“HOW PEOPLE LEARN” AT EPFL: EMOTIONS’ IMPACT ON PROJECT-BASED LEARNING

2024 Interactive Qualifying Project, Lausanne Project Center

Lauren McIlhenny, Katarzyna Racka, Kaitlyn Saidy, Christian Wagener

WPI

EPFL

Photo Credits: © Jamani Caillet / EPFL, 2022

"How People Learn" at EPFL: Emotions' Impact on Project-Based Learning

An Interactive Qualifying Project submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfilment of the requirements for the degree of Bachelor of Science/Arts.

by

Lauren McIlhenny

Katarzyna Racka

Kaitlyn Saidy

Christian Wagener

Date:

01 May 2024

Report Submitted to:

Professor Roland Tormey and Professor Nihat Kotluk

École Polytechnique Fédérale de Lausanne

Professor Laura Roberts and Professor Christopher Brown

Worcester Polytechnic Institute

Abstract

Academic emotions in project-based learning must be studied due to their critical role in education efficacy. This project examined students' academic emotional experience and formulated alterations for the professors to improve future students' experience in the project-based How People Learn course at EPFL. We analyzed course evaluations and conducted individual interviews, focus group interviews, and observations of students to develop a comprehensive understanding of the student emotional experience. We identified diverse emotions and their antecedents while recognizing student motivations. We recommended applicable projects, clear expectations, group support, objective explanation, and personality accommodation to improve students' learning experience.

Photo Credits: Dominik Gehl Photography

Executive Summary

Introduction

Emotions define student academic success, influencing their future professional careers (Pekrun & Stephens, 2012). The improvement of project-based learning courses considering students' emotional experience can help future engineers gain the necessary skills for success in the workplace. However, there is a lack of study on academic emotions, especially how emotions relate to project-based learning (PBL). We researched the impact of emotions on project-based learning to improve PBL course design and education.

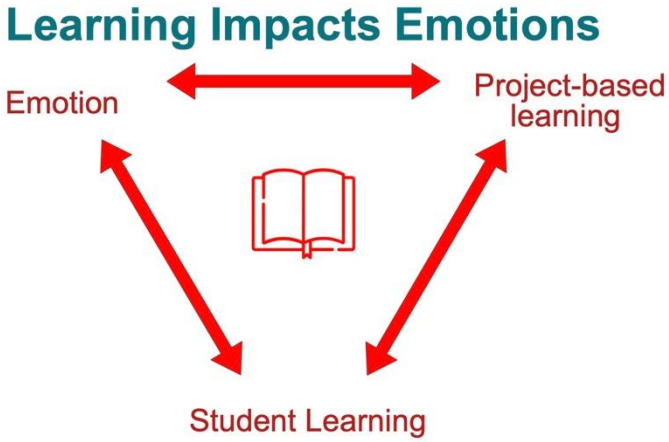


Figure 1: *The Relationship between Emotions, Project-Based Learning, and Student Learning*

The École Polytechnique Fédérale de Lausanne (EPFL) is a technical university in Lausanne, Switzerland. We studied students' experience in the How People Learn (HPL) course sequence at EPFL, taught by Professors Roland Tormey and Nihat Kotluk. The first semester (HPL I) familiarizes students with a variety of theoretical aspects of learning; the second semester (HPL II), requires students to apply the knowledge they have gained by designing their own learning tool through an open-ended project (R. Tormey & N. Kotluk, personal communication, February 13, 2024). The course helps students learn to utilize resources, manage time, contemplate feedback, embrace

