

Investigating Students' Emotional and Motivational Responses to Dashboards with Varying Social Comparison Groups

by

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Abstract

The utilization of Learning Analytics Dashboards (LADs) within the educational domain has been growing. Following the Weiners Attribution Theory, we designed LADs to understand how grades, time spent on the spent, and ability impact students' emotions and motivation who had different achievement goal orientations. We assessed this effect among students with mastery, performance-approach, and performance-avoidance goal orientations. To get an in-depth understating of students' attribution of achievement, we conducted a mixed-method study to collect multi-channel data through think-aloud interviews, surveys, and eye tracking. To delve deeper into time and ability effects, we split participants into two groups. Group one saw ability and grade, while group two saw time and grade on dashboards. Later, all participants viewed a dashboard with grades, time, and ability. Our results indicate that the time spent on the assignment plays a more effective role for students to attribute their performance to effort, compared to ability. Additionally, in order to maximize the positive effects of dashboards on motivation, considering achievement goal orientations of students is important. In the 'Time Group', students with high-mastery were the most motivated by the dashboard in which their peers were significantly better, while students with low-mastery and middle-performance avoidance were more motivated by seeing their peers performing similarly or lower than them. Among students with high mastery and low performance-avoidance, adding the 'Time' element to the dashboard increased their motivation. Students with high performance-avoidance were motivated to put in more effort when they saw peers with higher grades and lower abilities. However, participants with low mastery in the 'Ability Group' displayed high levels of demotivation.

Keywords: Learning Analytics Dashboard; Attribution Theory; Motivation; Achievement Goal Theory; Social Comparison

Dedication

To all the women who have stood up, fought, broken barriers, and continue to forge ahead despite adversity and inequality, your strength lights the way in the darkest of times and fuels my determination to create a world where every woman can flourish and pursue her dreams without constraint.

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Chapter 1

Introduction

There has been a significant growing interest in using technological systems in the educational domain [22]. Currently, students are exposed to diverse learning opportunities through modern e-learning tools and learning management systems (LMS). Researchers are increasingly exploring students' learning behaviors and experiences in relation to these technological platforms. [19]. The goal of these technologies is for learners to have better decisions about their academic procedures and consequently, have better learning and performing outcomes [3].

Students usually experience different feelings, thoughts, and behaviors during academic self-regulation which affects their perception of themselves and their subsequent actions in the process of reaching their goals [16]. Based on whether they are successful or unsuccessful in achieving this goal, students might have different feelings and emotions because of their performance. Emotions tied to achievements that emerge during the learning process can significantly influence motivation. Consequently, this motivation can shape how students manage and control their learning activities [34].

Learning analytics dashboards (LADs) are used to inform students about their performance, learning, and progress in the academic setting, which play an effective role in students' motivational response and learning [2]. As LADs become increasingly integrated into the education system, the educational technology research community has employed various approaches to investigate the impacts of these learning dashboards on students [5, 18]. LAD research delves into dashboards' effects on students' emotions, motivation, and performance. However, the integration of learning theories into the design of these dashboards remains a less frequent practice [30]. Emphasizing the use of a frame of reference for designing LADs [15, 33], the research community has used different learning theories such as Weiner's Attribution Theory, Festinger's Social Comparison Theory, Achievement Goal Theory (AGT), etc. in their research [1, 32].

This study aimed to investigate students' comprehension of the feedback they receive regarding their performance in a course activity. Central to this exploration was the incorporation of Weiner's Attribution Theory, which guided the examination of how students at-

tribute their performance and subsequently interpret the feedback. To understand students' viewpoints regarding our specific dashboard configurations, we conducted mixed-method research, encompassing both qualitative and quantitative approaches. By manipulating the content of LAD prototypes via Social Comparison Theory, this study aims to unravel the interplay between various elements within the dashboards and their influence on students' emotional responses and motivation concerning their accomplishments in a learning activity.

In the subsequent sections, we conduct a review of LAD research (Chapter 2), describe the theoretical framework (Chapter 3), describes the design of the LAD prototype employed in the study, and pose the research questions (Chapter 4), present the method of data collection and analysis (Chapter 5), and present the results of the study (Chapter 6). In Chapter 7, we provide a discussion, conclusions, and limitations of the study and directions for future research.

Chapter 2

Background and Literature Review

Students usually experience different feelings, thoughts, and behaviors during academic self-regulation which affects their perception of themselves and their subsequent actions in the process of reaching their goals [16]. Based on whether they are successful or unsuccessful in achieving this goal, students might have different feelings and emotions because of their performance. Current LAD research demonstrates that having a theoretical foundation in the design of dashboards is necessary for having successful LADs that aid students in their learning. [18]. Related theories that are applied in LAD research are outlined below. In section 2.1, we provide an overview of motivation and LAD research on motivation, in section 2.2, we explain the research done in Attributional Retraining and the research done in this field, and in 2.3, we give an overview of the use of Social Comparison Theory in LAD research.

2.1 Motivation and LAD Research

When reflecting on their success or failures, students tend to attribute them to various circumstances. Weiner's introduction of the dimensions of locus of control, stability, and controllability explains this attribution process. By classifying attributions as internal or external, the locus of control establishes whether we believe the cause is under our control or not. Controllability evaluates the degree to which we can regulate or control the attribute, and stability relates to whether the cause is temporary or continuous. When students try to find reasons and explanations for their academic performance, it can evoke different emotions and subsequently influence their motivation [32]. Based on Pekrun's taxonomy on achievement emotions [25], outcome emotions of individuals can be affected by their approach to achieving personal goals. Furthermore, the Control-Value Theory (CVT) analyzes the experienced emotions of individuals in the achievement context, focusing on their causal attributions and perceived value of the tasks or goals they pursue [23]. Previous LADs research has used these theories to understand the emotional experience of learners

by understanding the nuances of achievement emotions, and how students attribute their performance.

Lim and colleagues utilized CVT to explore students' perspectives and perceived emotions and provided students with weekly personalized feedback about their performance in the course [17]. Through focus group discussions and semi-structured interviews, the results of this study showed that most students showed positive emotions and improved motivation following the use of the dashboard.

Applying Weiner's Attribution Theory, Li and colleagues presented students with a LAD that showed their effort as well as that of their classmates in an online course [16]. The aim of this experiment was to determine whether providing students with analytics related to their effort would help them attribute their performance to controllable factors, and consequently, improve their performance. The dashboard showed students' and their peers' average grades and time spent on the assignment. Results of the experiment showed increased effort attribution and decreased (low) ability attribution among students who had poor performance. However, there was no significant impact on their actual performance.

Another use of Attribution Theory was in the paper "How Students' Emotion and Motivation Changes After Viewing Dashboards with Varied Social Comparison Group: A Qualitative Study" [1]. Researchers conducted a qualitative study to examine the impact of different elements in the designed LAD on students' motivation. Providing students with information about their grades, time spent on the assignment, and proficiency, the research work aimed to study the interpretation of participants of the dashboard and their attribution to their performance. Results showed that including elements in dashboards that promote effort (such as time spent) helps students to attribute their performance to unstable and controllable factors like effort.

Following the work of [7] on situated expectancy-value theory, Valle and Baek investigated the effect of task-value scaffolding feedback on students [30]. Motivation, learning performance, and the level of anxiety of participants were measured in this study. The feedback was on a statistics course with 146 graduate students as participants. Participants were categorized into two experimental groups (treatment and control) and a questionnaire was used to measure participants' motivation for the course. Participants also completed a Statistics Anxiety Rating Scale to rate their anxiety and agreement with various statistics-related concepts, such as "Statistics teachers talk a different language" and "Interpreting the meaning of a table in a journal article". Finally, quiz results and final grades were utilized to study students' learning progress. The results of the study showed no differences between the control group and the treatment group in motivation and learning performance. In addition, the influence of task-value scaffolding on the anxiety of the treatment group was detrimental.

Several studies have used Achievement Goal Theory (AGO) in the design of LADs. Aguilar and associates [2], studied the impact of their designed dashboard, which was based

on AGO, on learners' motivation. Researchers categorized participants into three groups: The control group was shown their actual score (the mastery feedback), the "Below Average" group was informed that their progress in the course was below average compared to the class (the performance feedback), and the "Above Average" group was provided with information that showed their performance was better than the others (the performance feedback). A one-way ANOVA on the quantitative data collected from students through questionnaires showed students in the performance condition, who were informed they had achieved "above average" showed lower performance-avoidance goals and lower performance-avoidance information-seeking behaviors.

2.2 Attributional Retraining

Grounded in Weiner's Attribution Theory, researchers use Attributional Retraining (AR) in the academic domain. AR is a motivational treatment to assist students explain their successes and failures based on controllable and unstable attributes, rather than uncontrollable and stable factors [13]. For instance, Perry and Hall used videotapes and writing exercises that invite students to assign controlled attributions to study the effect of AR on students' emotions and motivation. [13]. Another study by Hall's research group explored how students' emotions, motivation, and academic success were affected by causal explanations for computer problems [19]. Conducting two studies, the results of the first one showed that students who attributed their computing difficulties to their lack of skills and ability expressed negative emotions. However, students who attributed their problems to their wrong strategy expressed more positive feelings. While AR has been applied to many educational contexts for motivational treatment, the use of AR in LADs has been insignificant [27].

2.3 Social Comparison and LAD Research

Several studies have used comparative feedback in the design of LADs to explore the effects of peer comparison on learners. Different types of peer comparison have been used in dashboards, such as class comparison, teammates comparison, class ranking comparison, previous graduates comparison, and top students comparison [14]. Several papers mentioned in the section 2.1 used social comparison in the design of their LADs. [1] used class ranking and varied selected peers as a frame of reference in their dashboard. Moreover, in the study conducted by Li and colleagues [16], students were provided with information about their effort and their peers' effort. The research by Aguilar and colleagues [2] showed in their study that comparative feedback in the form of visualizations of students' performance (showing students that they performed above average) has a positive impact on students' engagement (motivation) in the course. A similar approach can be seen in [11]. Researchers designed a system called "Mastery Grids" which presented students' individual progress and performance compared to other students. While the experiment had no significant impact on the

participants' performance, students who were exposed to both social comparison (activity ranking) and mastery elements (individual grades) demonstrated more engagement in the course.

Orji and associates designed an online learning system to study its effects on students' engagement and performance in the course. Socially relevant methods of persuasion were applied in the visualizations in the dashboard. The results of this study showed positive effects on students' engagement and outcomes in the course [22].

In the research conducted by Gunther [12], students were shown a visualization of their time spent on the system, as well as the time spent by average students and most active students. Moreover, students were informed whether their study time was below average, above average, or the same as active students. Based on this data, students got feedback on being below average, good, and great. The learning habits of students were affected after being exposed to the dashboard. Students were successfully motivated to participate in online learning activities early in the semester rather than waiting until the end by the feedback system.

In the paper [10], researchers designed a social comparison-oriented LAD that gave personalized feedback to students. Students could see a grade comparison to their peers who have comparable goal grades. The results of the study showed significant improvement in both the motivation and learning performance of students who used the dashboard. Another personalized feedback system was designed by [6] in which students could compare themselves with previous high-performing students in Massive Open Online Courses (MOOCs). The study's findings suggested that giving students information on social comparisons boosted MOOC course completion. It is important to emphasize that this feedback method mostly benefited students with higher education.

Chapter 3

Theoretical Framework

With the growing deployment of Learning Analytics Dashboards (LADs) in the education system [5, 18], the Learning Analytics community has used different methods to examine the effects of learning dashboards on students. This research aims to investigate the effects of LADs on students' perception of their performance and the resulting emotions and motivation. We examined how students respond to the information presented in our dashboard and how their emotions and motivation are shaped by including or excluding specific information in our designed learning dashboards.

Incorporating learning theories into the design of LADs is important. In order to avoid the detrimental effects of dashboards that are only data-driven, LADs have to be designed based on well-established learning theories [18]. To facilitate the comprehension of dashboards and enable students to interpret their analytics effectively, providing a frame of reference is essential [33]. According to [15], three types of reference frames are used in learning dashboards as reference points that play a significant role to facilitate students making sense of the information presented to them: 1) Social reference frame: This type of reference frame focuses on the comparison of students' performance with their peers; 2) Progress towards goals: The reference point for achievement focuses on the progress students have made towards their objectives; and 3) Self-progress: This reference frame helps students to track their growth and development over time by comparing their current performance with their past performance. As explained in chapter 2 several studies have used Social Comparison Theory [9] as a frame of reference in the design of their LADs, presenting students' comparative performance information in the form of letter grades, class average, activity progress, etc. The objective of these studies has been to provide students with an understanding of how their performance aligns with an overall class or a group. Similarly, our theoretical framework uses this theory to provide students with information about their performance and their peers in different configurations to study the effect of peer selection on our participants.

Jivet emphasised the fact that LAD research lacks a theoretical foundation and the significance of incorporating learning sciences principles into the design of dashboards [15].

Similarly, our study builds on several theories described in the following sections. We conclude with the study design section that brings the theories into a unified framework.

3.1 Weiner’s Attribution Theory

Individuals bring different explanations for the causes of the events that happen to them. Weiner’s Attribution Theory suggests that individuals tend to attribute their failures and success to different factors by bringing different explanations for the causes of their outcomes [32, 31]. According to Weiner, there are three dimensions to the reasons people give for their performance: locus of control, stability, and controllability.

The first dimension, locus of control, refers to whether people attribute their performance to a reason that is internal, meaning it is under their control, or to something that is external, which means that factor is beyond their control. Internal factors can be such as effort and ability, and external factors can be circumstances like task difficulty or having two exams scheduled in one day, and task difficulty. The second dimension, stability, refers to the consistency or fluctuation of the cause over time. If a cause is permanent over time, it is considered stable, such as low ability, and if it changes, it is considered unstable (e.g., exam difficulty). Controllability, the last dimension, has to do with how much people believe they have control over an outcome. They may feel like the cause of their performance is controllable, such as effort, or they may feel it is uncontrollable, such as ability.

People interpret the causes of their own performance and that of others by taking into account these three dimensions. While these causes and factors can have a broad range, Weiner narrowed the causes of achievement outcomes into four categories: Effort, Ability, Task difficulty, and Luck. Effort and ability are regarded as internal, and task difficulty and luck are considered external factors. A variety of subsequent behaviors, such as emotions and motivation, can be influenced by these attributions in turn.

Weiner’s Attribution Theory can help us to study the complexity of how learners explain their performance in their academics, and how their consequent emotions and motivation change. Learners can attribute their poor performance to various factors. For instance, if a student ascribes their failure in a course to their inherent lack of ability, a stable and uncontrollable attribute, it has the potential to evoke feelings of shame and hopelessness. Subsequently, this can result in lower motivation going towards the course. On the other hand, if a student blames their poor performance in a course on their low effort—an unstable and controllable attribute—this might result in shame or guilt, and viewing the failure as temporary. Subsequently, this may increase the feeling of motivation to progress in the course [32]

We applied this theory in our study to understand how students explain their success or failure in the course, and how this impacts their emotions and motivation. We designed dashboards that show students’ performance according to their effort and aptitude. Our

aim was to understand how dashboards that promote effort - a controllable and unstable attribute - impact students' emotions and motivation compared to dashboards that promote ability, which is an uncontrollable and stable attribute.

3.2 Festinger's Social Comparison Theory

Festinger's Social Comparison Theory postulates "The tendency to compare oneself with some other specific person decreases as the difference between his opinion or ability and one's own increases" [9]. With a propensity for slightly upward comparison, individuals tend to compare themselves to those who have similar beliefs or abilities to them. Applying this theory in the academic setting, we can study how students compare themselves with others.

This suggests that incorporating other students' performance within a learning dashboard can impact how they judge and evaluate other elements in the dashboard and their own performance. Moreover, presenting elements like effort or ability in dashboards can affect how students compare themselves with others other than just providing information about grades. Hence, in order to study how learning dashboards impact students' emotions, we used Social Comparison Theory to evaluate how the impact of the utilization of different elements in learning dashboards on students' emotions.

3.3 Achievement Goals and Achievement Emotions

In order to understand one's motivation towards achieving a goal, Achievement Goal Theory was defined in the 1980s and gradually refined (see [29] for an overview). Goals that people set for themselves with the intention of raising their level of expertise are known as achievement goals [24]. The two main achievement goals originate back to [21, 8] research when theorists introduced learning goals (also known as mastery goals) and performance goals. Learning goals were known as objectives that individuals try to achieve to raise their self-competence and expertise. Performance goals were considered as objectives where individuals aim to outperform others and receive recognition for their success or avoid failing and receiving negative evaluations from other people. Later research grouped achievement goals into three main orientations for individuals' approach toward achieving competence-based academic goals: Mastery Goal Orientation, Performance-Approach Goal Orientation, and Performance-Avoidance Goal Orientation [28].

Individuals with *mastery goal orientation* focus on gaining mastery in a task. In order to advance and raise their knowledge, they seek to increase their knowledge and acquire new skills. They are motivated to work hard, progress, and focus on their mastery.

Students with *performance-approach goal orientation* always aim to perform better than others. They want to be known as the top student who outperforms their peers. Individuals with this orientation focus on the outcome of their performance rather than the ongoing activity, as opposed to students with mastery goals.

