learning sciences meet. Information and Learning Sciences, 120(1/2), 59-73.

Thompson, K., & Dale, V. (2022). The role of virtual placements in promoting self-regulated learning: stakeholder experiences of an online learning community during the Covid pandemic. *Journal of Perspectives in Applied Academic Practice*, *10*(1), 12-22.

Valentini, N. C., & Rudisill, M. E. (2006). Goal orientation and mastery climate: a review of contemporary research and insights to intervention. *Estudos de Psicologia (Campinas)*, *23*, 159-171.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Brière, N. M., Senécal, C. B., & Vallières, É. F. (1993). Academic motivation scale (AMS-C 28), college (CEGEP) *version. Educational and Psychological Measurement, 52(53)*, 1992-1993.

Villatoro Moral, S., & De Benito, B. (2021). An approach to co-design and self-regulated learning in technological environments. Systematic review.

Wandler, J. B., & Imbriale, W. J. (2017). Promoting undergraduate student self-regulation in online learning environments. *Online Learning*, *21*(2), n2.

Wong, J., Baars, M., He, M., de Koning, B. B., & Paas, F. (2021). Facilitating goal setting and planning to enhance online self-regulation of learning. Computers in Human Behavior, 124, 106913.

Xu, J., Núñez Pérez, J. C., Cunha, J., & Rosário, P. (2020). Online homework distraction scale: A validation study. *Psicothema*.

Zandvliet, D. (2020). Towards effective learning analytics for higher education: returning meaningful dashboards to teachers *(Doctoral dissertation, Vrije Universteit).*

Zimmerman, B. J. (2008). Goal Setting: A Key Proactive Source of. *Motivation and self-regulated learning: Theory, research, and applications*, *267*.

Appendix A: Information Sheet & Informed Consent

Appendix A.1: Information Sheet

Information sheet for research project "Student Facing Dashboard 2.0"

1. Introduction

You have been invited to take part in research project StudentFacingDashboard 2.0, because you are enrolled in on the following courses: Brain, body & behaviour or USE Basic Theme: Society and Digitalization.

Participation in this research project is voluntary: the decision to take part is up to you and will not have any consequences on your grades or study progress. The teachers of the course in which you are enrolled do not have access to any of the datasets used in this research project. They are not informed of which students consented to participation in the research project, and they do also not who receives which dashboard.

Before you decide to participate we would like to ask you to read the following information, so that you know what the research project is about, what we expect from you and how we go about processing your personal data. Based on this information you can indicate by way of the consent declaration whether you consent to taking part in this research project and in the processing of your personal data.

You may of course always contact the researcher via k.b.franken@student.tue.nl, if you have any questions, or you can discuss this information with people you know.

2. Purpose of the research

This research project will be managed by Uwe Matzat.

The purpose of this research project is to decide how we can design a mastery goal-oriented student dashboard to facilitate self-regulation and increase academic success, intrinsic motivation and self-control. In the project, a newly designed dashboard will be tested and its effects analyzed.

The newly designed dashboard will be designed based on previously designed dashboard (Project: 'Student Facing Dashboard'). It will be tested and its effects will be analyzed in a randomized field experiment by a Master Student at TU/e, hereafter referred to as 'researcher'. The research is part of the Human-Technology Interaction Group at TU/e.

The research project will lead to two main outcomes:

- the design of a "live" learning analytics dashboard with data refreshed once per day;
- evaluation of success of dashboard will be done via surveys.

During the development of your course, you will have access to a dashboard in which your learning behaviour will be displayed, based on your Canvas data. Simultaneously, you will be asked to complete three surveys: one at the beginning of the project, one during the development of the project and one at the end, via Limesurvey. The three surveys will contain questions about learning behaviour and motivation, and about the student number. Only the first survey will contain questions about student

number and email address (for the processing activities and purposes described in the following sections). The third survey will contain also questions about your experiences on using the dashboard during the course. During the last phase of the project, your Osiris data will also be analyzed to determine whether the use of the dashboard had an impact on your academic behaviour.