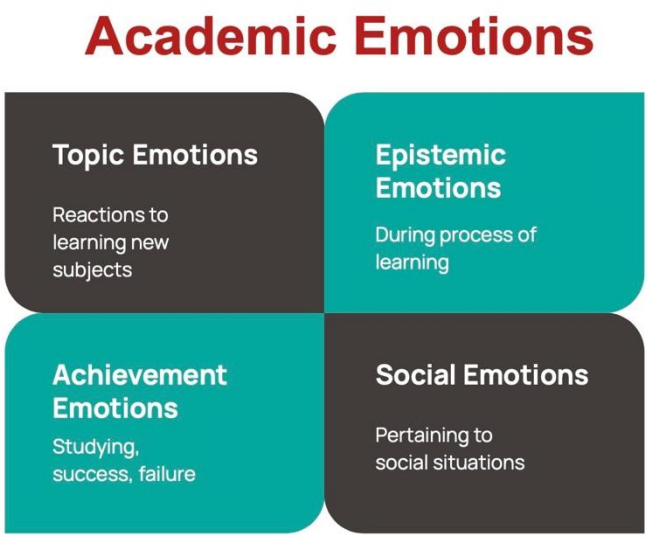


Figure 2: *Four Categories of Academic Emotions*

responsibilities, transcribe meetings, and consider ethics (“How People Learn: Designing Learning Tools II”, 2023).

This project aimed to assess the influence of emotions in project-based learning by researching students’ emotional experience in HPL. The perspectives from professors and surveys are limited as students may not feel as willing to share their feelings and opinions. Our goal was to inform the professors of their students’ experience with a focus on achievement, epistemic, topic, and social emotions and formulate course alterations to improve future students’ experience. As students working on our own project, we could relate to students on a deeper level to provide beneficial insight. By understanding student emotion and experiences through an insider’s perspective, we provided a valuable vantage point and recommendations to improve student learning.

Methods

Our first objective to achieve this goal was to build context for our research and understand past student sentiment and feedback on HPL by analyzing prior course evaluations. We studied and coded the feedback students provided for the instructors over the past years and identified emerging trends in emotion and areas for course improvement. These trends helped revise our interview questions for the students.

Our second objective was to understand the stories of current students in HPL. We spent our first two weeks on-site building rapport with the students through informal meetings and attending the weekly class session. Once more personable connections were established, we spent the next three weeks conducting a total of twenty-two interviews, five observations, and six focus groups with informed, consenting students. During the class periods, we observed groups as they worked for approximately ten minutes at a time to develop an understanding of the group’s dynamics and emotions shown through body language. We also conducted focus groups in which we asked groups about their teamwork and the emotions they felt while working together. Individual interviews elicited more personal understandings of the students’ emotions

and learning experiences. As a group, we examined the emotions, likes, and dislikes that each student expressed.