On the other hand, students with *performance-avoidance goal orientation* attempt to avoid performing poorly or being evaluated as a poor student compared to standards and other students. They usually put the minimum effort in order to avoid looking bad, and have low motivation to succeed. Much like the performance-approach goal group, they focus on the outcome, but with the aim of not being evaluated negatively.

Reinhard Pekrun also introduced Achievement Emotions as resulting emotions of achievement-related settings [23]. According to Pekrun, individuals' motivation is affected by their achievement goal orientation when attempting to achieve a goal in the academic context [24, 26]. Furthermore, this could affect their emotions. Pekrun categorized these emotions into two groups: Activity Emotions and Outcome Emotions. Activity emotions refer to emotions that arise during an achievement-related activity, such as boredom or enjoyment that might happen while learning new knowledge. Outcome emotions are emotions related to the outcome of the competence-relevant activity in the learning setting. For instance, the feeling of pride or shame that a person can have after their exam results are considered as outcome emotions. Achievement Emotions are considered to have a significant impact on academic performance and students' motivation.

In our research, we utilized the achievement goal orientation theory to study how students' goals and their subsequent behaviors and achievement emotions are influenced by viewing the dashboards with different compositions. With the focus on investigating how students with different achievement goal orientations respond to their performance feedback, we designed and presented to them several learning dashboards that visualize their performance in a course.

3.4 The Patterns of Adaptive Learning Scales (PALS)

With the aim of understating how individuals approach their objectives in the educational context, based on the achievement goal orientations, [20] introduced a questionnaire: The Patterns of Adaptive Learning Scales (PALS). This questionnaire measures learners' behaviors and attitudes toward reaching their objectives in the learning environment and also teachers' goal orientation and perceptions towards teaching approaches.

Similar to Aguilar's work [3], and focusing on the student scale and their personal achievement goal orientations, in order to measure students' goal achievement orientation (mastery goal orientation, performance-approach goal orientation, and performance-avoidance goal orientation) we used PALS survey in our user study.

Chapter 4

Study Design

The theoretical framework described in the previous section guided us to design a research that studies the impact of viewing dashboards of students' performance on their emotions and motivation. We utilized Weiners' attribution theory to analyze the data and uncover the specific assumptions and attributions students make after seeing their performance feedback on the dashboard. This allowed us to understand more about the intended behavioral change and cognitive process of students when explaining their (perceived) poor or good performance with the help of our designed learning dashboards. We examined resulting emotions using Pekrun's taxonomy of achievement emotions, the resulting motivation using Weiners' attribution theory, and Pekrun's analysis of achievement goal theory. Additionally, using achievement goal theory, we investigated the outcomes from the perspective of students' different goal orientations. In parallel, Social Comparison Theory was used to generate our final versions of LADs and see what emotional/motivational impact students elicit by comparing themselves with their peers.

According to Weiner's Attribution Theory [32] and Perkrun's analysis of outcome emotions [23] in an educational context, one's motivation can be negatively affected when they attribute their poor performance to low ability. Ability is considered a stable and uncontrollable attribute. Hence, attributing one's poor performance to a lack of ability can lead to hopelessness, frustration, and disappointment. These negative emotions can lead to lower motivation as they feel success is unattainable. On the other hand, if students explain the reason for their bad results to an unstable and controllable attribute, such as effort, they might feel guilt and shame. However, guilt and shame can result in more motivation to try harder to continue towards the course work and get better results next time [32]. Based on Attributional Retraining practices in education, students should explain their poor academic performance to lack of effort [13]. Hence, the educational system should provide an environment that encourages students to see that success can be achieved via their own efforts rather than via fixed qualifications such as intelligence or ability.

In light of the background work on LADs and the theoretical framework explained above, we aimed to investigate students' perception of their performance feedback in a course

activity. The literature review on Learning Analytics Dashboards shows that most research approaches on LADs have been quantitative and little research has been done using open-ended questions and think-aloud interviews [18]. In order to gain an in-depth understanding of students' perception of our dashboard we designed a mixed-method research consisting of qualitative and quantitative approaches. The methods are explained in Section 5.

We designed dashboards that showed students' performance on a course. Taking the previous work and theoretical base into consideration, we designed dashboards that presented three informational elements for the students and their peers: assignment grade percentage, time spent on the assignment, and ability. Among the array of feedback components incorporated within LADs, grades stand out as one of the most common and extensively employed elements. We considered time spent on the assignment to represent effort, giving students a clear understating of their own and their peers' determined attempts on the assignment. Additionally, including ability as an attribute would inform students about the primary programming skills and knowledge of all students in the course. Moreover, students entering the course with higher programming skills compared to other students are supposed to get higher grades, hence decreasing the likelihood of negative emotions, whereas students with lower abilities get lower grades compared to students with high proficiency. Skilled students in programming also may need to put less time into an assignment compared to a student with lower ability, determining the role of effort in studying.

Moving on from the implication of Attribution Theory in our study design, we used Festinger's Social Comparison Theory as a frame of reference to design dashboards where students could evaluate their performance compared to their peers. We designed our dashboards in different configurations, including different levels of grades, abilities, and time spent in our dashboard, to investigate how students compare themselves with others. According to Social Comparison Theory [9], "if the only comparison available is a very divergent one, the person will not be able to make a subjectively precise evaluation of his opinion or ability" (p.121), and "given a range of possible persons for comparison, someone close to one's ability or opinion will be chosen for comparison" (p.121). As a result, we were able to research the effects of this feature on students by including ability as a critical component in our dashboards. The final design of dashboards and details about them can be seen in 5.3, Appendix C and D. Each dashboard shows a group of five students who performed similarly with respect to the student viewing the dashboard, e.g. they all spent more time and got lower grades. In each dashboard, we included an outlier to reach a more in-depth understanding of Social Comparison Theory and who students would pick to compare themselves to whether they prefer to compare themselves with peers that outperformed them, students that were similar to them, or students with significantly lower performance compared to the student. So in our dashboard design, we have shown six selected peers as a frame of reference for students to make sense of the presented information.

In order to understand the role that 'Ability' and 'Time' elements played in our dashboards and their effects on students, we categorized participants into 'Time Group' and 'Ability Group'. We only showed the 'Time Group' the dashboards that included participants' and their peers' grades and their time spent on the assignment. In a similar way, dashboards including participants' and their peers' grades and abilities were shown to students in the 'Ability Group'. Following the six different dashboard configurations that were displayed to participants based on their group, they were finally shown the complete dashboard, which included all elements.

Another point of our design was setting the student's mark at 75%. This mark was chosen as it is not failing, and there is room for improvement. Also, it is an average or below-average grade for assignments in our chosen programming course that we used as a reference. The time spent the participant spent on the assignment was set to 7 hours and their ability to 3 out of 5. Similarly, these numbers were chosen to represent an average performance in the course we used as a reference.

4.1 Research Questions

In this study, we explore the following question: How do students assess and explain their academic performance based on the components included in our dashboard, and how does this affect their emotions and motivation? To address this topic, we divided it into two distinct research questions:

- **RQ1:** How do students make sense of the different components on the dashboard?
- **RQ2:** How are the emotional responses to the dashboards and motivation shaped by the comparative performance of peers displayed in the dashboard?

Chapter 5

Methods

In this chapter, we provide an overview of the methods of data collection and analysis in this user study. In each section, we go into detail about each method.

5.1 Overview

In this study, we conducted a mixed-method approach to study how including different elements in our dashboards impacts students' perception of their performance. We examined the resulting emotions and motivation and how these are shaped by including and excluding different elements representing students' effort (time spent on the assignment) and ability (self-assessed proficiency). To study the impact of our designed dashboards in a particular social comparison group, we have designed the prototypes in different configurations to understand how different values of elements impact students' responses. The variation of prototypes was driven by the Social Comparison theory, studying how using different social comparison groups changes the interpretation/enhances information included (effort and ability)

We used different methods of data collection in order to gain in-depth insights into the effect of dashboards on students' emotions and motivation. We conducted think-aloud interviews on our dashboard prototypes, used surveys to gather students' demographics, and understand students' achievement goal orientation. Moreover, we captured eye-tracking data while students interacted with our dashboards to study their pattern of attention on the dashboard and which students in the comparison group they focused on.

The user study occurred in the lab setting. At the beginning of the study, participants were provided with the consent form (approved by the university ethics board) to get familiar with the study. The details are brought below. Next, they were asked to fill out our questionnaires. In the final step, participants had to sit in front of a monitor for the think-aloud interview. Before the interview starts, we familiarized them with the eye tracker and the calibration process, and how it would be used while they were looking at the monitor.

During the interview, we showed our dashboards and conducted the interview. We used wire-framing to design the dashboard prototypes.

Interview data was collected in the form of video and audio recordings and the researcher's notes from interview responses, which were labeled with an anonymous participant ID. Recordings were used to create transcripts of the interviews, for further analysis. Recordings were transcribed immediately after the interview and all identifying information if any, was replaced with the letter P followed by a number (e.g. P01, P02, etc.). We coded the interview data based on the theoretical framework provided in chapter 3, conducted a statistical analysis on questionnaires to explore different achievement goal orientations of participants, and analyzed the changing pattern of students' attention gaze looking at the dashboard.

5.2 Participants

39 participants were recruited from an undergraduate program in an interdisciplinary school focusing on the conception of new media and the design of interactive technologies. 36 participants were aged from 18 to 24, 2 participants were between 25 and 30, and one participant was aged more than 30. 25 participants identified as women, 12 as men, 1 as non-binary, and 1 participant preferred not to specify their gender. All participants, with the exception of one, were familiar with bar charts when questioned about their knowledge of visual charts. Pie charts and line charts, respectively, were both familiar to 37 and 28 individuals. Only 11 and 9, respectively, of the participants had prior knowledge of scatter and stacked charts.

5.3 Materials

All prototypes were designed in Adobe XD wire-framing tool¹. As explained in 4, participants were grouped into 'Time Group' and 'Ability Group'. Each group has been shown eight dashboards: Starting with the dashboard shown in Figure 5.1 that showed only grades, followed by the six configurations of time dashboards with elements as shown in Figure 5.2 ('Time Group') or in Figure 5.3 ('Ability Group'), and finishing the study with showing the full dashboard Figure 5.4. Below I describe the type of dashboards as shown throughout the study:

Step 1

- Selected participants: all participants
- Type of dashboard: Showing only grade (Figure 5.1)

¹<https://helpx.adobe.com/ca/support/xd.html>

Table 5.1: Demographic Statistics

Variable	N
Gender	
Female	25
Male	12
Non-binary	1
Prefer not to say	1
Age Range	
18-24	36
25-0	2
> 30	1
Number of Credits Taken	
0-30	1
30-60	13
60-90	12
90-120	12
> 120	1
Familiarity with Visual Charts	
Bar Chart	38
Pie Chart	37
Line Chart	28
Scatter Chart	11
Stacked Chart	9

Step 2

Time Group

1. Higher Grade + Higher Time

- Selected participants: Time Group
- Description: Most students performing with higher grades and higher time spent compared to the participant, including one student with similar time spent. (Figure 5.2)

2. Higher Grade + Lower Time

- Selected participants: Time Group
- Description: Most students performing with higher grades and lower time spent compared to the participant, including one student with similar time spent. (Figure C.2)

3. Same Grade + Higher Time

- Selected participants: Time Group
- Description: Most students performing with similar grades and higher time spent compared to the participant, including one student with lower time spent. (Figure C.3)

4. Similar Grade + Lower Time

- Selected participants: Time Group
- Description: Most students performing with similar grades and lower time spent compared to the participant, including one student with higher grade and time spent. (Figure C.4)

5. Lower Grade + Higher Time

- Selected participants: Time Group
- Description: Most students performing with lower grades and higher time spent compared to the participant, including one student with higher grade and lower time spent. (Figure C.5)

6. Lower Grade + Lower Time

- Selected participants: Time Group
- Description: Most students performing with lower grades and lower time spent compared to the participant, including one student with higher grades and lower time. (Figure C.6)

Ability Group

1. Higher Grade + Higher Ability

- Selected participants: Ability Group
- Description: Most students performing with higher grades and higher ability compared to the participant, including one student with the same ability. (Figure 5.3)

2. Higher Grade + Lower Ability

- Selected participants: Ability Group
- Description: Most students performing with higher grades and lower ability compared to the participant, including a student with the same ability. (Figure D.2)

3. Similar Grade + Higher Ability

- Selected participants: Ability Group
 - Description: Most students performing with similar grades and higher ability compared to the participant, including one student with a higher grade and a lower ability. (Figure D.3)
4. Similar Grade + Lower Ability
- Selected participants: Ability Group
 - Description: Most students performing with similar grades and lower ability compared to the participant, including one student with a higher grade and a higher ability. (Figure D.4)
5. Lower Grade + Higher Ability
- Selected participants: Ability Group
 - Description: Most students performing with lower grades and higher ability compared to the participant, including one student with a higher grade and a lower ability. (Figure D.5)
6. Lower Grade + Lower Ability
- Selected participants: Ability Group
 - Description: Most students performing with Lower grades and lower ability spent compared to the participant, including one student with a higher grade and a higher ability. (Figure D.6)

Step 3

1. Full Dashboard
- Selected participants: All participants
 - Description: Students with different grades, time spent on the assignment, and ability (Figure 5.4)

5.4 Questionnaires

All questionnaires were printed on paper and filled out by participants in the lab at the beginning of the study. The first questionnaire collected the demographic data of the participants, their general knowledge of charts, and their habit of using Canvas (Please refer to Appendix A).

The second questionnaire was Patterns of Adaptive Learning Scales (PALS) [20] to assess participants' achievement goal orientations. We used this questionnaire to learn more



Figure 5.1: Composite dashboard mockup showing only grades.



Figure 5.2: Composite dashboard mockup shown to participants in the 'Time Group' with peers performing with higher grades and higher time spent on the assignment. The other 5 alternatives of these dashboards are shown in the appendix C

Assignment 3

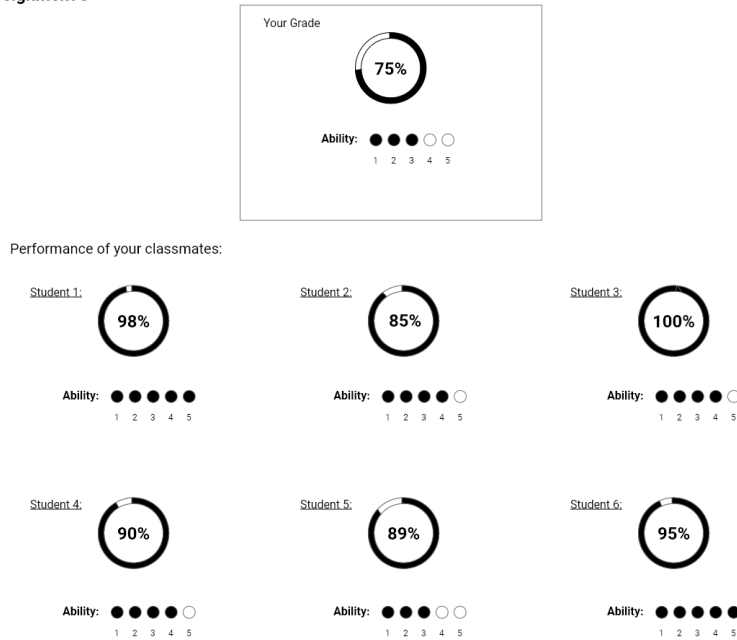


Figure 5.3: Composite dashboard mockup shown to participants in the 'Ability Group' with peers performing with higher grades and higher ability. The other 5 alternatives of these dashboards are shown in the appendix D

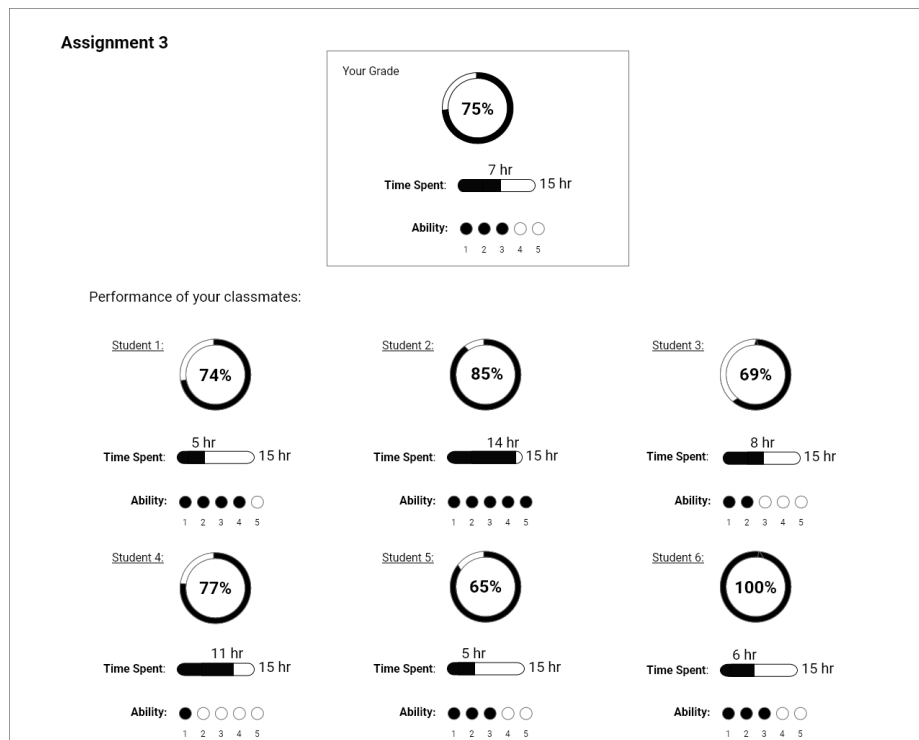


Figure 5.4: The final dashboard consisting of all elements shown to all participants.

about how students behave and their motives for participating in academic activities. 14 questions were grouped into three categories based on their orientation on Achievement Goal Theory: Mastery goal orientation, Performance-approach goal orientation, and Performance-avoid goal orientation. We used the 5-point Likert Scale method, 1 being equal to "Not at all true" and 5 being equal to "Very true". The inclusion of items that align with the Mastery goal orientation allowed us to assess students' desire to expand their knowledge base. This orientation emphasizes intrinsic motivation and personal growth, focusing on the acquisition of skills and understanding rather than external rewards or comparisons to others. Questions related to this orientation encompassed five questions, each designed to gauge the extent to which students demonstrated a Mastery goal orientation. For instance, one of the questions presented to participants was as follows: "It is of great importance to me that I acquire a substantial amount of new concepts throughout this academic year." The second part of the questionnaire consisting of 5 questions focused on understanding the level of Performance-approach goal orientation of students. Questions regarding this orientation focused on students' competitive behavior, their tendency to perform better than others and prove their competence. For instance, one of the questions asked in this category was: "One of my goals is to show others that I'm good at my class work". The next four questions in this questionnaire focused on demonstrating students' Performance-avoidance behavior. The goal of using these questions was to study learners' objectives to prevent them from showing signs of ineptitude in class. One of the questions in this category was: "It's important to me that I don't look stupid in class". The full PALS questionnaire used in our study can be found in Appendix B.