The research project will only process and analyze pseudonymized data. The researchers will not be able to identify you directly, because your student number will be replaced by a hashed value and your email address will not be included in the research database. Your email address is required only to create the account by which you will be able to access your dashboard and to send you the information regarding the payment of the compensation. Your email address will not be used to link your Canvas, Osiris and Limesurvey data.

3. Controller in the sense of the GDPR

TU/e is responsible for processing your personal data within the scope of the research. The contact data of TU/e are:

Technische Universiteit Eindhoven
De Groene Loper 3
5612 AE Eindhoven

4. What will taking part in the research project involve?

You will be taking part in a research project in which we will gather information by:

- asking you to fill out a survey on three [3] different moments, about your learning behaviour and study motivation;
- accessing your study data in Canvas and Osiris, in order to provide you with a personalized dashboard related to your learning behaviour;
- analyzing your answers to the survey in combination with your Canvas and Osiris data.

For your participation in this research project you will receive a compensation of 20 euros as a sign of our appreciation.

5. What personal data from you do we gather and process?

Within the framework of the research project we process the folllowing personal data:

Processing activity	Personal data
Registration research participants	- Student number
Performing and archiving research questionnaire	- Student number - Email address (only in survey No. 1) - Survey answers on self-regulated learning behavior and motivation, as well as experience of the dashboard.
Set-up and display of Dashboard to the student	- Student number - User ID - Course information (including course code, when course is given, dates of tests, exams, lectures) related to all courses as mentioned above

	- Course setup (including information on modules, (video) lectures, discussion forums, wikis, assignments, such as type of test/exam, correct answers), by course - Student answers to tests and assignments, and performance on tests/exams/assignments, by course - Clickstream data (every click within a specific course with time stamps) by course
Creation of accounts for the students to access their individual Dashboard	- Student number - Email address
Register study progress	- Exam results (by course) - Course results (all results of a course) - Student number
Select, aggregate and pseudonymize data in a research dataset	- All of the above
Analysis of merged data	- All of the above (except student number and email address)
Correspondence and payment	- Email address

Your student number will be pseudonymized and your email address will only be used for the purposes of creating your dashboard account and to contact you for payment purposes. Your data from Canvas, Osiris and the survey will not be directly traceable to you.

The teachers of the course in which you are enrolled do not have access to any of the datasets used in this research project. They are not informed of which students consented to participation in the research project, and they do also not who receives which dashboard.

6. Withdrawing your consent and contact data

Participation in this research project is entirely voluntary. You do not have to answer questions you do not wish to answer. You may end your participation in the research project at any moment, or withdraw your consent to using your data for the research, without specifying any reason. Ending your participation will have no disadvantageous consequences for you or for any compensation you may already have received]

If you decide to end your participation during the research, the data which you already provided up to the moment of withdrawal of your consent will be used in the research.
Do you wish to end the research, or do you have any questions and/or complaints? Then please contact the researcher via k.b.franken@student.tue.nl. In deviation from what is stated hereabove on page 1, the researcher will be able to directly identify you by your e-mailaddress if you e-mail him. He will however not be able to link your research-data to your e-mailaddress. If necessary for executing your request, for example to carry out a withdrawal, the researcher will request the authorized employee involved to take care of the request.

If you have specific questions about the handling of personal data you can direct these to the data protection officer of TU/e by sending a mail to functionarisgegevensbescherming@tue.nl. Furthermore,

you have the right to file complaints with the Dutch data protection authority: the Autoriteit Persoonsgegevens.
Finally, you have the right to request access, rectification, erasure or adaptation of your data. Submit your request via privacy@tue.nl.

7. Legal ground for processing your personal data

To be permitted to process your personal data, the processing must be based on one of the legal bases from the GDPR. For this research project StudentFacingDashboard that is explicit consent.