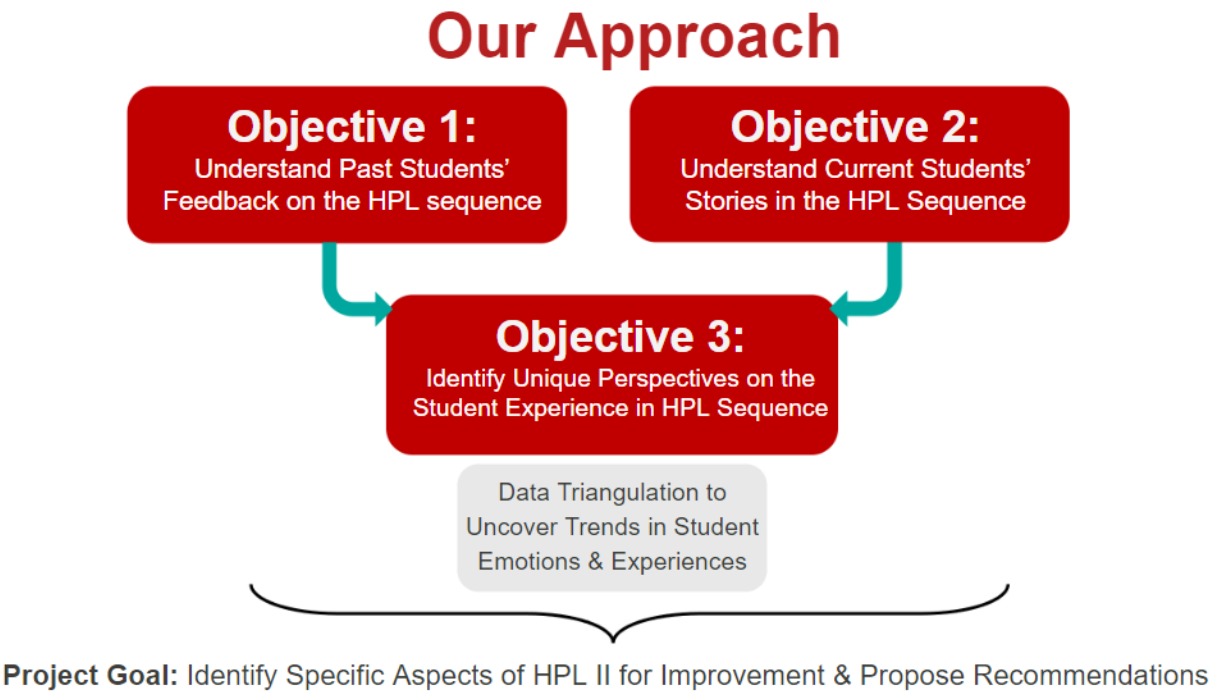


Figure 3: *Our Three-Fold Approach*

Next, we compared data from the individual interviews to the data from the observations and the focus groups to complete our final objective of identifying unique perspectives on the student experience in the HPL sequence. We accomplished this by a thorough review of all previous data to recognize broader trends and drew overarching conclusions regarding student experience in HPL, summarizing students' common emotions and their causes. Finally, using this insight we formulated comprehensive emotion trajectories for the student experience in HPL and recommendations for the professors to improve the course.

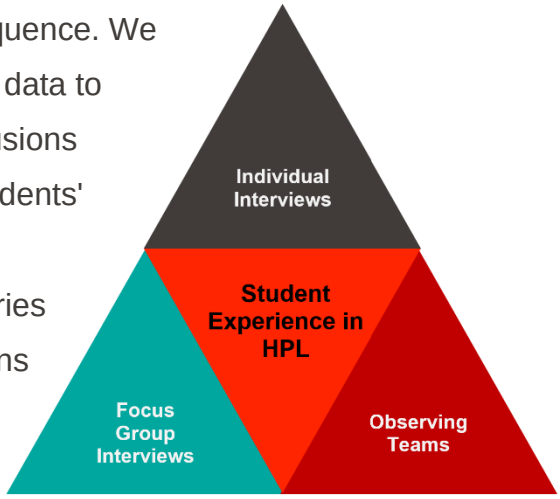


Figure 4: *Three Methods of Learning the Current Student Experience in HPL*

Findings

We analyzed and categorized emotions through the lens of academic emotions, sorting student emotions into topic, epistemic, achievement, and social emotions. Emotions ranged from positive to negative to neutral and had varying sizes of prevalence within student experiences. We noted students feeling topic emotions, with prominent interest in the course content or topics of their projects.

Epistemic emotions arose from working on their projects, with motivation regarding the development process, stress to manage time, and confidence in progression.

Figure 5: *Student Feelings Caused by the Course Concepts*

Students felt overwhelmed and disappointed by the stress on the process and struggled to see the value of this model. Similarly, unclear instructions and expectations resulted in student confusion and disengagement.

Irritation, from an achievement emotion perspective, stemmed from a lack of reward from the project, “planning of planning” assignments, or struggling to see course value. This was offset by a major appreciation of the usefulness of course content. As a Social and Human Sciences course, students prioritized the work for their major related courses, causing them to feel

Figure 6: *Student Feelings Caused by their Project*

stressed and overwhelmed by the assignments. Students were highly motivated to produce a successful learning tool but also felt anxious about their plans smoothly coming to life. Additionally, students appreciated the manageable workload, allowing them to feel relaxed, but some were nervous about producing a solid deliverable in time.

Social emotions included motivation from encountering new social situations and enjoyment or comfort from positive group dynamics. Group dynamics brought about negative emotions as well, such as irritation, frustration, stress, and anxiousness. As students worked through the project, group communication and coordination, as well as managing project tasks and achieving deadlines caused such feelings.

Figure 7: *Student Feelings Caused by Group Interaction*

Finally, students were initially thrown off by the professor's teaching style but quickly came to enjoy its passion and interactive nature. The students appreciated the professors' willingness to build relationships, availability to provide guidance, and openness to constructive feedback.