5.5 Interview

After participants filled out the questionnaires, the interview section started. At first, each participant was informed about the process of the think-aloud interview and that they would be asked to provide feedback on a few dashboard prototypes. The interview was audio and video recorded for further transcription of data. Next, they got familiar with the eye tracker in front of them and the process of calibration. After the calibration was successful, the participant was asked to imagine that they were taking a specific programming course in their major. They were informed that the data that was going to be shown to them showed their performance and some of their peers in the class. It was noted that the data was not real and all the names were anonymous.

First, we asked them a few questions about their habitual use of Canvas and following their progress in a course. Next, we introduced them to the eye tracker placed in front of them and familiarized them with the steps of calibration. After the calibration, we told the participant to imagine that they were taking one particular programming course in their department. We told them that they were going to see a dashboard on the monitor that

displayed their performance and some of their peers' performance in the class. In order to familiarize students with the study, first we showed them 5.1 that only showed them their grades and their peers' grades.

The participant was then informed that the next dashboard will include a new component. We introduced the "time spent on the assignment" component or the "ability" based on the group the participant belonged to ('Time Group' or 'Ability Group'). We explained that "time spent on the assignment" and "ability" were self-reported and self-assessed respectively. Showing the dashboards 5.2 and 5.3, to participants in the 'Time Group' and 'Ability Group' respectively, we asked how they think they are doing, why they think that way, with whom they compare themselves the most, how they feel about the information presented to them and their academic standing in the class, and how is their motivation affected. Furthermore, We showed six different configurations of these dashboards as explained in 4 and brought in the appendix.

Finally, we presented participants with the full dashboard 5.4 after displaying each of the six configurations of our dashboard in order. We informed the participants in the Time Group and the Ability Group know that the dashboard would include the ability and time components, respectively. Similar to our previous process, we asked similar questions about the participant's feelings, evaluation of their performance, motivation, and comparison to others.

In the end, we thanked the participant for participating in our research and let them know how they could contact us regarding any issues or questions.

5.6 Eye Tracker

In order to explore the pattern of changing attention of participants as they looked at different parts of the dashboard, we utilized an eye tracker in our study. We used the 'gazept' eye tracker ² in our study. The model of the eye tracker we utilized in the study was GP3SD V2, which is a screen-based eye tracker which had to be placed close to a computer screen.

The eye tracker used in the study comprised two software components. The first, named 'Gazept Control', facilitated the calibration process for the user. The second software, 'Gazept Analysis (The Standard Edition)', supported researchers in managing projects, storing user files, and collecting data. Once the data collection was complete, researchers had the option to export the gathered data in CSV format. Throughout the data collection, the software recorded the screen and logged the fixation sequences of the user on the screen. The sampling frequency of the eye tracker was 60HZ.

²<https://www.gazept.com>

5.7 Data Analysis

We used different methods of data analysis for the multi-channel data collected from the user study. Each method is explained in a subsection below.

5.7.1 Questionnaire Data Analysis

For questionnaires, we ran the data in R programming language and extracted three clusters based on their achievement goal orientation.

We performed a basic statistical analysis on the three sub-scales of PALS questionnaire (mastery, performance-approach, and performance-avoidance). We calculated Cronbach's alpha, which is a measure of internal consistency. It quantifies how well the items in the sub-scale are correlated with each other. Moreover, the reported mean values by [20] for mastery, performance-approach, and performance-avoidance goal orientations were 4.15, 2.46, and 2.40, respectively. Comparing the Mean value in our study to [20] showed that the mean for mastery goal orientation and performance-avoidance goal orientation enhanced. This means that in our research, students had more mastery and performance-avoidance goal orientation compared to [20]. The values are shown in Table 5.2

Table 5.2: Descriptive Statistics for Clusters

Subscale	Mean, SD
Mastery Subscale	4.25, 0.84
Performance-Approach Subscale	2.26, 1.15
Performance-Avoidance Subscale	3.02, 1.26

We employed hierarchical clustering to categorize students according to how similar their scores were on the three sub-scales of PALS questionnaires. Figure 5.5 shows the scatter plots of cluster members' distribution along the three sub-scales.

We have labeled and interpreted the clusters as follows:

Cluster 1: High Mastery – Low Performance-Avoidance: Participants in this cluster were positioned in the upper half of the mastery scale and bottom half of the performance-avoidance scale. They score in the bottom two-thirds of the performance approach scale. We expect these students to care about their ability to be successful on the assignment, while they would not be concerned with how their performance is viewed by their classmates or measured by their grades. The number of participants in this cluster was 19.

Cluster 2: High Mastery – High Performance-Avoidance: The majority of participants were at the high end of the mastery scale and at the high end of the performance-avoidance scale. They were evenly distributed along the performance-approach scale. Simi-

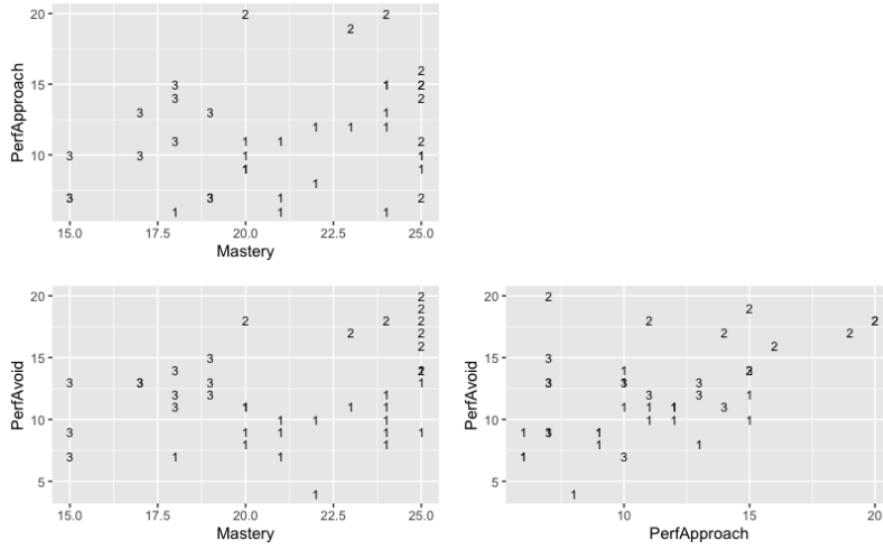


Figure 5.5: Scatter plots of cluster members' distribution along the three sub-scales

larly to the prior cluster, these students should care about their ability to be successful in the assignments. However, they are concerned about how their skills and performance are viewed by others. 9 students were in this cluster.

Cluster 3: Low Mastery - Low Performance-Approach - Middle Performance-Avoidance: The participants were distributed in the bottom half of the mastery scale and bottom half of the performance approach scale. They were distributed in the interquartile range for the performance-avoidance scale. This group of learners does not care about the level of their knowledge, and they do not put much weight on their performance being recognized by others. Their concern about being seen as incompetent is in the middle of the range. This cluster had 11 students.

5.7.2 Interview Data Analysis

The qualitative coding of interviews was done in NVivo³, a qualitative data analysis software. We coded the interviews from three perspectives based on our theoretical framework: attributions, emotions, and motivations. First, we transcribed the interview audio records using the Descript Audio Editing tool⁴. For each dashboard that was displayed to the participants, we identified themes relating to attributions, motivation, feelings, and social comparison. Additional themes were extracted that related to the research context or participant repetition of a statement. A part of the coding scheme can be seen below. The whole coding scheme can be found in the Appendix E.

³<https://lumivero.com/products/nvivo/>

⁴<https://www.descript.com/>

For the attributions, we categorized attributions into four main identified attributions by Weiner [32]. Each attribution consisted of statements that participants used for themselves to explain their results and performance. We have brought one example of each attribution in the list below.

- Attributions
 - Ability
 - * I am less smart or have fewer skills OR Others are smarter or have more skills
 - Effort
 - * I did not put enough effort
 - Luck
 - * I was lucky
 - Task and Teacher
 - * There was something wrong with the instructor of the course
 - Performance is influenced by various factors unique to each individual.

The emotions we used in our coding scheme were based on the achievement emotions taxonomy of Pekrun [25]. Pekrun identified two types of achievement emotions: Activity Emotions and Outcome Emotions. Since activity emotions are related to the experience a student has during an academic activity, we only considered outcome emotions for our analysis. Apart from the outcome emotions identified by Pekrun, we extracted additional feelings from some statements that students said during the interview.

- Feelings
 - Positive
 - * Assurance
 - * Pride
 - * Relief
 - Negative
 - * Confused
 - * Disappointed
 - * Upset
 - * Hopelessness
 - * Uncomfortable
 - * Dishonesty

- Neutral

Moving on to motivation, we saw that students found some dashboards demotivating and some just not motivating. The final themes with one example for each can be found below:

- Demotivating
 - Demotivating since I worked the hardest but got the lowest grade
- Motivating
 - Motivated to improve my performance by raising the time spent, working harder, or raising my ability
- Not Motivating
 - I keep doing what I'm doing since I feel it's enough

Other than the three main attributions in our analysis, we extracted more themes during the data analysis such as finding the dashboard overwhelming, task value (not considering a programming course really important), etc. The complete coding scheme is shown in Appendix E.

5.7.3 Eye Tracker Data Analysis

The eye tracker exported data was in a CSV format that consisted of several data records of the user. We wrote a Python program that took the users' gaze points (where the eyes are looking at). Based on the position of the gaze points and the position of the elements on the screen, we recorded which peer they were looking at along with the corresponding duration captured by the eye tracker.

For the first dashboard in each group (Fig 5.2 and Fig 5.3), we analyzed the sequence of students the participant was looking at and ran a descriptive quantitative data analysis to find a pattern among students. As Fig. 5.2 elicited the most comments, emotions, and participant motivation, we selected the first dashboard for both groups to analyze the eye-tracking data and compare the results.

We analyzed this data for the different parts of the interview. First, we asked the student to take some time and look at the dashboard after we showed them the prototype. Next, we looked at parts when we asked them who they compared themselves the most with. We explored relationships between different variables, grouping data by specific columns, and analyzing data differences using box plots and ANOVA.

Chapter 6

Results

In this section, we have brought the results of analyzing the multi-channel data that was collected in this user study. Each subsection analyzes the coded transcripts for one dashboard. Within 'Time Group' and 'Ability Group' each dashboard is analyzed for its participants and PALS clusters. Results of the questionnaire and the eye tracker are brought in the two next sections.

6.1 Results for Time Dashboards

6.1.1 Time Group - Dashboard 1: Higher Grades - Higher Time

Attribution: After seeing the first dashboard, 85% of participants in the 'Time Group' attributed their performance to the lack of effort. 20% of students explained their lower grades compared to other students because they were less smart or less skilled. Also, two students mentioned that they probably did not understand the requirements or the course material.

Emotions and Motivation: Regarding motivation, 75% of students were motivated to improve their performance by working harder or spending more time on the assignment. Moreover, 25% students mentioned that seeing the information on the dashboard helps them understand why they got this grade and how they could improve it. For instance, P18 said:

"I think this one [dashboard] is better than the last one cause I know how, uh, what I should do." - P18

However, 2 students were demotivated by the dashboard since everybody else was outperforming them and one student mentioned that they would not change anything and keep doing what they were doing. Moreover, 20% of students said they were disappointed and upset with the information showing on the dashboard.

Social Comparison: 80% of participants compared themselves with student 4, who had similar time spent to them and the lowest grade among all six students. Still, 3 students compared themselves with student 5 with the highest grade (100%). It is notable to mention

that 25% students said they do not like comparing and find it unnecessary to compare themselves with others.

High Mastery and Low Performance-Avoidance: Analysis of the questionnaires showed that all students in the first cluster of the PALS questionnaire, with high mastery and low-performance avoidance orientation, mentioned the lack of effort they put into the assignment. 25% also negatively attributed their overall performance to low ability. Moreover, 75% of the participants in this cluster were motivated to work harder and increase their effort for the next time.

High mastery and High Performance-Avoidance: 40% of the participants with high mastery and high-performance avoidance attributed their performance to incompetence and 80% of them mentioned that they might have not put enough effort into the assignment. What is more, negative feelings aroused in this group were notable. 60% of the students in this group felt disappointed or upset with their results. Results regarding their motivation were mixed as well. When participants saw everyone else performing better than they did, 20% became demotivated, whereas 80% felt inspired to work harder. 40% believed that the information about their performance was useful for them.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: Moving on to the third cluster, a majority of participants (71.4%) believed that they did not put sufficient effort into the assignment. In addition, 14.3% attributed their performance to a perception of not being smart, while another 14.3% acknowledged that they likely did not fully comprehend the assignment's requirements. The level of motivation was lower in this cluster. Only 57% participants with low mastery and performance-approach and middle performance-avoidance orientation were motivated to work to increase their effort. Among all participants, 14.3% expressed that they found the dashboard to be demotivating and another 14.3% indicated that they would maintain their current approach and not make any adjustments to their effort levels. Moreover, 14.3% were disappointed with their results.

6.1.2 Time Group - Dashboard 2: Higher Grades - Lower Time

Attribution: Spending more time but getting lower grades led to mostly negative reactions among participants. 40% of them mentioned that their poor performance was because of their lack of skills or other students being smarter than them. Moreover, 20% of participants felt that they did not understand the requirements or the course material. One student stated that their strategy must have been wrong in the assignment.

Emotions and Motivation: Most students felt demotivated seeing this dashboard. 55% said that they feel demotivated to improve their performance since they worked the hardest but they got the lowest grade. Only two students said that they are motivated to improve their performance. Due to spending more time than everybody, two students mentioned that they would keep doing what they were doing as it shows that they cannot improve more than this. For instance, P25 said:

"Maybe I will just not really want to work harder, because I think that I'm the one who work harder already, but I still got the lowest grade, so that makes no sense." - P25

One student mentioned that they have to spend their time more efficiently and one student believed that the information presented to them was useful and showed why they got this result.

Feelings towards this dashboard were mostly negative. 3 participants felt disappointed with their performance. One felt confused and one felt hopeless. One student felt neutral toward the dashboard.

Social Comparison: 40% of the participants compared themselves with student 4, who had the lowest time among all. Also, 40% of participants said that they compare themselves with student 5 who had similar time spent to them. 3 participants compared themselves with student 3, who had the highest grade (100%). Two students compared themselves with student 2, and one student said that they do not compare themselves with anybody.

High Mastery and Low Performance-Avoidance: Half of the participants with high mastery and low performance-avoidance approach negatively attributed their low performance to lack of ability (25% said they were less smart than other students and the other 25% said they did not understand the requirements). Additionally, 12.5% said that the strategy was probably wrong in this assignment. 12.5% of students were confused and disappointed to see their results on the dashboard. Regarding their motivation, 25% felt demotivated (because of their high amount of time spent and lowest grade) against the 12.5% that felt motivated to improve their performance.