8. Who has access to your personal data?

Access to personal data within TU/e

All relevant employees who are involved in the research project have access to your pseudonymized personal data, but only as far as is necessary to fulfil their respective tasks. These employees are:

- the research team: consisting of three researchers;
- the Analytics Product Owner;
- the Manager of Innovation in Education.

Beside these employees, only authorized persons in the relevant sections of TU/e like the Analytics Data engineer will have access to your data, but only as far as is necessary to fulfil their respective tasks.

Access to personal data by other parties

Within the framework of the research project, your personal data will be shared with the following third parties:

- storage solution: Microsoft;
- survey tool: LimeSurvey;
- data analysis tool: Databricks.

These third parties are processors: they processes your personal data on our instructions. We concluded an agreement with them concerning the processing of your personal data. This agreement stipulates that certain obligations for protection of your personal data are respected, to ensure that the data are processed in such a way that the requirements and standards of TU/e are met.

TU/e will process your personal data only within the European Economic Area (EEA) by storing the data on a server inside the EEA.

9. How are your personal data protected?

TU/e has implemented appropriate technical and organizational measures for protection of personal data against unintended or unlawful destruction, unintended damage, loss, alteration and unauthorized publication or access, and against all other forms of unlawful processing (including, but not limited to unnecessary gathering of data) or further processing. These appropriate technical and organizational measures include limitation of access to data through authorization and authentication, guidelines within the organization concerning the processing of personal data and storage on protected locations that are offered by the ICT service of TU/e.

10. How long will your personal data be retained?

Your personal data will be retained in accordance with the GDPR. The data are retained no longer than is necessary to achieve the goals for which the data were gathered and are deleted as soon as you withdraw your consent and there is no other ground to process your data lawfully. The research data will be retained for a period of 10 years, in line with regulatory requirements regarding retention periods for research data. At the latest after expiration of this time period, the dataset(s) will be deleted. We are legally obliged to retain your financial data for 7 years.

11. Confidentiality of data

We will do everything we can to protect your privacy as best as possible. The research results that are published will in no way contain confidential information or personal data from or about you through which anyone can recognize you, unless you have by way of our consent form explicitly consented to mentioning your name, for example in a quote. The research data will if necessary (for example for a check on scientific integrity) and only in anonymized form be made available to people outside the research group.

Finally, this research has been assessed and approved [research manager fills in] by the ethical committee of Eindhoven University of Technology.

Appendix A.2: Informed Consent

Consent form for participation by an adult

By signing this consent form I acknowledge the following:

1. I am sufficiently informed about the research project through a separate information sheet. I have read the information sheet and have had the opportunity to ask questions. These questions have been answered satisfactorily.

2. I take part in this research project voluntarily. There is no explicit or implicit pressure for me to take part in this research project. I am clear that I can end participation in this research project at any moment, without giving any reason. I do not have to answer a question if I do not wish to do so.

Furthermore, I consent to the following parts of the research project

3. I consent to processing my personal data gathered during the research in the way described in the information sheet.

   YES ☐ NO ☐

4. I consent to using my answers for quotes in the research publications – without my name being published in these.

   YES ☐ NO ☐

Name of Participant:
Signature:
Date:

Name of Researcher:
Signature:
Date:

Appendix B: Survey Items

[Intrinsic/Extrinsic motivation; survey 1,2 & 3]
How much do you feel like the following statements correspond with why you are participating in the course (0HV30 or 0SAB0-SD)?

I participate in this course…

- Because I think that this course is interesting. **(Intrinsic)**
- Because I think that this course is pleasant. **(Intrinsic)**
- Because I feel good when doing this course. **(Intrinsic)**
- Because I am supposed to do it. **(External Regulation)**
- Because I don't feel like I have a choice. **(External Regulation)**

[Goal Orientation; survey 1,2 & 3]
Within 0HV30 or 0SAB0-SD, how much do you agree with the following statements?