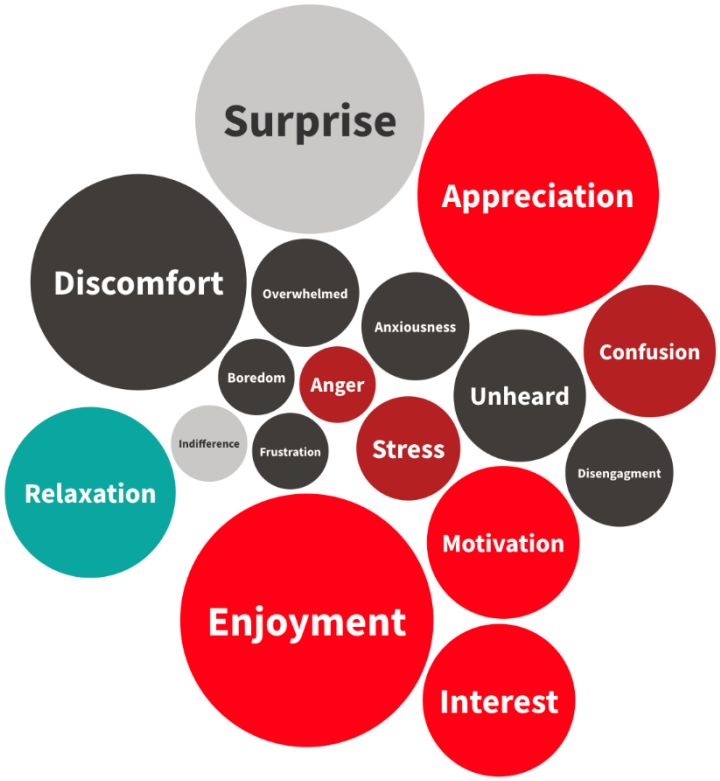


Figure 8: *Student Feelings Caused by Teacher-Student Interaction*

Recommendations

1. **Make Projects More Applicable to Help Motivate Students**

   Students felt their project was not rewarding as their learning tool would not be implemented. Knowing their artifact would be used or presenting it to peers could improve their motivation.

2. **Communicate Clearer Expectations to Students**

   Some overwhelmed students wished there was a time plan showing when assignments were due. Students were lost on what and how to complete the project and assignments and asked for more guidance

3. **Provide Structured Support for Group Functioning**

   Students suggested having mandatory group check-ins with the instructors to help resolve issues with work engagement in their project group. Having groups complete team charters could prevent issues.

4. **State Learning Objectives Emphasizing the Value of the Process**

   Students admitted they did not truly reflect on the project process. Stating learning objectives and how strategies learned could be applied outside of class would help students realize the assignments' value.

5. **Keep Strong Interactions but Be Mindful of Shyer Students**

   Be mindful that despite many students' engagement and appreciation for the instructor's active teaching style, some students became distressed when called upon by name during class or due to the dynamic lectures.

Conclusion

After analyzing students' emotions and their causes, we came to understand that there exists a wide overlap between academic emotions, which indicate emotions are not experienced in isolation but rather influence each other. The emotional trajectory of students in HPL illuminated how not all negative emotions are "bad," but some, such as anxiousness or stress, can, in moderation, act as a motivator. We observed how

positive and negative emotions stemming from project group interactions influenced the emotional experiences of students.

Our research on the How People Learn course exemplified that PBL can be a confusing, complex experience for students and may be accompanied by unpleasant feelings like stress or socially-induced irritation. However, students should rest assured that these emotions are normal and part of the PBL process given its vast differences from traditional learning. We observed that emotions serve as a bridge connecting individuals—especially students—and recognizing them reveals the common threads of experience between people.

Photo Credits: © Jamani Caillet / EPFL

Acknowledgements

We would like to thank many individuals who played integral roles in our research. Thank you to the students currently enrolled in How People Learn (HPL) who participated in our research. We appreciated their willingness to share their emotions and experiences. This comprehensive understanding of the course would not have been made possible without their insights.

Next, thank you to our wonderful sponsors, Professor Roland Tormey and Professor Nihat Kotluk who graciously welcomed us to EPFL and willingly answered the questions we had during our research process. We are thankful to them for proposing this research question, so we could better understand emotions' impact on PBL in the HPL sequence.