High mastery and High Performance-Avoidance: All participants with the high mastery and high-performance avoidance orientation attributed their poorer performance compared to others due to lack of ability. 80% said that they are less smart than others and 40% said that they might have not understood the course material very well. Feelings towards their performance on the dashboard were negative as well, with 20% feeling disappointed and 20% feeling hopeless. 60% of this group felt demotivated due to getting the lowest grade against spending the most time. However, 20% were motivated to increase their effort to get a better result next time.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 42.9% of this cluster attributed their performance to ability, with 14.3% and 28.6% assuming that they did not understand the requirements and they are less smart than others respectively. Additionally, 14% felt disappointed seeing their results on the dashboard. It is notable that all participants in this cluster expressed their lack of motivation. 85.7% said that they feel demotivated as they have the lowest grade and the most amount of time spent on the assignment and 14.3% said that they cannot improve more than this anymore.

6.1.3 Time Group - Dashboard 3: Similar Grades - Higher Time

Attribution: Students offered diverse explanations for their results when seeing other students having similar grades yet spent higher time spent compared to them. 3 participants said that the assignment has been probably difficult since everybody spent lots of time but the grades are similar. One student felt that they have spent enough time on the assignment whereas another student felt they spent less time compared to others. Moreover, one student stated that there must have been something wrong with the instructor of the course that students with a high amount of time spent, performed average. Two students mentioned that the dashboard shows that spending time and working hard leads to better performance.

Emotions and Motivation: Similarity to other students made them comfortable with their performance and not want to go above and beyond. Half of the students said that they would keep doing what they were doing and would not change their approach or work harder. 20% of the students said that they are motivated to improve their performance by putting in more effort. Additionally, 20% said they cannot improve more than this. For instance P3 said:

"Some students are still doing less and with a same grade. Mm-hmm. . So yeah, it's like, um, it's just get me to the point that like, even if I study more or less, probably we all get the same grade together." -P03

Given that everyone was performing the same, it was interesting to see one student express their motivation while another felt demotivated as a result. In addition, one student mentioned that they do not feel that they need to know about others' performance. Regarding the emotions expressed via seeing this dashboard, 35% of the participants felt proud and good about themselves. Two students felt neutral. One student felt relieved with the results and one student felt disappointed.

Social Comparison: Participants selected different students in this dashboard to compare themselves against, much like when making attributions. Most of the participants (35%) compared themselves with student 2, who had the exact same grade and lower time spent in comparison to the student. 20% of participants favored making the comparison to Student 1, who spent the same amount of time (7 hours) as the participant. 3 students compared themselves with student 5, who had the highest grade among all. Only one student compared themselves with student 4. It is interesting to note that 3 participants claimed they did not compare themselves to others because everybody was similar.

High Mastery and Low Performance-Avoidance: Participants in this cluster did not have any significant explanations regarding their effort or ability towards the dashboard. However, 25% said that the assignment was probably difficult (task difficulty dimension) and 12.5% said that the instructor was probably the issue. 37.5% and 12.5% of this cluster felt proud and disappointed, respectively. 12.5% of participants felt neutral seeing their

results alongside others. 50% of the participants in this cluster felt demotivated and said they cannot improve more than this. Moreover, 50% said that they will keep doing the same. 12.5% felt motivated to improve and 12.5% said they did not need to know about other students' performance.

High Mastery and High Performance-Avoidance: 20% of participants with high mastery and high-performance avoidance said they did not put enough effort and 20% said the assignment was probably very difficult. 40% of this group felt proud, showing positive emotions with their results. 40% said that they would continue doing what they were doing without changing anything. What is more, 20% said they feel motivated and another 20% of the cluster felt demotivated since everyone was similar.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 20% of participants with low mastery and high performance-approach and middle performance-avoidance showed their appreciation of effort towards the dashboard, saying that working harder would lead to better performance. Their feelings were mostly positive, with 28.6% feeling proud and 14.3% feeling relieved. 42.9% said that they were motivated to increase their effort and 57.1% said they would keep doing the same.

6.1.4 Time Group - Dashboard 4: Similar Grades - Lower Time

Attribution: Since other students spent less time but got similar or higher grades, 50% of participants attributed their performance to having lower programming skills or being less smart. Moreover, one student said that perhaps they did not understand the course material. Still, 25% of the participants showed appreciation for effort, saying that working hard can lead to better performance. 3 students attributed their poor performance to lack of time spent and one student said that there are different factors involved for each person that affects performance.

Emotions and Motivation: 30% of participants were motivated to improve their performance. It is noteworthy to say that mostly seeing student 2 - the outlier student with a significantly higher time and a higher grade - made them feel like that. For instance, P12 mentioned:

"If I look at student number two, it makes me feel a bit motivated. Maybe if I put more effort, more time, I might get a higher grade." - P12

Additionally, 30% felt not motivated since everybody was similar. 3 students said they would keep doing what they were doing and not change their approach, and one student felt demotivated as they felt they could not improve more than this. Regarding the emotions shown towards this dashboard, 25% of students felt neutral. Moreover, one student felt confused with the results.

Social Comparison: 50% of participants chose student 2 (who was the outlier, with a 90% mark and 11 hours of time spent) to compare themselves to. 30% of participants compared themselves with student 3, who had the lowest time spent. 20% of students compared

themselves with student 1, because of the overall similarity they saw between each other. Moreover, two students picked student 4, who spent the same amount of hours as them, for comparison. Finally, one student made a comparison between themselves and student 5, while another student compared themselves to student 6.

High Mastery and Low Performance-Avoidance: 50% of participants with high mastery and low-performance avoidance attributed their performance to lack of ability, with 37.5% feeling not smart and 12.5% assuming that they did not understand the assignment's requirements. 25% said that they did not put enough time, while 12.5% said they spent enough time on the assignment. 12.5% of participants in this cluster also said that they feel neutral. It is worth mentioning that 50% of the participants expressed feeling motivated to enhance their performance, while 12.5% admitted feeling demotivated to improve and strive for better results.

High mastery and High Performance-Avoidance: Moving on to participants with a high mastery and high performance-avoidance, 40% of participants in this cluster felt they were less smart in comparison to other students shown on the dashboard. In addition, 20% of participants showed effort and appreciation towards the information presented, feeling that working might lead to better results in the future. What is more, 20% felt neutral after seeing the data. Regarding the feeling of motivation, 40% felt demotivated since everybody shown on the dashboard was the same. 20% said they would continue doing what they were doing, and the other 20% said they were motivated to improve their performance.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: Majority of students in this cluster (71.4%) felt less smart compared to other students shown on the dashboard. Additionally, 14.3% said that they did not put enough effort into the assignment. 28.6% showed appreciation of effort towards the data, feeling that if they work harder they can get a better result. 42.9% felt neutral when asked about their feelings and emotions. 28.6% and 14.3% felt demotivated and motivated respectively. Students who felt demotivated said that they feel this way since everybody is performing similarly. Finally, 28.6% mentioned that they keep doing what they were doing.

6.1.5 Time Group - Dashboard 5: Lower Grades - Higher Time

Attribution: Seeing their spending much more time and getting higher grades made 25% of participants in the 'Time Group' to feel they were smarter or have more programming skills compared to others. Moreover, 3 students said that they probably understood the course material well and 2 said that working hard leads to better performance. However, since everybody spent a lot of time but got lower grades, 3 participants assumed that the course is hard itself. For the same reason, one student blamed the instructor for the results and thought they were lucky. P23 said:

"Some shortcoming in the professor's technique is happening, and I'm only ahead now, but I'm only ahead by a little. Only about 10%, 15%. So I'd be worried that I might get caught behind as well. If this continues like this. Maybe I just got lucky." - P23

Emotions and Motivation: Seeing their results, 45% of participants said that they would keep doing what they were doing. 25% said that they did not feel motivated as they were performing better than everybody. Additionally, 20% said they were motivated to continue doing better next time. One student said that they could not improve more than this. The students had diverse opinions and emotions about this dashboard. 25% felt proud of their performance, one student felt confused, another student felt disappointed, one student felt relieved, one student felt upset, and one student felt neutral.

Social Comparison: 75% of participants compared themselves with student 5 (the outlier), who had a slightly better grade and lower time spent compared to the student. This student had an overall similarity to the student and had the highest mark among all. 3 students compared themselves with student 6, who got the lowest grade. Two and one participants chose student 4 and student 1 respectively, for comparison.

High Mastery and Low Performance-Avoidance: 12.5% participants in this cluster felt they were smarter than others. 25% felt the assignment must have been difficult, 12.5% felt they got lucky or the professor was the issue there. Regarding emotions, 25% of the cluster showed negative feelings (12.5% confused and 12.5% disappointed). Moreover, 37.5% had positive feelings, with 25% being proud and 12.5% feeling relieved. What is more, 37.5% felt demotivated and 25% felt motivated to improve their performance. Moreover, another 37.5% said they would keep doing what they were doing in the course.

High mastery and High Performance-Avoidance: 40% of students with high mastery and high performance-avoidance attributed their performance to high ability and skills: 20% of participants said that they felt smarter than others and other 20% said that they had understood the course material pretty well. 20% stated that the assignment must have been difficult. 40% felt did not feel motivated since they were better than everybody. 40% said that they could continue doing what they were doing. Still, 40% felt motivated to do better and raise their performance.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 42.9% of participants with low mastery and performance-approach and middle performance-avoidance felt that they were smarter than other students. Moreover, 28.57% of participants said that they must have understood the course material very well. 28.6% showed appreciation of effort towards the dashboard, saying that if they work harder, they might get a better grade. With 42.9% feeling proud, this cluster had the most positive feelings towards the dashboard. Additionally, 14.3% felt upset and 14.3% felt neutral. 57.1% mentioned that they would keep doing what they were doing, while 14.3% did not feel motivated since they were better than everyone.

6.1.6 Time Group - Dashboard 6: Lower Grades - Lower Time

Attribution: A significant portion of the participants, specifically 45%, provided a consistent explanation for the data presented in the dashboard. They attributed the lower grades of other students to the fact that they had spent less time. What is more, 40% of the participants said that they have put enough time into the assignment. 25% also showed appreciation towards effort, stating that working hard can lead to better performance. Two students positively attributed their performance to ability, assuming that they understood the course material pretty well. It was interesting that one student felt they got lucky as all their peers were performing lower than them:

"I think I'm doing well for the moment, but again, it's sort of, uh, concerning how low everyone else is getting. Maybe everyone else is missing something or maybe I just got lucky and I'm like, don't like when that happens." - P23

Emotions and Motivation: 25% of students said they still would like to improve themselves and increase their grades, after seeing their information presented in the dashboard. 3 students said they would keep doing what they were doing and not change anything about their approach. 2 students mentioned that the dashboard is more validating rather than motivating. For instance P07 said:

"Perhaps less useful in a sense that I know the work I'm doing is paying off, I guess, so it's, it's more validating than motivating." - P07

One student said they were motivated since they were outperforming everyone, whereas another student who did not feel motivated as they were better than everyone. Emotions towards the dashboard were mostly neutral. After viewing the dashboard, 35% of the participants expressed a neutral response, indicating that they did not have strong positive or negative emotions. Additionally, 3 students felt a sense of pride in their performance, while 2 students felt reassured and found the dashboard to be validated in their efforts.

Social Comparison: Majority of participants compared themselves with student 3, who was the outlier and had the closest performance to the student. 2 students compared themselves with student 1, who had the lowest time among all. 2 students did not compare themselves with anybody and 1 student chose student 4 for comparison.

High Mastery and Low Performance-Avoidance: Participants in this cluster mostly considered their effort as an effective factor in their performance. 12.5% said that they probably got lucky. Regarding the expressed emotions, 37.5% felt neutral and 12.5% felt proud seeing their results. What is more, 25% felt motivated to work harder and get better grades, and 12.5% felt motivated as they were doing the best among all peers (37.5% feeling motivated in total). However, 12.5% felt demotivated since they were better than everyone.

High mastery and High Performance-Avoidance: Similar to the previous cluster, Students with high mastery and high performance-avoidance said that they put in enough time. 40% said that they put in enough effort and 40% mentioned that the dashboard

shows that working hard leads to a better performance. Emotions were mostly positive as well. While 40% felt neutral, another 40% felt proud of their results, and 20% felt relieved. 80% did not feel motivated seeing this dashboard. 40% said that they would keep doing what they were doing, and 40% said that the dashboard is not motivating, but validating.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 42.9% of participants with low mastery and performance-approach and middle performance-avoidance orientation, mentioned that they put enough effort into the assignment. 57.1% appreciated the role of effort, saying that the dashboard shows that working hard leads to better performance. Moreover, 28.6% and 14.3% felt proud, respectively. 42.9% felt motivated to increase their effort and work harder in the future, while 14.3% said they continue doing what they were doing.

6.1.7 Full Dashboard - Time Group

Attribution: 20% participants in the 'Time Group' said that the dashboard shows working hard leads to a better performance after seeing the full-dashboard. Three participants said that there are different factors involved for one student and three students mentioned they see a correlation between students' confidence and their ability rating. Moreover, two students said they feel less smart and one said that they did not understand the material pretty well. Pointing at student 4, two students attributed this student's better performance to their effort.

Emotions and Motivation: Three participants were confused and three participants were neutral after seeing the full-dashboard. For instance P25 said:

"It got me confused because looking at student 4, the student did not have very much knowledge but still spent a really long time finishing the assignment compared to student 6, it's like the same ability but spend less hour and get 100%. So I get confused and I don't get the point of the assignment, so yeah. with that ability and time spent why they get higher grade and people who are hard working and have a good ability." - P25

Two participants mentioned other students' dishonesty in reporting either time spent or ability, one felt disappointed and one felt relieved.

Regarding motivation, 25% said the information shown is useful for them and 20% felt motivated to improve their performance. For instance, P03 said:

"So with my ability, like three only, um, I should probably work more on it so I can have like a more efficient skill compared to others. By spending more time on it my grade can be better." - P03

Two students were demotivated and felt they cannot improve more than this. One student felt demotivated since they worked hard and did not get a good grade, and one student did not find the dashboard motivating because of their low ability. One student felt motivated to ask others about their strategies and methods and two students felt they did not need to know about others' performance.

Social Comparison: 40% of students compared themselves with student 6 who had the highest grade. 20% of students compared themselves with student 2 and 20% compared with student 1. Moreover, three students picked student 5 for comparison and two students picked student 4. In addition, one student said they did not like comparing.

High Mastery and Low Performance-Avoidance: 25% of participants found a relation between ability and confidence and 12.5% appreciated the role of effort. 62.5% said their performance is average. 25% felt confused, 12.5% felt disappointed and 12.5% felt others were dishonest. 12.5% felt neutral and another 12.5% felt relieved.

25% of the participants in this cluster did not feel motivated, with 12.5% saying they got a low grade compared to their reported ability and 12.5% saying their ability is low compared to others. Still, 12.5% felt motivated to increase their effort. 12.5% said they did not need to know about their peers' performance and 12.5% found the dashboard useful.

High Mastery and High Performance-Avoidance: 20% of participants with high mastery and high performance-avoidance achievement goal orientation said they were less smart than others. 60% appreciated the role of effort, saying that if they put in more time they can get a better grade. 20% said there are different factors involved for each student. It is noteworthy to mention that all students in this cluster felt their performance was average.

20% said they cannot improve more than this, feeling demotivated. 40% said they are motivated (20% wanting to improve their effort and 20% feeling this way as they felt others were similar to them). Moreover, 40% found the full-dashboard useful.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: Participants in this cluster attributed their performance to a wide range of factors. 14.3% said they did not understand the assignment, 14.3% said they were less smart, and 14.3% found a correlation between individuals' confidence and their ability rating. Moreover, 28.6% of participants appreciated the role of effort after seeing the dashboard. 28.6% said there are different factors involved for each student. Remarkably, 28.6% evaluated their performance as 'good' and 57.14% said their performance was average.

With 28.6% expressing negative feelings, 14.3% felt confused and 14.3% mentioned others' dishonesty. 28.6% felt neutral. What is more, 14.3% felt demotivated, saying they cannot improve anymore. 28.6% found the information useful and 28.6% said they were motivated.