- My aim is to completely master the material presented in my most difficult class. **(Mastery)**
- I am striving to do well compared to other students.**(Performance)**
- My goal is to learn as much as possible. **(Mastery)**
- My aim is to perform well relative to other students. **(Performance)**
- I am striving to understand the content of my most difficult class as thoroughly as possible. **(Mastery)**
- My goal is to perform better than the other students. **(Performance)**

[Self-control; survey 1,2 & 3]
Using the scale below, indicate to what extent each of the following items corresponds to your behavior while working on online homework assignments in either 0HV30 or 0SAB0-SD.

- I daydream while doing online assignments.
- I start conversations unrelated to what I am doing.
- I stop online assignments to watch my favorite TV show.
- I stop online assignments to play video games.
- I stop online assignments to send or receive email.
- I stop online assignments to send or receive text messages.

[Academic Persistence; survey 1,2 & 3]

The following questions address how you have dealt with difficult periods while studying for your course (0HV30 or 0SAB0-SD). in Q4. We are not interested in how often you experienced such periods, as all students experience them now and then. We want to know how you dealt with them. There are no right or wrong answers.

- When I was feeling bored studying for this online course, I forced myself to pay attention.
- When my mind began to wander during a learning session for this online course, I made a special effort to keep concentrating.

- When I began to lose interest in this online course, I pushed myself even further.
- I worked hard to do well in this online course even if I didn't like what I had to do.

- When work was difficult in this online course, I continued to keep working.

- Even when I felt lazy or bored when I studied for this online course, I finished what I planned to do.
- Even when materials in this online course were dull and uninteresting, I managed to keep working until I finished.

[Engagement; survey 2 & 3]

How often did you take a look at the dashboard? *

Please choose **only one** of the following:

- Not at all
- one single time
- two times
- three times
- more than three times
- Other

About how many minutes did you spend using the dashboard?

[Dashboard Usefulness; survey 2 & 3]
How much would you agree with the following statements while using this learning dashboard? *

- I think that I would like to use this dashboard frequently.
- I found the dashboard unnecessarily complex.
- I thought the dashboard was easy to use.
- I found the various functions in this dashboard were well integrated.

- I thought there was too much inconsistency in this dashboard.
- I would imagine that most people would learn to use this dashboard very quickly.
- I felt very confident using the dashboard.
- I am satisfied with having this learning dashboard for this course.
- This learning dashboard provides me the information that I need.
- I feel like this learning dashboard is a useful tool for my studies in this course.
- I think the learning dashboard presents my data in a useful manner.
- What do you like most about the dashboard?
- What do you miss in the dashboard?
- What should be improved in the dashboard?

[Cognitive Load; survey 3]