Thank you to Professor Nancy Burnham for finding this project and connecting us with our sponsors. We are grateful to have conducted our research on-site at EPFL over the past seven weeks.

Finally, we would like to thank our WPI advisors, Professor Laura Roberts and Professor Christopher Brown for their guidance and support throughout the project. We appreciate their time and effort to provide us feedback on our research on-site and this report. Our work would not have reached such caliber without them.

Authorship

This report took form through individual and collaborative work among group members. For each section written, each member would claim a part to write individually. These assignments were broken up based on the interest and knowledge of the specific subject in each group. During the drafting of the introduction, Kaitlyn wrote the background, Katarzyna wrote the rationale, Christian wrote the state-of-the-art, and Lauren wrote the approach. For the methods chapter, Katarzyna focused Objective 1, Christian and Kaitlyn focused on Objective 2, and Lauren focused on Objective 3. In regard to the Findings and Recommendations, prevalent emotions and their related recommendations were divided evenly among group members. Each group member was responsible for the data analysis and corresponding writing of their assigned emotions. During the outlining process, we minimized repetition by combining similar sections on different emotions.

After a section had been finished, each member of the group provided an editorial review using the Google Docs Suggesting tool. The resulting suggestions were considered as a group. To ensure the intended message was not lost, we followed a general rule that suggestions were approved by another group member. After receiving feedback from the advisors, the team would iterate through the process again as necessary.

Acronyms

PBL – Project-Based Learning

EPFL – École Polytechnique Fédérale de Lausanne

WPI – Worcester Polytechnic Institute

HPL – How People Learn Course Sequence offered at EPFL

HPL I – The first of two How People Learn Courses in a sequence offered at EPFL

HPL II – The second of two How People Learn Courses in a sequence offered at EPFL

SHS – Social and Human Sciences

Meet the Team

Lauren McIlhenny - *Class of 2025, Biology and Biotechnology with Computer Science Minor*

I am from Carlisle, Massachusetts and am studying the life sciences at WPI with a focus on computational biology and bioinformatics. I have observed the shift of many classes to take a more project-based approach to student learning, from organic chemistry to computer programming. Given the interdisciplinary nature of my field, I am interested in project -based learning because of its emphasis upon cross-collaboratory research and was drawn to this project's focus on engaging with engineering students to improve the PBL experience at EPFL.

Katarzyna Racka - *B.S./M.S. 2026, Robotics Engineering with Computer Science Minor*

I am a WPI student from Holden, Massachusetts. Much of my experience is derived from the numerous projects I've completed, most of which were during project-based learning courses. Throughout that time, I have observed the large effect my own moods and emotions have had on my learning experience. As a result, I became interested in others' people's experience and how others' learning was influenced by their emotions. Through this project, I got to gain a deeper understanding whilst also assisting two of the professors of EPFL.

Kaitlyn Saidy - *Class of 2025, Aerospace Engineering with Computer Science Minor*

I am a WPI student from Nashville, TN. I have experienced a lot of project-based learning in many courses which have allowed me to apply more theoretical knowledge through coding, designing, and building with other people. As a student, I know a range of emotions can be associated with project-based learning. Therefore, I am interested in understanding the insights and recommendations that can be made to promote a positive and valuable experience for students in the project-based learning course at EPFL.

Christian Wagener - *Class of 2025, Biochemistry*

I grew up in Germany in a small town south of Frankfurt. After I moved to the States with my family, I went to study Biochemistry at WPI. During my laboratory hours and my humanities courses I have experienced a lot of collaborative projects. As I really enjoy working in the laboratory, I am always very interested in learning how I could improve my cooperation with future lab partners. Since I never took any course on learning myself, I was very engaged in this project about this course at EPFL that does exactly that.