6.1.8 Summary of Time Dashboards for Goal Orientation Clusters

Fig 6.1 shows the summative results for each type of coded attribution made by participants, i.e. attribution to the low ability, insufficient effort, luck and task difficulty. The results are shown for each cluster separately, comparing seven dashboards. Cluster 1, with high mastery and low performance-avoidance goal orientation, and cluster 2 with high mastery and high performance-avoidance, mostly attributed their performance to their effort after viewing dashboard 1 and dashboard 6 (Fig. C.1 and Fig. C.6). After viewing dashboards that their peers were performing the same or better with a significantly lower time (Fig. C.2 and

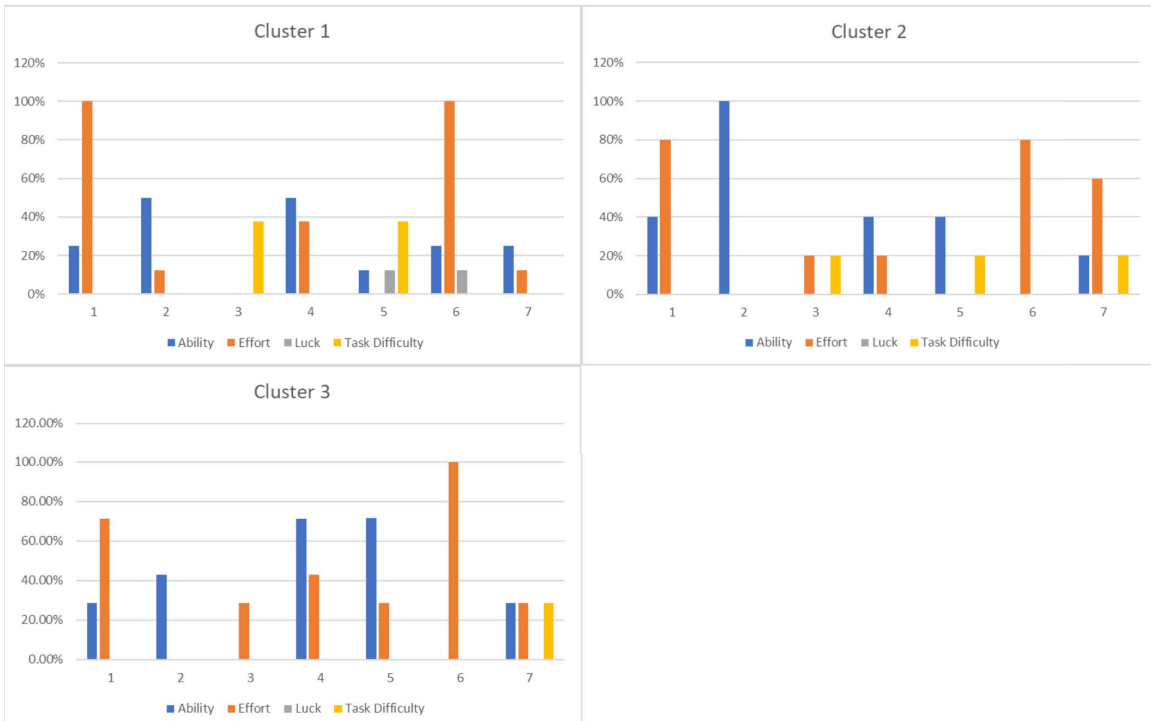


Figure 6.1: Attribution charts for three clusters (Cluster 1: High Mastery and Low Performance-Avoidance, Cluster 2: High Mastery and High Performance-Avoidance, Cluster 3: Low Mastery and Low Performance-Approach and Middle Performance-Avoidance) after viewing the Time dashboards. Horizontal axes show Time dashboards 1-6, with dashboard 7 being the full dashboard.

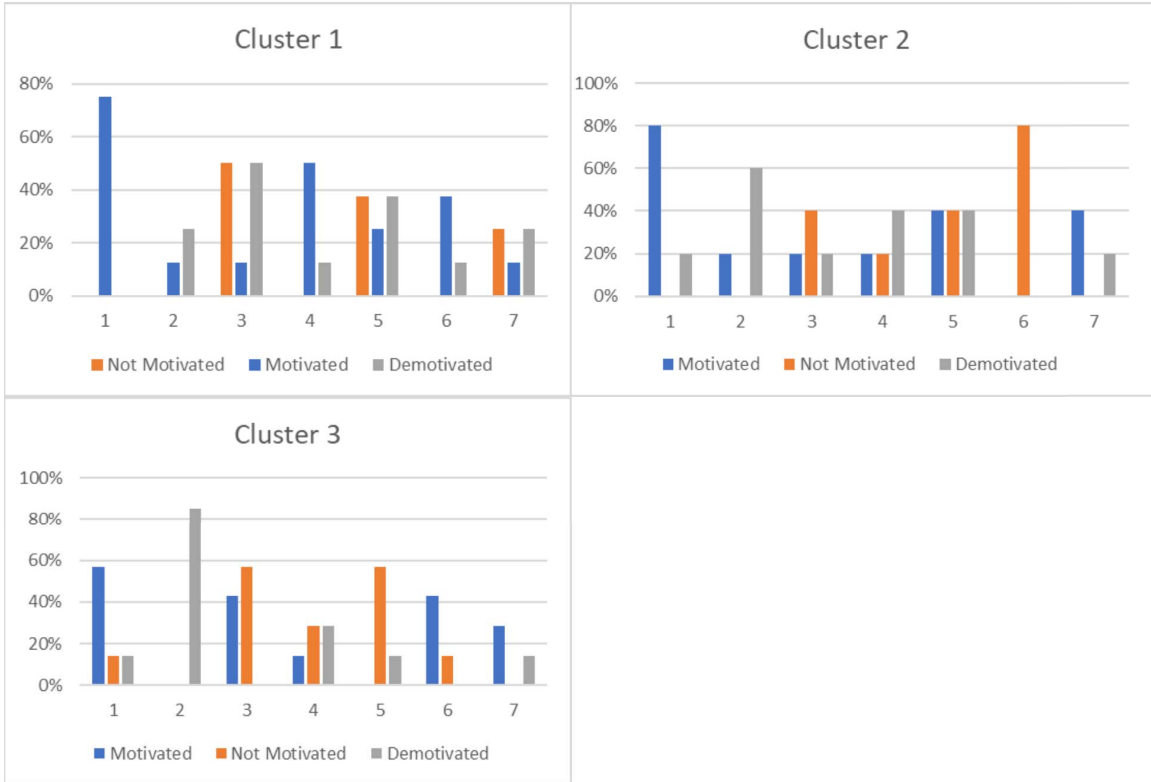


Figure 6.2: Motivation charts for three clusters (Cluster 1: High Mastery and Low Performance-Avoidance, Cluster 2: High Mastery and High Performance-Avoidance, Cluster 3: Low Mastery and Low Performance-Approach and Middle Performance-Avoidance) after viewing the Time dashboards. Horizontal axes show Time dashboards 1-6, with dashboard 7 being the full dashboard.

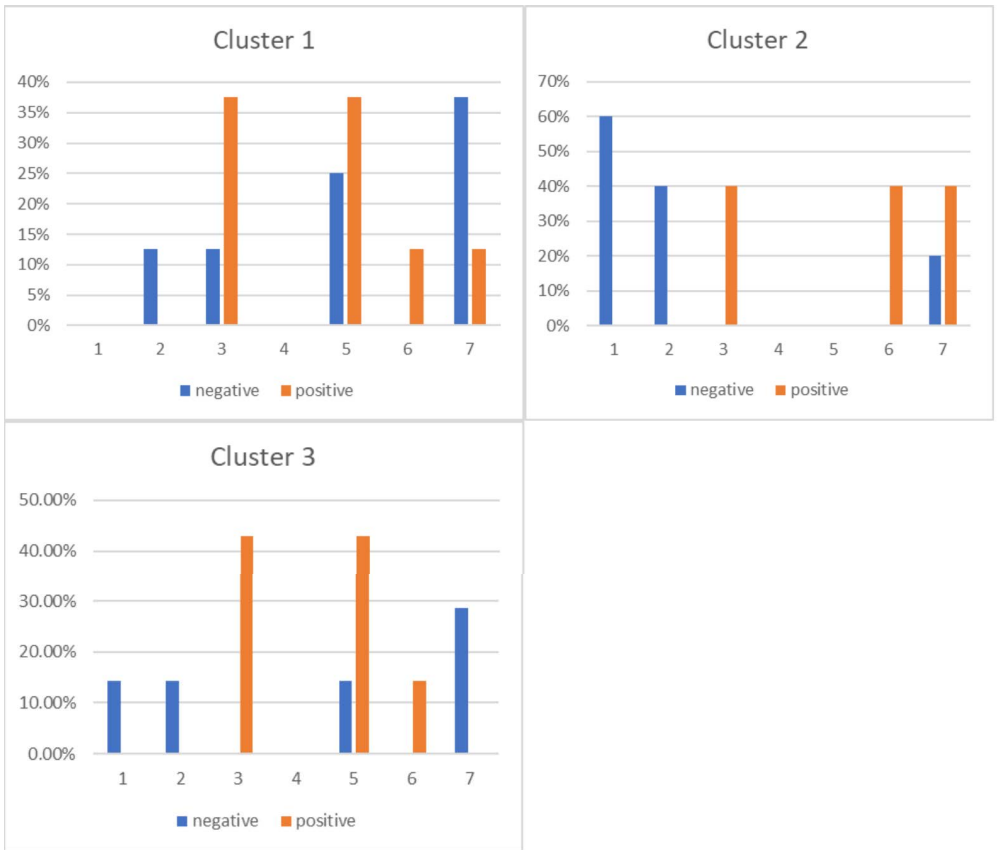


Figure 6.3: Emotion charts for three clusters (Cluster 1: High Mastery and Low Performance-Avoidance, Cluster 2: High Mastery and High Performance-Avoidance, Cluster 3: Low Mastery and Low Performance-Approach and Middle Performance-Avoidance) after viewing the Time dashboards. Horizontal axes show Time dashboards 1-6, with dashboard 7 being the full dashboard.

Fig. C.4), cluster 1 attributed their performance to lack of ability. Participants in cluster 2 as well, significantly attributed their performance to the lack of ability, after viewing dashboard 2 (Fig. C.2). On the other hand, participants in the third cluster attributed their performance to effort positively, after viewing dashboard 6 (Fig. C.6), with their peers significantly doing worse. It is notable that all students in the 'Time Group' attributed their performance to effort much less after seeing the full dashboard (Fig. 5.4), in which the ability element was added.

As it can be seen in Fig. 6.2, the first cluster with high mastery and low performance-avoidance, was motivated the most by the first dashboard (Fig. C.1). In addition, this cluster expressed their lower motivation after viewing the third dashboard, with other students having similar grades and higher time spent (Fig. C.3). Similar to the first cluster, students in the second cluster with high mastery and high performance-avoidance goal orientation were motivated the most by the first dashboard (Fig. C.1), in which their peers had higher grades and higher time spent. They also felt demotivated the most, after viewing the second dashboard (fig. C.2), in which other students performed significantly better with a lower time spent. The first dashboard (Fig. C.1) was the most motivating dashboard for the third cluster, with low mastery, low performance-approach, and middle performance-avoidance goal orientation as well. Also, the second dashboard (Fig. C.2) was the most demotivating for this cluster.

It is noteworthy to mention that while the second dashboard (Fig. C.2) was highly demotivating for the second and third clusters in Fig. 6.2, the first cluster was demotivated the most by the third and fifth dashboards (Fig. C.3 and C.5). Hence, students in the second cluster and the third cluster with high or middle performance-avoidance felt significantly demotivated when seeing others outperform them with much lower effort. However, students with high mastery and low performance-avoidance (cluster 1), were demotivated the most when they saw other students were spending higher time, but getting lower grades than them. This situation put students in a position where they felt there must be something wrong that not all students are performing well, with the amount of time they are spending. One possible explanation for this can be that they were afraid the same would happen to them.

Additionally, students in cluster 1 and cluster 2, with high mastery goal orientation, were motivated to increase their effort after viewing the first dashboard (Fig. C.1), in which other students had higher grades and higher time. Cluster 3 in Fig. 6.2 was motivated the most by the first dashboard as well, but not as much as the other two clusters. It is notable that the next dashboards that motivated cluster 3 the most were dashboards 3 and 6 (Fig. C.3 and Fig. C.6), in which their peers were performing worst than them generally. Hence, students with high mastery showed significantly higher motivation when seeing their peers spending more time and getting better grades, while this level of motivation was lower for students with low mastery. In addition, students with low mastery and middle performance-

avoidance felt motivated by seeing others performing much lower and spending significantly lower time.

Regarding the emotions expressed, students in the second cluster showed the most negative emotions after seeing the first dashboard, while the first and the third cluster did not. Students in all clusters showed positive emotions after seeing the third dashboard. The results can be seen in Fig. 6.3.

6.2 Results for Ability Dashboard

6.2.1 Ability Group - Dashboard 1: Higher Grades + Higher Ability

Attribution: 21% of participants in the 'Ability Group' related the good performance of other students to their higher abilities. For instance P30 said:

"I think that my performance was weak, but just comparing my ability to, the other students' ability, their average ability percentage was higher than me. So it's hard to say, I don't have to expect a lot from myself to have a great performance in this course." - P30

Furthermore, three interviewees noted their lack of smartness or the high ability and skills of other classmates. For instance P9 mentioned:

"I think they are good at programming and they, they get higher scores." - P09

3 participants related the ability to one's confidence, meaning that usually participants with higher confidence rate their ability higher. Moreover, 2 students mentioned their lack of effort in this assignment and one student noted that there are different factors involved for each person that affects performance.

Emotions and Motivation: Regarding the emotions aroused during the interview, 2 participants felt upset, one felt uncomfortable, and another felt relieved. For instance P27 mentioned:

"I would be pretty relieved as long as I am not doing worse than that or failing. Yeah. Um, this overall grade is not as bad as I, I would've hoped" - P27

Additionally, 2 students said that they feel neutral.

It is noteworthy to note that 42% of participants felt motivated to improve their performance next time and one person was motivated to ask other people or the instructor about their methods or change of strategy. Still, 36% did not feel motivated at all. 3 students felt demotivated because of their lower ability, and 2 students said they probably cannot improve more than this. Additionally, 2 students felt demotivated since everybody was outperforming them.

Social Comparison: Majority of participants (73%) compared themselves with student 5, who had similar ability to them (Grade: 89% - Ability: 3 out of 5). Three and two participants compared themselves to student 1 and student 6, respectively. One participant chose Student 2, another participant chose Student 3, and a third participant chose Student

4 for the purpose of comparison. Furthermore, one participant mentioned that they did not like comparing.

High Mastery and Low Performance-Avoidance: 27.3% of participants in the high mastery and low performance-avoidance cluster mentioned that other students' high ability had led them to have higher results. 18.2% participants in this cluster attributed their performance to lack of smartness or others being highly smart. Moreover, 9.1% felt a relation between ability and effort. 9.1% said that they did not put enough effort and another 9.1% said various factors can be involved in one's performance.

Regarding feelings, 9.1% felt upset, 9.1% felt relieved, and 18.2% felt neutral. Moreover, 27.3% of the participants mentioned feeling demotivated. Another 9.1% expressed a sense of inferiority, believing that everyone else was better than them, while an equal percentage mentioned a perceived inability to improve due to their low skills. On the other hand, the majority, accounting for 45.5%, reported feeling motivated and determined to increase their efforts.

High mastery and High Performance-Avoidance: 25% of students with high-mastery and high-performance avoidance orientation mentioned being less smart than other students. Another 25% also mentioned the relation between ability and confidence. Moreover, 25% said they did not put in enough effort. 50% in this cluster felt motivated to increase their performance while 25% said that they felt demotivated because of their low ability. Moreover, 25% felt upset looking at the dashboard.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 25% of participants in this cluster attributed the good results of others to their higher ability, and another 25% felt a connection between confidence and ability. It is noteworthy to say that 75% of this cluster felt demotivated after seeing this dashboard, with 25% feeling they cannot improve anymore, 25% feeling not motivated because of others outperforming them, and another 25% feeling demotivated because of their low ability. Only 2% in this cluster felt motivated.

6.2.2 Ability Group - Dashboard 2: Higher Grades + Lower Ability

Attribution: 26% of participants felt that they did not put enough effort into the assignment, after seeing the information presented on the dashboard. Two participants mentioned the relationship between ability and confidence. One participant said that they did not understand the assignment requirements or the course material. One student attributed their performance to a lack of ability. One participant said their strategy was wrong and another appreciated the role of effort.

Emotions and Motivation: Most participants expressed their negative feelings towards this dashboard. 3 felt confused, 2 felt disappointed, 2 felt hopeless, and 2 felt upset. Moreover, 2 students mentioned that they felt neutral.

Regarding motivation, 26% of participants said that they feel motivated to improve their performance by raising their time spent, working harder, or raising their ability. Moreover, two students felt motivated to ask other people or the teacher about their methods. Two students felt demotivated because of their low ability and one student was demotivated to see that others outperformed them.

Social Comparison: 52% of participants compared themselves with student 5, who had a similar ability to them. 21% said they would not compare themselves with anyone specific and one student said they do not like comparing. Another 21% compared themselves with student 1, with a 95% grade and 1 out of 5 ability rating. Moreover, 3 students compared themselves with student 2, two students compared themselves with student 6, and one student compared themselves with student 3.

High Mastery and Low Performance-Avoidance: 18.2% of participants in this cluster attributed their bad performance to their low ability, with 9.1% saying they did not understand the requirements and 9.1% saying they feel less smart. 27.3% said they did not put enough effort into the assignment, 9.1% said their strategy was wrong, and 9.1% said that working hard would lead to better performance. Feelings expressed were mostly negative (35.5% negative). 9.1% felt confused, 18.2% felt disappointed, 18.2% felt upset, and 9.1% felt hopeless. Regarding motivation, 36.4% of participants in this group felt motivated to perform better next time, with 18.2% seeking help and 18.2% wanting to increase their effort. 9.1% were demotivated because of their low ability.