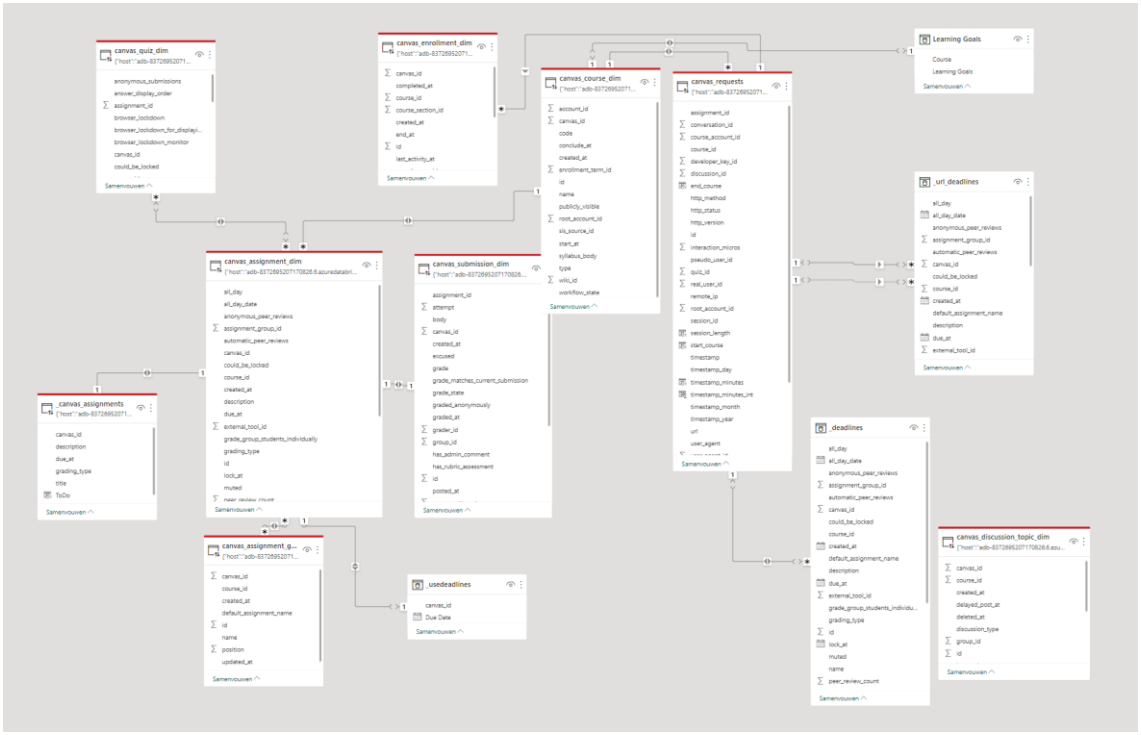
- The topic/topics covered on the learning dashboard were very complex.
- The dashboard covered concepts and definitions that I perceived as very complex.
- The instructions and/or explanations for the dashboard were very unclear.
- The instructions and/or explanations on the dashboard were, in terms of learning, very ineffective.
- The instructions and/or explanations on the dashboard were full of unclear language.
- The dashboard really enhanced my understanding of my learning behavior for the course.

[Feature usefulness; survey 3]
Per feature:
How much do you agree with the following statements about the feature? Please answer using the following scale: (1) Strongly disagree, (2) Moderately disagree, (3) Neither disagree nor agree, (4) Moderately agree, (5) Strongly agree.

- This feature was very useful.
- I would like to see this feature in future courses.
- This feature was very unclear.
- Using this feature can improve my learning behavior.