Table of Contents

Table of Figures

Table of Tables

1

PROJECT BASED LEARNING AT EPFL

Photo Credits: EPFL

1. Background

Project-based learning (PBL) is an alternative to traditional learning as seen in Figure 1 (Movahedzadeh et al., 2012). As used within the context of this research study, traditional learning includes lectures, textbook readings, and simple problem solving, which is not an accurate representation of problems encountered in the workplace (Johnson et al., 2015). PBL is a form of active learning in which students work on a subject-applicable project. An effective PBL course includes the application of knowledge rather than just acquisition of knowledge, as well as faculty involvement in the form of feedback and expectations (Heinricher et al., 2013). It is through PBL that students learn how to learn and establish the core skills needed to be successful in the workplace (Heinricher et al., 2013; Johnson et al., 2015).

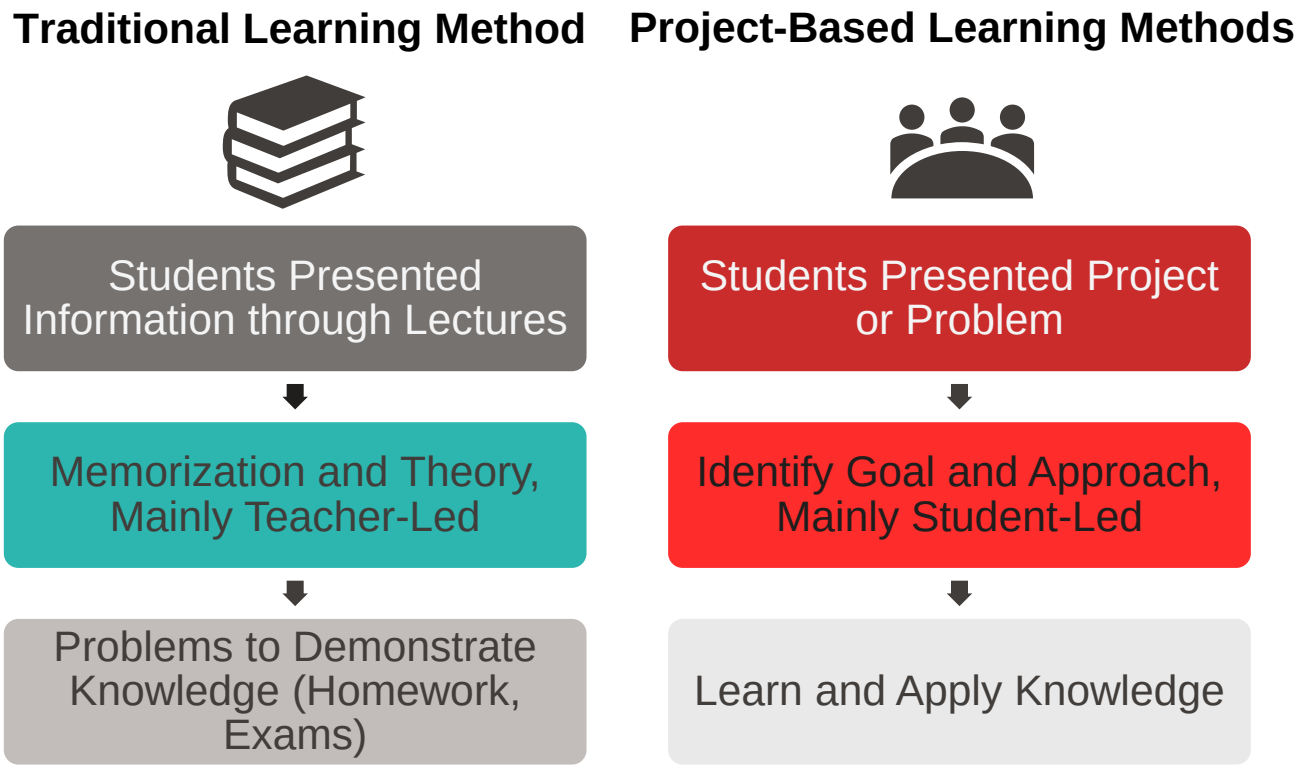


Figure 1: *A Comparison of Traditional Learning Methods to Project Based Methods*
The traditional learning process differs greatly from the project-based learning process due to the latter's focus on collaboration and applicability of learning concepts. While traditional methods gauge achievement of learning objectives through exams or worksheets, student learning is PBL is assessed throughout the development process to emphasize the utilization of introduced concepts.