High mastery and High Performance-Avoidance: 25% of participants with a high mastery and high performance-avoidance orientation said they did not put enough effort. In addition, 25% felt confused looking at the data. It is noteworthy to mention that 75% of this cluster expressed their positive motivation.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 25% of participants with this orientation mentioned the relation between confidence and ability. Moreover, 25% said they did not put enough effort into the assignment. 50% of feelings were negative after viewing the dashboard, with 25% feeling confused and 25% feeling hopeless and less confident. With 25% feeling demotivated because of their low ability and another 25% feeling demotivated because they got low grades but had high ability, 50% expressed their decrease in motivation towards the dashboard.

6.2.3 Ability Group - Dashboard 3: Same Grade + Higher Ability

Attribution: After participants were shown the third dashboard with other students performing with similar grades and higher ability, 3 participants mentioned the relation they found between confidence and ability. Two participants assumed that the assignment was hard itself. Moreover, two participants appreciated the role of effort, saying that the dashboard shows them that working hard leads to better performance. One participant attributed their performance to a lack of effort.

Emotions and Motivation: 26.3% were motivated to improve their performance after seeing this dashboard. 3 participants said they would keep doing what they were doing and 3 participants said they did not find the dashboard motivating since everybody was performing the same. One participant was motivated to ask other students or the teacher about their strategy, one student felt they cannot improve more than this, and another student said they do not feel that they need to know about others' performance.

36.8% of participants mentioned they feel proud seeing this dashboard. For instance P34 said:

"I feel pretty good about myself because like seeing that I have lower ability but still able to get the same grades as student two." - P34

One student felt relieved and one student felt neutral.

Social Comparison: Most participants (42.1%) compared themselves with student 2, who had the exact same grade (75%) and a higher ability (5 out of 5). Moreover, 31.5% chose student 6, the outlier with higher grades and lower ability, for comparison. 26.3% of participants chose student 3, who had the same ability rate compared to the participant. In addition, student 5 was picked by 3 participants. Two students mentioned that they do not pick anyone for comparison. One participant compared themselves with student 1 and another compared themselves with student 4.

High Mastery and Low Performance-Avoidance: 9.1% of participants with high mastery and low performance-avoidance orientation mentioned the relation between ability and confidence. Another 9.1% appreciated the role of effort and said the dashboard shows that working hard leads to better performance. 18.2% of students said the task was hard. Regarding emotions, 18.2% of participants felt proud, 9.1% felt relieved, and 9.1% felt neutral. In addition, 27% felt demotivated since everybody was the same, and 27.3% were motivated to increase their effort. 9.1% said they do not need to see their peers' performance and 9.1% said they would continue doing the same.

High mastery and High Performance-Avoidance: 25% of participants in this cluster stated the relation they found between confidence and effort. Moreover, 25% appreciated the role of effort. 25% felt proud and good about themselves, seeing their results on the dashboard. 25% said they were motivated to increase their effort, 25% said they were not motivated at all and could not improve more than this, and another 25% said they would keep doing what they were doing.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 25% of participants with low mastery and performance-approach and middle performance-avoidance mentioned the relation between ability and confidence and another 25% appreciated the role of effort. Half of the participants in this cluster felt proud seeing the information on the dashboard. 50% were motivated, with 25% wanting to seek help and another 25% wanting to increase their effort. Moreover, 25% said they would keep doing what they were doing.

6.2.4 Ability Group - Dashboard 4: Same Grade + Lower Ability

Attribution: 3 participants appreciated the role of effort after seeing this dashboard. For instance P35 said:

"cause even the person who has lower ability than me has similar or the same grades as me. So that like proves that with my skill, I can, like, if I just put more effort on it, I can get like better grades." - P35

Two students mentioned the relation between confidence and ability, one student said they must have not understood the material well, and another student attributed their performance to a lack of ability and smartness. Additionally, One participant attributed the better performance of the outlier student (Student 3) to their higher ability.

Emotions and Motivation: 36.8% of participants felt motivated after seeing the dashboard. 3 of these participants said they were motivated to improve their performance, 2 of the said they were motivated to ask the teacher or other students about their strategy, and two students felt motivated because of their higher ability compared to others. In addition, one student found the dashboard validating rather than motivating and another student mentioned they don't feel that they need to know about other students' performance.

Regarding the expressed emotions, 3 students said they feel neutral, one student felt relieved and another student felt assured by their performance on the dashboard.

Social Comparison: 42.1% of participants compared themselves with student 3, the outlier, who had a higher grade and higher ability compared to the participant. What is more, 36.8% of participants compared themselves with student 4, who had a similar ability (3 out of 5) to the participant. 4 participants chose student 1, the student with the same grade as the participant. Two and one students picked student 6 and student 2, respectively. Moreover, one student compared themselves with student 5 and another student said they compare themselves with no one specific.

High Mastery and Low Performance-Avoidance: 9.1% participants with high mastery and low performance-avoidance said that higher ability can lead to better performance, based on the data shown on the dashboard. 18.2% of participants appreciated the role of effort and mentioned that hard work can lead to better results. 18.2% of participants felt neutral, while 1 another 18.2% showed positive emotions (9.1% felt relieved and 9.1% felt proud). What is more, 36.4% of participants felt motivated, with 9.1% wanting to seek help, 18.2% aiming to increase their effort, and 9.1% feeling motivated because of their high ability. Additionally, 9.1% mentioned that the dashboard is more validating rather than motivating.

High mastery and High Performance-Avoidance: After participants with the high mastery and high performance-avoidance goal orientation saw the dashboard, 50% of them mentioned the relation between ability and confidence. Moreover, 25% of them appreciated the role of effort. 25% of this cluster said they were motivated because of their high ability.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 50% of participants with low mastery and performance-approach and middle performance-avoidance attributed their performance to lack of ability, with 25% saying they were less smart and another 25% saying that they did not understand the material really well. 25% of this cluster felt neutral after seeing their performance on the dashboard. Moreover, 50% of participants in this cluster felt motivated, with 25% wanting to seek help and 25% wanting to increase their effort. 25% said they do not feel that they need to see other people's performance on the dashboard.

6.2.5 Ability Group - Dashboard 5: Lower Grade + Higher Ability

Attribution: Participants attributed their performance shown on the dashboard to a wide range of factors. Two participants mentioned the relation between ability and confidence, Two participants said others got lower grades because they worked less and spent less time, and one student attributed their performance to luck. Moreover, one student said their strategy must have been wrong, one student said there must have been something wrong with the instructor, and another student assumed that the assignment was hard. One student said that students' skills can be different and students' technical and design skills differ.

Emotions and Motivation: Two students felt proud, two students felt relieved, and one student felt confused after seeing the information on the dashboard. Regarding motivation, 21% of participants said they were motivated to enhance their performance and 21% said they would keep doing what they were doing. Three students found the dashboard not motivating because they were better than everybody. What is more, one student felt motivated to seek for help from other students or the teacher.

Social Comparison: 52.6% of participants chose student 6, the outlier, for comparison. 21% of participants compared themselves with student 5. Two students compared themselves with student 2 and one student compared themselves with student 4. Two students could not pick anyone specific for comparison.

High Mastery and Low Performance-Avoidance: 9.1% of participants mentioned that students' skills and abilities might be different and that is why their performance differs. 9.1% said their strategy was wrong and another 9.1% said working hard leads to better results, appreciating the role of effort. Moreover, 9.1% attributed their better grade to their luck and 9.1% blamed the professor for other students' performance. 18.2% felt neutral, 9.1% felt proud, and 9.1% felt confused. Moreover, 18.2% felt demotivated as they were better than everybody else. However, 27.3% felt motivated, 18.2% aimed to increase their effort and 9.1% wanted to seek help. 36.4% said they would keep doing what they were doing.

High mastery and High Performance-Avoidance: 25% of participants with high mastery and high performance-avoidance mentioned that ability rating is related to individuals'

confidence. Also, 25% appreciated the role of effort. It is noteworthy to mention that 50% were motivated to enhance their performance next time.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: 25% of participants in this cluster attributed their low ability shown on the dashboard to a lack of ability and smartness. Moreover, 25% also said that ability and confidence are correlated. 25% said the assignment must have been difficult. Regarding feelings, 25% of this cluster were proud of their performance, and 25% were demotivated since they were better than others.

6.2.6 Ability Group - Dashboard 6: Lower Grade + Lower Ability

Attribution: Three students attributed the low performance of others to task difficulty, with two saying that the assignment must have been difficult and one saying that something must have been wrong with the instructor. Moreover, seeing their better performance compared to others, two students mentioned that working hard leads to better performance. One student also attributed their good performance to their good luck. Another student attributed the good performance of student 3 to their high ability.

Emotions and Motivation: 31.5% of participants felt neutral seeing the dashboard. Two students felt good about themselves (proud) and one student felt assured by their performance. Moreover, one student was confused with the results. Two students were motivated to improve their performance by raising the time spent, working harder, and raising their ability. One student found the dashboard validating and another said that the information shown on the dashboard is useful. Another student did not find the dashboard motivating since others were significantly lower than the participant.

Social Comparison: Majority of participants (68.4%) compared themselves with student 3, who was the outlier with an 81% mark and 4 out of 5 ability. 26.3% of participants compared themselves with student 2, who had a similar ability to the participant. One student chose student 5 for comparison.

High Mastery and Low Performance-Avoidance: 9.1% participants with this achievement goal orientation said they were lucky and another 9.1% said the assignment was difficult. 9.1% appreciated the role of effort and 9.1% said higher ability leads to a higher grade, pointing at the outlier student. 45.5% of participants were neutral seeing the data on the dashboard, while 9.1% felt confused, 9.1% felt proud, and 9.1% expressed their assurance. Regarding motivation, 9.1% said they do not find the dashboard motivating since they were better than others. 9.1% found it validating and 9.1% said the information is useful.

High mastery and High Performance-Avoidance: 25% of participants with high mastery and high performance-avoidance orientation blamed the professor for students' low performance. 25% felt demotivated since they were outperforming most students and 25% were motivated to increase their effort. Additionally, 25% felt neutral.

Low Mastery and Performance-Approach and Middle Performance-Avoidance: In this cluster, 25% of participants appreciated the role of effort and another 25% said the assignment was difficult. Moreover, 25% felt proud and 25% were motivated to improve their performance.

6.2.7 Full Dashboard - Ability Group

Attribution: 68.4% of participants in the 'Ability Group' said the full dashboard shows that working hard leads to better performance. For instance, P37 said:

"I think it reflects more about the effort that student puts in, beyond just ability, which makes me think maybe if I put in more time or less time, I can get either better or less, um, despite my ability." - P37

Two participants attributed their performance to a lack of effort and one student said their strategy must have been wrong. Two students said that there are different factors involved that affect students' performance and one student said that students' skills can be different, pointing out that not all students in their majors are proficient programmers. Moreover, one student attributed their performance to lack of ability and another student mentioned the correlation between ability and confidence.

Emotions and Motivation: The emotional response to the full dashboard was muted, not many students expressed emotions. Three participants felt neutral after seeing the full dashboard, one student felt upset and one student felt disappointed. Two students felt that not everyone was honest about reporting their time or ability, especially pointing out student 6.

31.5% of participants found the information presented in the full-dashboard useful. Moreover, 42.1% were motivated to improve their performance. For instance P09 said:

"I'll say it's motivating because I can see how long everyone else spent on their time. So if someone is more efficient than me, it is motivating to me. And if someone spends a long time and got a good grade, that's also motivating." - P09

Two students said they should spend their time more efficiently, one student said they would keep doing what they were doing, and another student felt they did not need to know about other students' performance. Also, one student was motivated to seek help.

Social Comparison: 42.1% of participants compared themselves with student 6, who had the highest grade. 31.5% of participants compared themselves with student 2, who spent the most time on the assignment. Moreover, 21% chose student 1 for comparison. Two students compared themselves with student 3 and another two compared themselves with student 4. Two students said they do not like comparing themselves with their peers.

High Mastery and Low Performance-Avoidance: 9.1% of participants in this cluster attributed their performance to a lack of smartness and ability, and 9.1% mentioned the correlation between students' confidence and their ability rating. 9.1% said that students' skills might be different and another 9.1% said their strategy must have been wrong. 63.6%

of participants appreciated the role of effort. 9.1% of participants mentioned that different factors can be involved in one's performance.

63.6% of participants said their performance is average compared to others. 18.2% felt neutral, 9.1% felt others were dishonest, and 9.1% felt disappointed at themselves. 54.6% of participants felt motivated, with 9.1% wanting to seek help, and 45.5% aiming to increase their effort. 9.1% said they do not need to see their peers' performance, and 36.4% said the information on the dashboard is useful for them. 18.2% said they should spend their time more efficiently next time.

High Mastery and High Performance-Avoidance: 25% of students in this group said they did not put in enough effort. 75% appreciated the role effort, saying the dashboard shows that if they spend more time they might get a better grade. 75% felt their performance was average compared to others. Moreover, 50% of participants said they are motivated to get better results and improve their performance next time and 25% said the dashboard was useful.

Low Mastery and Low Performance-Approach and Middle Performance-Avoidance: 25% of participants said they did not put enough effort into the assignment and 75% appreciated the role of effort. 25% said there are different factors involved in one's performance. 75% also said their performance was average. 25% of this cluster expressed negative emotions, saying they feel others are dishonest. 25% said they felt neutral. Regarding their motivation, 25% said they feel motivated to increase their effort and 25% said they keep doing the same. 25% said the information was useful for them.

6.2.8 Summary of Ability Group dashboards for Goal Orientation Clusters

A summary of attributions made by the 'Ability Group' can be seen in Fig. 6.4. The chart shows that most students in the 'Ability Group' attributed their performance to effort after seeing the full dashboard (Fig. 5.4), in which the 'Time' component was added. In general, the 'Ability Group' could not attribute their performance to different factors as much as the 'Time Group'. However, this situation changed after seeing the full dashboard.

As shown in Fig. 6.5, the first cluster (high mastery and low performance-avoidance) was motivated the most after seeing the full dashboard (Fig. 5.4), when the 'Time' element was added to the dashboard. Surprisingly, the second cluster (high mastery and high performance-avoidance) was motivated the most by the second dashboard (Fig. D.2), in which students performed much better with lower abilities. Next, they were motivated by the full dashboard. The third cluster (low mastery, low performance-approach, and middle performance-avoidance) showed their demotivation more than motivation in general. They were mostly motivated by the fourth dashboard (Fig. D.4), in which students had similar grades and lower abilities compared to the participant. Cluster 1 and cluster 2 in Fig. 6.5 had the highest demotivation for the first and the third dashboard (Fig. D.1 and D.3), in

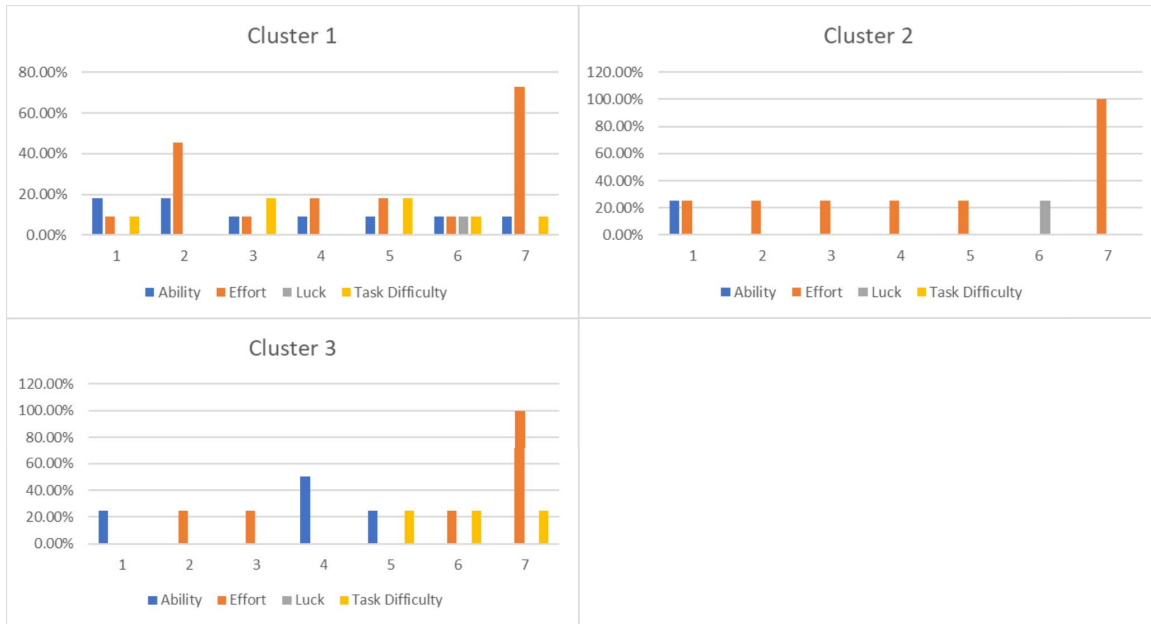


Figure 6.4: Attribution charts for three clusters (Cluster 1: High Mastery and Low Performance-Avoidance, Cluster 2: High Mastery and High Performance-Avoidance, Cluster 3: Low Mastery and Low Performance-Approach and Middle Performance-Avoidance) after viewing the Ability dashboards. Horizontal axes show Ability dashboards 1-6, with dashboard 7 being the full dashboard.

which their peers had higher ability, but were performing better or equally compared to the participant. Cluster 3 in Fig. 6.5 had the highest demotivation after viewing dashboard 1 (Fig. D.1).