Appendix C: Data Model and Explanation Video

C.1 Data model

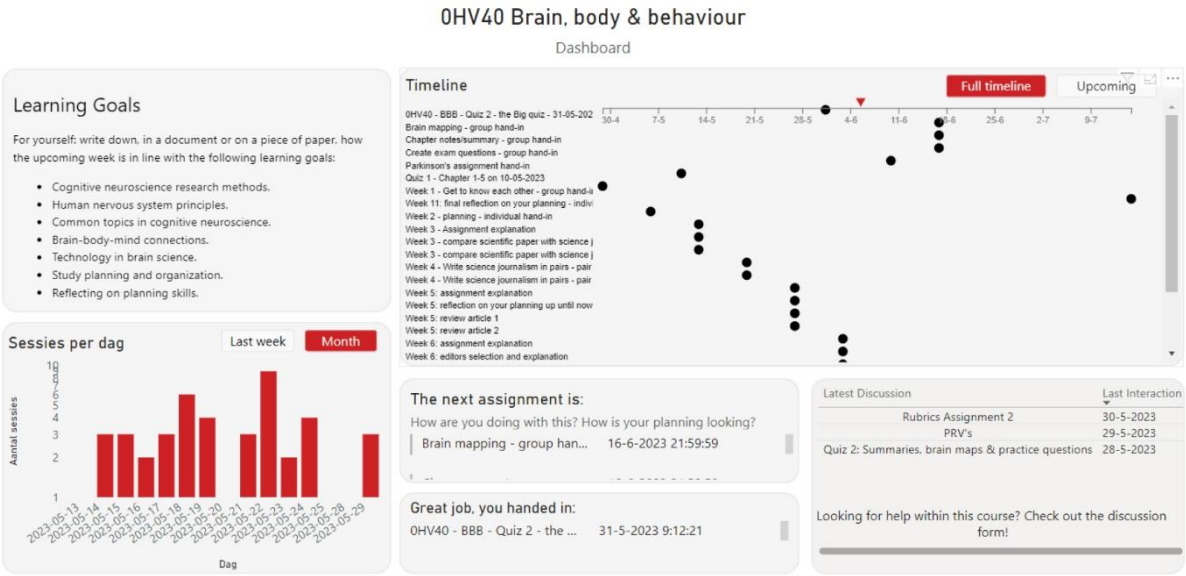


C.2 Explanation Video

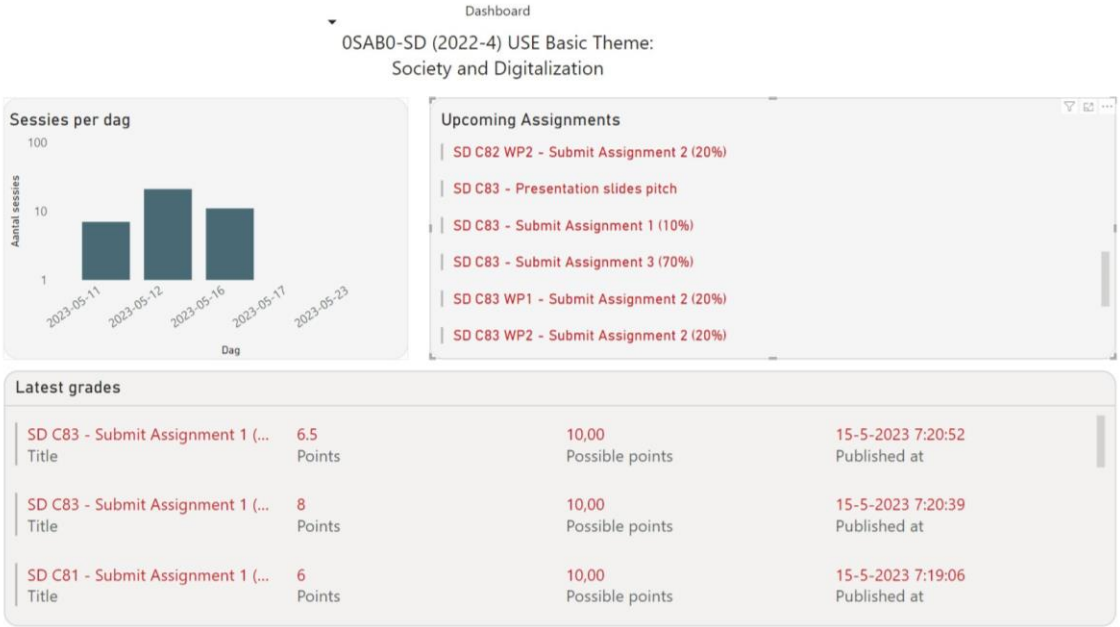
Power BI Explanation Video.mp4

Appendix D: Dashboard Views

D.1 Mastery Dashboard (treatment group)



D.2 Normal Dashboard (control group)



Appendix E: Extra Results Tables

E.1 Results of Usability, Cognitive load and Minutes as Covariates

	Usability		Cognitive Load	
Variable	Coefficient	P-value	Coefficient	P-value
Intrinsic motivation during	-.30	- .99	-	-
Intrinsic motivation after	-.33	- 1.00	-.14	.62
Persistence during	-.04	.91	-	-
Persistence after	-.08	.80	-03	.65
Mastery goal orientation during	-.33	.46	-	-
Mastery goal orientation after	.35	.44	-.03	.75

E.2 Results of Self-reported Minutes on Dashboard

	Minutes spent on dashboard	
Variable	Coefficient	P-value
Intrinsic motivation	-.02	.64
Persistence	-0.01	.24
Mastery goal orientation	<0.00	.84