Emotions are directly linked to students' learning. In their 2012 publication, Pekrun & Stephens define academic emotions as sentiments that stem from an educational setting, including achievement emotions, epistemic emotions, topic emotions, and social emotions as shown in Figure 2. The authors identify achievement emotions as resulting from activities like studying, attending class, and taking exams. These emotions can also be based on success or failure. Examples include excitement for a course or anger at tasks that seem unreasonable. Pekrun and Stephens also define epistemic emotions as those generated during the process of learning. For example, a student can feel frustration from their failure to solve a problem (achievement emotion) or focus on the frustration as a cognitive incongruity (epistemic emotion). The authors then explain topic emotions, which concern students' reactions to learning new subjects, such as surprise in response to a historical event. Finally, the term social emotions describes emotions pertaining to social situations. These include empathy, admiration, anger, and envy (Pekrun & Stephens, 2012).

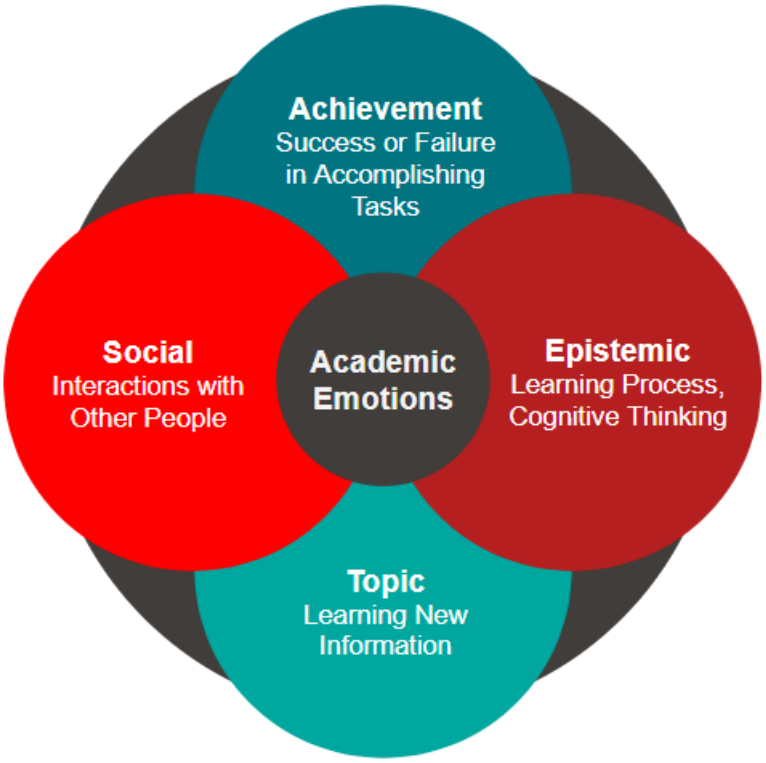


Figure 2: *Academic Emotions and the Ways they are Brought About*
Students experience a variety of emotions when working in an academic setting. These are especially prevalent in project-based learning due to its hands-on and collaborative nature.

The École Polytechnique Fédérale de Lausanne (EPFL) is a technical university in Lausanne, Switzerland. Professor Roland Tormey and Professor Nihat Kotluk teach first year master's students in the How People Learn course sequence at EPFL. "How People Learn: Designing Learning Tools I" familiarizes students with a variety of theoretical aspects of learning. The sequential class, "How People Learn: Designing Learning Tools II," requires students to apply the knowledge they have gained by designing their own learning tool through an open-ended project (R. Tormey & N. Kotluk, personal communication, February 13, 2024; "How People Learn: Designing Learning Tools I", 2024; "How People Learn: Designing Learning Tools II", 2024). They must consider the subject of learning, who will use it, and how best to teach this information (R. Tormey & N. Kotluk, personal communication, March 20, 2024). In the past, projects have included software, games, and handbooks (R. Tormey & N. Kotluk, personal communication, February 13, 2024). The course helps students learn to utilize resources, manage time, contemplate feedback, embrace responsibilities, transcribe meetings, and consider ethics ("How People Learn: Designing Learning Tools II", 2023).