Moving on to the emotions, for all three clusters the most negative emotions were expressed after viewing the second dashboard (Fig. D.2), in which students were performing much better with a lower ability.

It is worth noting that the 'Ability Group' showed notably lower levels of expressions concerning attribution, emotions, and motivation compared to those in the 'Time Group'.

The results show that adding the 'Time' component to the dashboard helped students to attribute their performance to effort. Moreover, the full dashboard 5.4 seems to be a motivating dashboard for students with high mastery. Also, the 'Ability' component seems to not be very positively effective on students with low mastery and low performance-approach.

6.3 More Themes

6.3.1 Preference of Elements

Among all 39 participants, 38.4% said their 'Ability' is self-reported and not very reliable. For instance P19 said:



Figure 6.5: Motivation charts for three clusters (Cluster 1: High Mastery and Low Performance-Avoidance, Cluster 2: High Mastery and High Performance-Avoidance, Cluster 3: Low Mastery and Low Performance-Approach and Middle Performance-Avoidance) after viewing the Ability Dashboards. Horizontal axes show Ability dashboards 1-6, with dashboard 7 being the full dashboard.



Figure 6.6: Emotion charts for three clusters (Cluster 1: High Mastery and Low Performance-Avoidance, Cluster 2: High Mastery and High Performance-Avoidance, Cluster 3: Low Mastery and Low Performance-Approach and Middle Performance-Avoidance) after viewing the Ability Dashboards. Horizontal axes show Ability dashboards 1-6, with dashboard 7 being the full dashboard.

"Ability isn't something to take so seriously. Because I think everybody has a different view of how good or bad they are." - P19

Similarly, 38.4% said the same for the 'Time' element. Moreover, 23% said they prefer to see the grade after they saw all dashboards. For instance P21 said:

"I guess in the end, grades is what matter the most, no matter how much time you spend on it like it's still important, but grades are what is gonna stay there, not the process." - P21

It is noteworthy to mention that 30% of participants preferred 'Time' over 'Ability' after they saw all dashboards, while only one student preferred to see 'Ability' rather than 'Time'. Moreover, 20.5% of participants said the 'Ability' might be unhelpful and 15% said they did not consider 'Time' the only factor to evaluate their performance.

6.3.2 Task Value

Two students mentioned the worth of the course or the assignment for them. Since the program that our participants majored in is an interdisciplinary degree, and students with different interests and background study in this program, it was worth mentioning the task value concept from Pekrun's Control-Value Theory [23]. For instance P16 said:

"I don't really think I'll be using Java [the programming language] in the future. I don't think I'll be getting into multimedia programming anytime soon. So I think it's just intrinsic, like, do I benefit from this knowledge?" - P16

6.3.3 Too Much Information

Some students gave feedback on the design or the amount of information they were getting from dashboards. 17.9% of users expressed that they found the dashboard they were viewing, which was mostly the Full Dashboard 5.4, to be overly complex. Mostly, the information presented was too much and overwhelming for them and they felt they can not process or analyze it easily.

6.4 Eye Tracker Results

We performed eye tracker analysis on the first dashboards of the 'Time Group' (Fig. 5.2) and 'Ability Group' (Fig. 5.3).

6.4.1 Eye Tracker Data Analysis for the 'Time Group'

Cluster 2 of the PALS questionnaire, with high mastery and high performance-avoidance goal orientation, spent less time fixating their gaze on Student 3 (Grade: 95% - Time Spent on the Assignment: 13 hours), compared to the other two clusters. In addition, this cluster also spent significantly higher time on Student 5, (Grade: 100% - Time Spent on the Assignment: 11 hours), while cluster 1 (high mastery and low performance-avoidance) spent lower time on the student compared to two other clusters.

Analyzing the prescreening time of participants when they had their first glance on the dashboard, 10 participants focused on Student 2 with the highest time spent, 8 participants focused on Student 5 with the highest grade, and 2 participants focused on Student 4, with similar time spent.

When asked about how they think they are doing, the following comparisons were made: 4 participants answered directly, 3 participants revisited all students on the dashboard, 10 participants focused on Student 2 with the highest time, 5 participants focused on Student 5 with the highest grade, and 6 participants focused on Student 4.

When participants were asked with which student on the dashboard they compare themselves, 11 participants focused on Student 4 with a similar time, 5 participants focused on Student 5 with the highest grade, and 4 participants focused on Student 2 with the highest time.

6.4.2 Eye Tracker Analysis for the 'Ability Group'

Students in the 'Ability Group' had notably much shorter time spent on themselves compared to the students in the 'Time Group'. There were no time differences for PALS clusters

when looking at box plots. 7 participants spent the most time on Student 5, who had the same ability, and 7 students spent the lowest time on Student 6, with a 5 out of 5 ability. It is worth mentioning 4 students spent the maximum time on Student 1, who was similar to Student 6.

Analyzing the prescreening time for the 'Ability Group' showed that 6 participants focused on Student 5 with the same ability. 7 participants focused on Student 2, who had the closest grade to the participant. 6 participants focused on Student 1 (Grade: 98% - Ability: 5 out of 5).

When asked about how they think they are doing, the following comparisons were made: Student 2 was considered by 8 students, and Student 3 and Student 5 were considered by 4 and 5 participants respectively. Additionally, 2 participants answered the question directly, one looked at only themselves, and 9 participants reviewed the majority of the students.

Moving on to the second prompt, when we asked participants who they compare themselves with the most, 9 participants focused on Student 5, and 6 participants focused on Student 2. Moreover, only 2 participants reviewed the majority of students while the rest focused on the comparison of a smaller set of students.

Chapter 7

Discussion and Conclusions

7.1 Discussion

Participants' categorization into the 'Ability Group' and 'Time Group' led us to distinct patterns in their engagement and interpretations. Compared to the 'Time Group', participants in the 'Ability Group' found it harder to explain their performance, emotions, and motivation. Showing the full dashboard (Fig. 5.4) to the 'Ability Group', in which participants could see the 'Time' element added to the dashboard, helped participants to attribute their performance to effort more. As expected, most participants in the 'Time Group' attributed their performance to their effort when they observed their peers performing significantly worse with a lower time spent and notably better with a greater time spent. In addition, when participants saw others spending less time and getting higher or similar grades to them, they felt they were less smart and blamed their performance on a lack of ability. All participants showed the most negative emotions when they saw their peers performing better in less amount of time. Except for the 'Ability Group' which was the most motivated by the full dashboard, all participants were motivated the most to improve their performance when they saw others spending more time and getting higher grades. This case is different when looking into each cluster. For instance, cluster 3 in the 'Ability Group' with low mastery, low performance-approach, and middle performance-avoidance orientation, were the most demotivated by the first dashboard, in which other students had higher grades and higher abilities.

In accordance with the Social Comparison Theory, individuals mainly compared themselves with individuals who were close in grade, time spent, or ability to them. It is noteworthy that the outlier student captured the attention of a significant number of participants in each dashboard. For instance, several participants compared themselves to the person who received higher marks when looking at classmates with similar grades to them. Another important finding from the comparison in each dashboard was that while the grade, time spent, and ability of the student were consistent across all dashboards, participants thought they were doing poorly when their peers were performing better than them, but were sat-

ified with their results when they were outperforming their peers. It is worth mentioning that although most students compared themselves with someone similar to themselves, other peers with higher or lower performance were determining the emotional response and resulting motivation of the participant.

As summarized in 6.1.8 and 6.2.8, students with different achievement goal orientations demonstrated varying attributions, emotions, and motivation in relation to dashboards. In the 'Time Group', students with high mastery showed much stronger motivation after witnessing their peers putting in more effort and receiving better marks. However, students with low mastery and moderate performance-avoidance were motivated to increase their effort by seeing others do poorly and put in disproportionately less effort. Participants with high or middle performance-avoidance felt demotivated when they saw their peers performing significantly better with a lower time spent. However, participants with low performance-avoidance and high mastery felt the most demotivated seeing their classmates spending notable time on the assignment and getting lower grades. Seeing not all students achieving well given the amount of time they were spending in class, made this group concerned. Regarding the 'Ability Group', different dashboards were the most motivating for participants in each cluster. However, all clusters were the most demotivated by seeing others outperforming them with higher abilities. It is also worth mentioning that the full dashboard was more positively effective for students with high mastery compared to students with low mastery.

The eye tracker analysis and participant responses revealed several interesting patterns in how students engaged with and compared themselves to their peers on the dashboard. The findings suggest that individual differences in achievement goal orientations influenced students' attention, comparisons, and perceptions. In the 'Time Group', students with high mastery and high performance-avoidance goal orientations demonstrated distinct engagement patterns. They spent less time on the student with a higher grade and higher time spent and more time on a student with the highest grade and a lower time indicating a preference for comparisons that aligned with their goal orientations. The initial glance at the dashboard indicated that the peers who had invested the most time or grades attracted the attention of a substantial number of participants. This initial tendency to notice high achievers and those who invested substantial time underscores the importance of these attributes in capturing students' attention. In addition, in the Ability dashboards, the students who shared the same ability as the participants attracted the greatest attention from them. This highlights the influence of peers with similar attributes in capturing students' interest and potentially serving as benchmarks for self-comparison. Many participants focused on a smaller set of students for comparison, rather than reviewing the majority of students. This indicates a preference for targeted and relevant peer comparisons, possibly driven by the desire to assess performance in a more manageable context.

One of the important aspects of this study is the subject of concept validity. In our research, we utilized 'Time' and 'Ability' to represent effort and programming skills, respectively. However, they might have been perceived as weaker indicators for the subjects of our study. Differences in estimation of the reliability of this measure across participants can affect the results of any comparisons across subjects and consequently, reduce the effect of the measurement for effort and ability. While 'Time' is more straightforward to comprehend and participants would easier connect the 'lack effort' to spending less time', understanding what 'Ability' represents, alongside showing grade, might lead to different interpretations by participants.

Lastly, it is essential to determine whether the findings of this study can be applied to all student types in different fields. The theories we applied are general, so the emotional responses can be carried out in all domains. It is important to consider the emotional responses identified in these theories across various fields. It suggests the need for a standardized measure of effort that can be consistently applied across diverse fields of study. Such a measure can have a significant impact on our understanding of these domains and how we gather information about them.

7.2 Limitations

In the course of conducting this study, it is important to acknowledge the limitations that might impact on the findings.

One of the limitations of this study was the small number of participants in some clusters. After categorizing 39 participants into two groups, and then having three clusters for each group, some clusters were left with a small number of participants (the smallest being 4 participants in each the performance-approach and performance-avoidance clusters in the 'Ability Group'). A small sample size in some clusters might not accurately capture all students embodying those specific goal orientations.

Another limitation of this study was having participants from an interdisciplinary major with different focuses. Not all students' concern was to achieve high success in a programming course. This variation in educational priorities, personal interests, and perceived usefulness of task can affect the findings. Hence, students' emotional responses to their performance could be affected by the value and worth the course has for them. As Eccles considers task-value as one of the key factors in determining motivation [7], considering the expectancy-value theory into the theoretical framework can give us novel findings.

Additionally, the grade, time spent on the assignment, and ability that was set for the participants across all dashboards (75%, 7 hours, and 3 out of 5), represented an average performing student, who has not failed but still has room for progress. The results of the study might be different by showing the same data for high-performing students or low-performing ones.

It is worth to mention that the data presented to participants was not real. While showing participants their real academic data enhances the risks of the study, if participants were shown their real performance and their peers' performance, their emotional responses and behavioral changes might have been different.

There are a few points to the design that are important to note as well. The designer bias that shaped the content of the LADs must be acknowledged. The LAD designing may be more frequently associated with high-achieving students since the designer is a high achiever with a strong mastery goal orientation. Moreover, The choice of the visual representation of elements in dashboard may have played a role as well. The selection of a bar graph to represent 'Time' is grounded in the understanding that time inherently possesses a continuous nature, and the bar graph effectively communicates the idea of a span or duration. On the other hand, 'Ability' was shown as dots since it was showing the student's level of skill in a rating system. This design provided a discrete representation of varying levels of ability. Additionally, we employed anchoring techniques to visualise the grade in order to avoid using only numerical information and to establish a visual hierarchy. Studying the impact of anchoring techniques in design is essential for comprehending their effect on users. Lastly, as there were few participants in each cluster, we opted for presenting the dashboards in the same order for all participants, beginning with the dashboard with the highest grade and ending with the dashboard with the lowest grade. If the order of the dashboards had been different (starting with a different dashboard), the results might not have been the same.

7.3 Future Directions

Given the limitations of this study, one of the potential routes for future research is to provide students with actual performance statistics for themselves and their classmates. If students are presented with actual performance statistics, they are more likely to have a stronger emotional connection to their achievements. Similarly, the influence of peer's performance on one's emotions and motivation can be different when the data is real. As a result, even if giving students simulated versions of their data might result in novel conclusions, it is essential to acknowledge the importance of giving students real data in future research.

Additionally, to have broader results, this study can be performed on both top students who accomplish highly and students who perform poorly in their academics. By not only focusing on students who are average and have room for progress, including participants who excel or struggle with their academics can help us understand what kind of dashboard to provide to students, and how students in different situations react to the dashboards. Therefore, to enhance the richness and generalizability of the findings, the study can be conducted on a broader spectrum of participants in relation to their academic performance.

Future research could benefit from taking into account additional student characteristics like task value. Researchers can gain a greater understanding of how students' different academic objectives interact with their emotional reactions to performance feedback by taking task value into account as a basic component of the participants' characteristics. The task value is known to have impact on the motivation, and it was also mentioned by some participants, future research need to consider value students put on the tasks for which the results are shown as the task-value can interact with other students' characteristics.

7.4 Conclusion

In conclusion, our results show a comprehensive exploration of students' interactions with the educational dashboard provided valuable insights into the complex dynamics of self-comparison, performance attribution, emotions, and motivation. These insights emphasize the importance of considering individual differences and their goal orientations when designing educational dashboards and interventions that aim to enhance motivation, self-assessment, and learning outcomes.

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Appendix A

Demographic Survey

Please choose the answer that fits your current status.

1. With which gender do you most identify?
 - Man
 - Woman
 - Non-binary
 - Prefer to self-describe:
 - Prefer not to answer
2. What is your age?
 - 18-24
 - 25-30
 - Over 30
3. How many credits of university courses have you completed so far?
 - 0-30
 - 30-60
 - 60-90
 - 90-20
 - More than 120
4. Have you used any applications with common visualizations in your everyday life? If yes, please select from the list below [4]
 - Banking graphs (ex. a checking account balance)
 - Educational graphs
 - Utility graphs (ex. Electricity or gas usage)
 - Telephone or internet usage graphs

- Loan payment graphs (ex. Mortgage, student loans)
 - Time planning or tracking software graphs
 - Laboratory result graphs
 - Health or exercise tracking graphs
 - Other:
5. How have you used Canvas during the past year?
- Once a week
 - Multiple times a week
 - Once a day
 - Multiple times a day
6. How confident are you in understanding the information presented in these types of charts? Select the ones that are applicable.
- Bar chart
 - Line chart
 - Pie chart
 - Stacked bar chart
 - Scatter plot

Appendix B

Patterns of Adaptive Learning Scale (PALS) [20]

Please choose the answer that fits your current status.

■ Mastery Goal Orientation

1. It's important to me that I learn a lot of new concepts this year.
2. One of my goals in class is to learn as much as I can.
3. One of my goals is to master a lot of new skills this year.
4. It's important to me that I thoroughly understand my class work.
5. It's important to me that I improve my skills this year.

■ Performance-Approach Goal Orientation

6. It's important to me that other students in my class think I am good at my class work.
7. One of my goals is to show others that I'm good at my class work.
8. One of my goals is to show others that class work is easy for me.
9. One of my goals is to look smart in comparison to the other students in my class.
10. It's important to me that I look smart compared to others in my class.

■ Performance-Avoid Goal Orientation

11. It's important to me that I don't look stupid in class.
12. One of my goals is to keep others from thinking I'm not smart in class.
13. It's important to me that my teacher doesn't think that I know less than others in class.
14. One of my goals in class is to avoid looking like I have trouble doing the work.

Appendix C

Time Dashboards

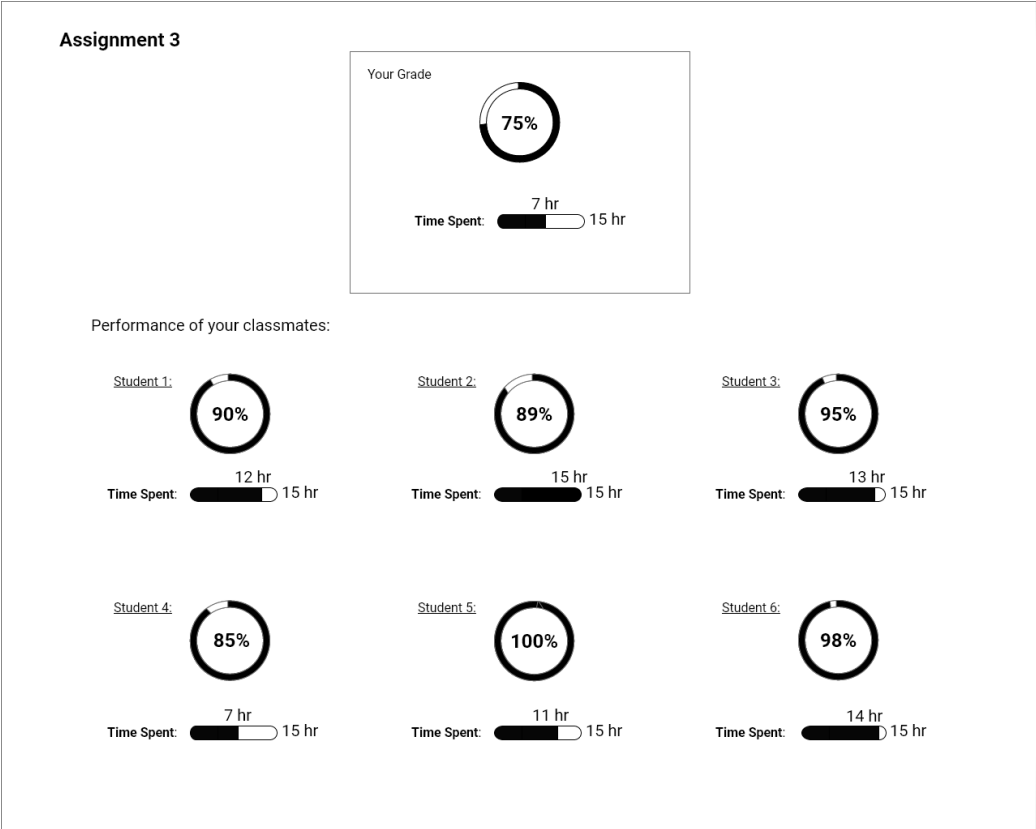


Figure C.1: Composite dashboard mockup shown to participants in the 'Time Group' with peers performing with higher grades and higher time spent on the assignment. The other 5 alternatives of these dashboards are shown in the appendix



Figure C.2: Composite dashboard mockup shown to participants in the 'Time Group' with most peers performing with higher grades and lower time spent on the assignment, including one outlier with similar time spent as the student



Figure C.3: Composite dashboard mockup shown to participants in the 'Time Group' with most peers performing with similar grades and higher time spent on the assignment, including one outlier with lower time spent

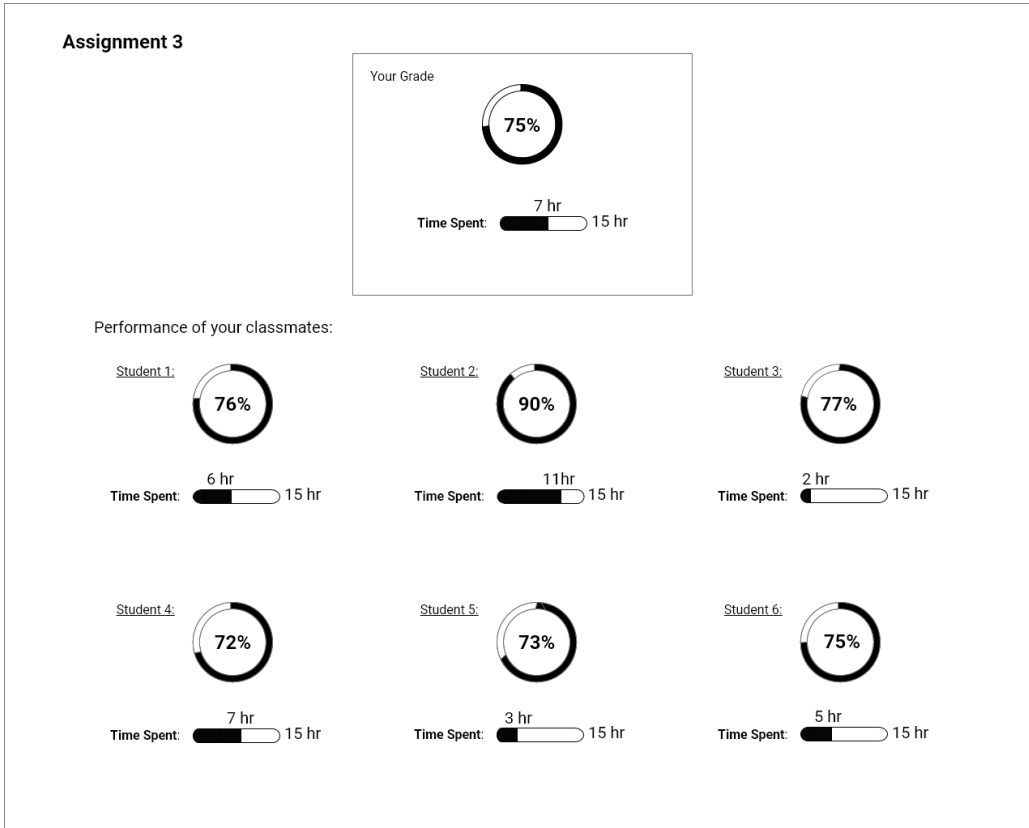


Figure C.4: Composite dashboard mockup shown to participants in the 'Time Group' with most peers performing with similar grades and lower time spent on the assignment, including one outlier with higher grade and lower time spent compared to the student



Figure C.5: Composite dashboard mockup shown to participants in the 'Time Group' with most peers performing with lower grades and higher time spent on the assignment, including one outlier with slightly higher grade and lower time spent compared to the student.

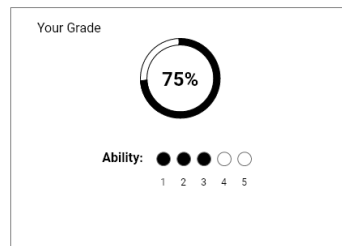


Figure C.6: Composite dashboard mockup shown to participants in the 'Time Group' with most peers performing with lower grades and lower time spent on the assignment, including one outlier with slightly higher grade and slightly lower time spent compared to the student.

Appendix D

Ability Dashboards

Assignment 3



Performance of your classmates:

Student 1:



Ability: ● ● ● ● ● ○
1 2 3 4 5

Student 2:



Ability: ● ● ● ● ○ ○
1 2 3 4 5

Student 3:



Ability: ● ● ● ● ○ ○
1 2 3 4 5

Student 4:



Ability: ● ● ● ● ○ ○
1 2 3 4 5

Student 5:



Ability: ● ● ● ○ ○ ○
1 2 3 4 5

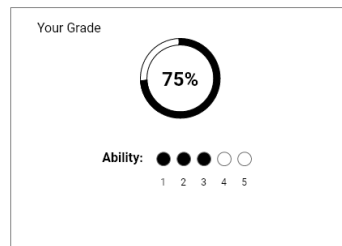
Student 6:



Ability: ● ● ● ● ● ○
1 2 3 4 5

Figure D.1: Composite dashboard mockup shown to participants in the 'Ability Group' with peers performing with higher grades and higher ability. The other 5 alternatives of these dashboards are shown in the appendix

Assignment 3



Performance of your classmates:

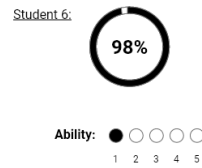
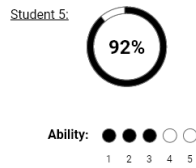
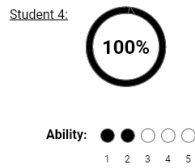
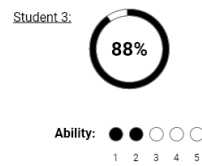
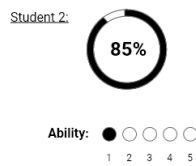
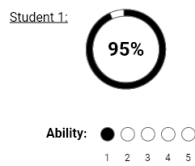


Figure D.2: Composite dashboard mockup shown to participants in the 'Ability Group' with most peers performing with higher grades and lower ability, including one outlier with similar ability compared to the student.



Figure D.3: Composite dashboard mockup shown to participants in the 'Ability Group' with most peers performing with similar grades and higher ability, including one outlier with higher grade and slightly lower ability compared to the student.



Figure D.4: Composite dashboard mockup shown to participants in the 'Ability Group' with most peers performing with similar grades and lower ability, including one outlier with higher grade and higher ability compared to the student.

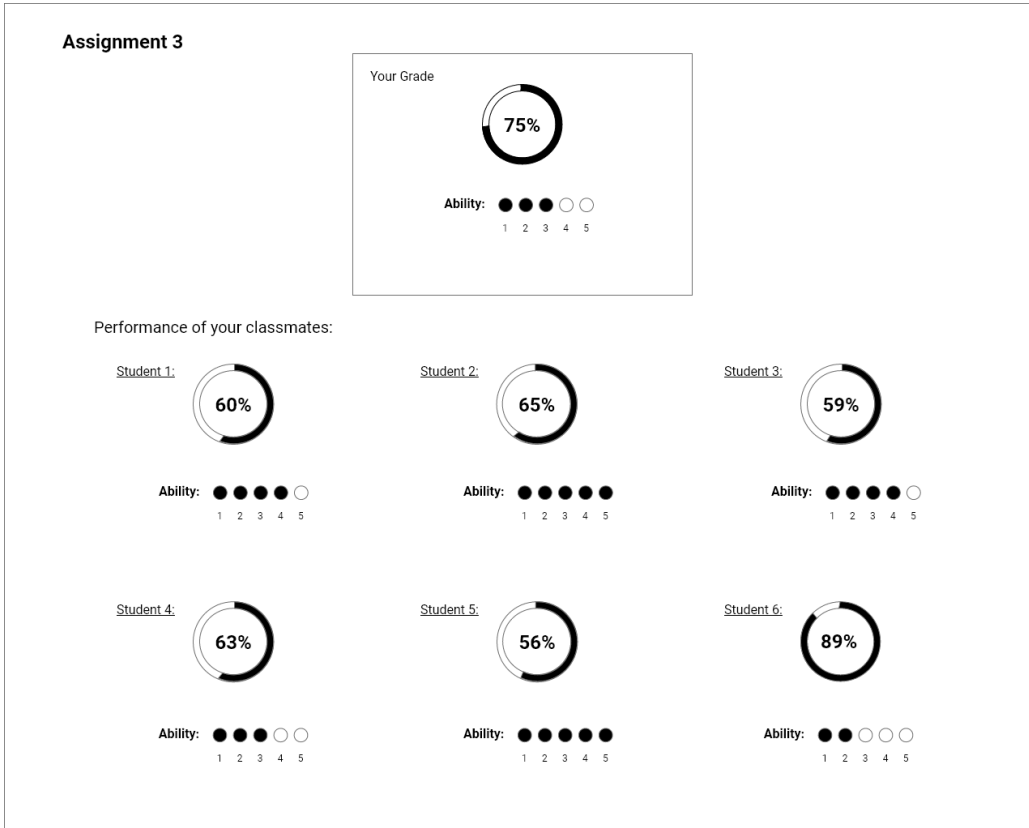


Figure D.5: Composite dashboard mockup shown to participants in the 'Ability Group' with most peers performing with lower grades and higher ability, including one outlier with higher grade and lower ability compared to the student.



Figure D.6: Composite dashboard mockup shown to participants in the 'Ability Group' with most peers performing with lower grades and lower ability, including one outlier with higher grade and higher ability compared to the student.

Appendix E

Coding Scheme

- Ability Dashboards
 - 1- Higher Grade - Higher Ability
 - 2- Higher Grade - Lower Ability
 - 3- Same Grade - Higher Ability
 - 4- Same Grade - Lower Ability
 - 5- Lower Grade - Higher Ability
 - 6- Lower Grade - Lower Ability
- Time Dashboards
 - 1- Higher Grade - Higher Time
 - 2- Higher Grade - Lower Time
 - 3- Same Grade - Higher Time
 - 4- Same Grade - Lower Time
 - 5- Lower Grade - Higher Time
 - 6- Lower Grade - Lower Time
- Full Dashboard
- Attribution
 - Ability
 - Effort
 - * I did put enough time or effort
 - * I didn't put enough effort
 - * My strategy was wrong
 - * They spent less time so they got lower grade
 - * They worked hard so they got a good grade
 - * Working hard leads to better performance (appreciation of effort)

- Luck
 - * I was lucky
- Task and Teacher
 - * There was something wrong with the instructor of the course
 - * The assignment or the course is hard itself
- Performance is influenced by various factors unique to each individual.
- Feelings
 - Negative
 - * Confused
 - * Dishonesty
 - * Disappointed
 - * Hopelessness
 - * Uncomfortable
 - * Upset
 - Positive
 - * Assurance
 - * Pride
 - * Relief
 - Neutral
- Motivation
 - Demotivating
 - * Demotivating since everybody is better
 - * Demotivating since I worked the hardest but got the lowest grade
 - * Demotivating since my ability is higher but I got lower grade
 - * I cannot improve more than this
 - * Not motivating because everybody is the same
 - * Not motivating because I am better than everybody
 - * Not motivating because of my low ability
 - Motivating
 - * Motivated to ask other people OR teacher about their methods
 - * Motivated to improve my performance by raising the time spend, working harder, and raising my ability
 - * Motivating because everybody is the same
 - * Motivating because I am better than everybody
 - * Motivating because of my high ability
 - Not Motivating
 - * I don't feel that I need to know about other students' performance
 - * I keep doing what I'm doing since I feel it's enough

- * I should spend time 'efficiently' OR reduce time
- * It give useful information about my performance and why I got this grade
- * Validating rather than motivating
- Social Comparison
 - Compared to no one OR everybody
 - I don't like comparing
 - Student 1
 - Student 2
 - Student 3
 - Student 4
 - Student 5
 - Student 6
- Preference of Elements
 - Ability is self-reported and not very reliable
 - Ability is unhelpful
 - Prefer ability over time
 - Prefer time over ability
 - Prefer to see the grade only
 - Time is not a factor - no correlation
 - Time is self-reported and not reliable
- Task Value
- This does not represent all students
- Time depends on ability
- Too much information - too complicated

Appendix F

Interview Script

Thank you for your time and participation. Today I want to show you a dashboard prototype and get your feedback on different aspects of its design. Please note there is no right or wrong answer to the questions and your responses will not affect your grade in any coursework. So feel free to express your opinion. I will take notes from your responses and I will audio-record and video-record this session in order to transcribe them later. Do you have any questions? So before I get started, I want to mention during the interview, at some points, you may feel like that I repeat y questions. This is because I want to fully understand your point of view and feelings. So are you ready to get started?

F.1 Interview Part 1

How do you track your progress in a course? Please elaborate. In case of giving a vague answer: How do you track your performance to know what is your current situation or current status in a course?

What features of Canvas do you use the most? How do you use them? 2.1. Why do you find them useful?

Is there a feature you would like to see on Canvas that is not there?

Have you taken IAT 265 before?

Now I am going to use an eye tracker to capture your eye movements while you are looking at the screen. Before we start, to get an accurate gaze point, we have to go through a calibration procedure. (Explains the calibration procedure). Now, imagine you are taking the course IAT 265 (which you know is mostly a programming course and students learn to code in the multimedia context), and you are trying your best to do well in the course. The dashboard I am going to show you displays your and some of your peers' performance in the course. Note that all the names are anonymous, meaning that you won't know the names of the students shown in the dashboard and others won't know your name too.

F.2 Interview Part 2 - Grade Only

How do you think you are doing in the course? Please elaborate. In case of a short answer: Why do you think you are doing poorly/well in the course?

With whom do you compare yourself the most? Why?

How does this information presented in the dashboard affect your motivation? Please elaborate. In case of a short answer: How does seeing your grade alongside other students' grades affect your motivation (desire to continue working hard for this course)?

F.3 Interview Part 3 - Ability and Time Dashboards

For the 'Ability Group': Now I am going to show you the next dashboard. Another element is added to the dashboard called 'Ability'. The measure of 'Ability' is self-assessed by the students and it refers to the level of programming skills one has or how much proficient someone is in programming).

For the 'Time Group': Now I am going to show you the next dashboard. Besides grades, this dashboard shows the amount of time spent on the assignment. Time spent on the assignment is self-reported by students and refers to the number of hours a person spent working on the assignment.

Now, how do you think you are doing in the course? Please elaborate.

Why do you think you are performing poorly/well in the course?

With whom do you compare yourself the most? Why?

How does this affect your feelings?

Who do you think is doing the best in the class? (The answer could be based on grade or time, or the combination)? Why?

Seeing this dashboard, how is your motivation affected? Is it changed compared to the last dashboard?

F.4 Interview Part 4 - Full Dashboard

Now I am going to show you the last dashboard. This dashboard also shows the amount of time spent on the assignment. Time spent on the assignment is self-reported by students and refers to the number of hours a person spent working on the assignment.

Now, what do you think about this dashboard?

How do you evaluate yourself?

Why do you think you are performing poorly/well in the course?

Who do you think has worked harder on the assignment?

How does this affect your feelings?

With whom do you compare yourself the most? Why?

Who do you think is doing the best in the class?

Seeing this dashboard, how is your motivation affected? Is it changed compared to the last dashboard?

What do you think is the best measure to determine who has put the most effort into the assignment?