Photo Credits: © Vincent Guignet

Photo Credits: © Alain Herzog + Mediacom/SI/EPFL, 2022

1.1 Project Objective

This project aimed to assess the influence of emotions in project-based learning by researching the How People Learn sequence at EPFL. Our goal was to suggest course alterations to improve future students' emotional experiences with a focus on achievement, epistemic, topic, and social emotions.

1.2 Rationale

Project-based learning has benefits and drawbacks on students' emotional states. Emotions' role in learning is especially critical in project-based learning, where independent research and teamwork are used to develop solutions to real-world problems. Emotions define student academic success, influencing their future professional careers (Pekrun & Stephens, 2012). The improvement of project-based learning courses based on consideration for student emotion equips future engineers with the necessary skills for success in the workplace. Investigating student emotional experience through professors' perspectives or surveys allows for only a limited understanding. Students may be unwilling to share parts of their experience with professors due to teacher-student dynamics, and surveys may collect quantitative data on student experience, but do not provide a comprehensive understanding of the causes for student emotion. There have already been efforts to improve the course prior to our study. The professors of the HPL course have used course evaluations and outside professional

Photo Credits: © 2023 EPFL

perspectives to gain a deeper understanding on the improvement of their course. However, our insight was necessary given that we are also students completing our own project; we could relate to the students on a deeper level. By understanding student emotion and experiences through an insider's perspective, we provided recommendations to improve student learning. We could see perspectives on the course that the professors could not due to their positions as educators.

1.3 State-of-the Art

The role of emotions in education has been researched and defined by many, e.g. Pekrun & Linnenbrink-Garcia (2014) state that emotions are not only experienced during education but influence learning ability. Their classification of emotions reflects the innate involvement of emotions in education. They differentiate between achievement, epistemic, topic, and social emotions.

Educators in engineering traditionally think that learning and emotion should be independent, which can be identified as separate knowing (Kellam et al., 2018). However, emotions combined with reason can be integral to problem-solving as expressed in Figure 3 (Sutherland, 2014). Research on connected knowing, which involves exploring perspectives, empathizing, and feeling, shows that emotions play a critical role in learning due to their ability to affect students' attitude, performance, and decision making (Kellam et al., 2018).

Figure 3: *Emotions Influence Student Learning, Especially in Engineering Education*

Engineering students at EPFL experience academic emotions as they engage with their courses. Rather than viewing these as separate from their studies, connected knowing emphasizes the role emotions play in learning.

Photo Credits: EPFL

It is through Connected Knowing that students can develop strong relationships with professors through perseverance, personally engage with their learning, and become responsive to information that will aid them in discovering their identities as engineers (Kellam et al., 2018).

"Nihat and I, in terms of our work, identify emotions as being an important aspect to the learning process…So I think understanding that better is always good. That's the most fundamental part."

-Roland Tormey, 13.02.2024

As the field of emotions in education is still developing, no singular method for analyzing emotions has established itself as the standard in research. However, some useful methods have been developed. For example, Positioning Theory is a prominent method for considering social interactions, which can be applied to gain another perspective, easing observation of emotions. It is most effective when analyzing power issues due to the relation between emotion and rights associated with a position. In the use of Positioning Theory for engineering education as described by Lönngren, students were studied on how they position themselves relative to emotional storylines, or the meanings of how emotions are performed, in engineering contexts. In Lönngren's study, they found that referring to exact recorded data and examining context was essential to understand interviewee's position on certain topics. Additionally, they noticed that the relationship between the interviewer and the interviewee plays a vital role in the emotional positions an interviewee will take (Lönngren et al., 2021).

For the categorization of emotions, the Cognitive Motivational Model is a method developed by Pekrun et al. (2002). This organization groups emotions by their effects on student learning. This is done mainly in two dimensions, the valence of an emotion, i.e. if an emotion is positive or not, and the activation of an emotion, such as boredom, which would be a negative deactivating emotion. Using this organization, the Cognitive Motivation Model draws conclusions about the effect of emotions on motivation and cognition. The model found easily applied concepts on emotions impacting learning; for example, emotions categorized as negative deactivating are usually detrimental to student learning (Pekrun et al., 2002). As seen in Figure 4, multiple theories have been used to describe the role of emotions in learning.

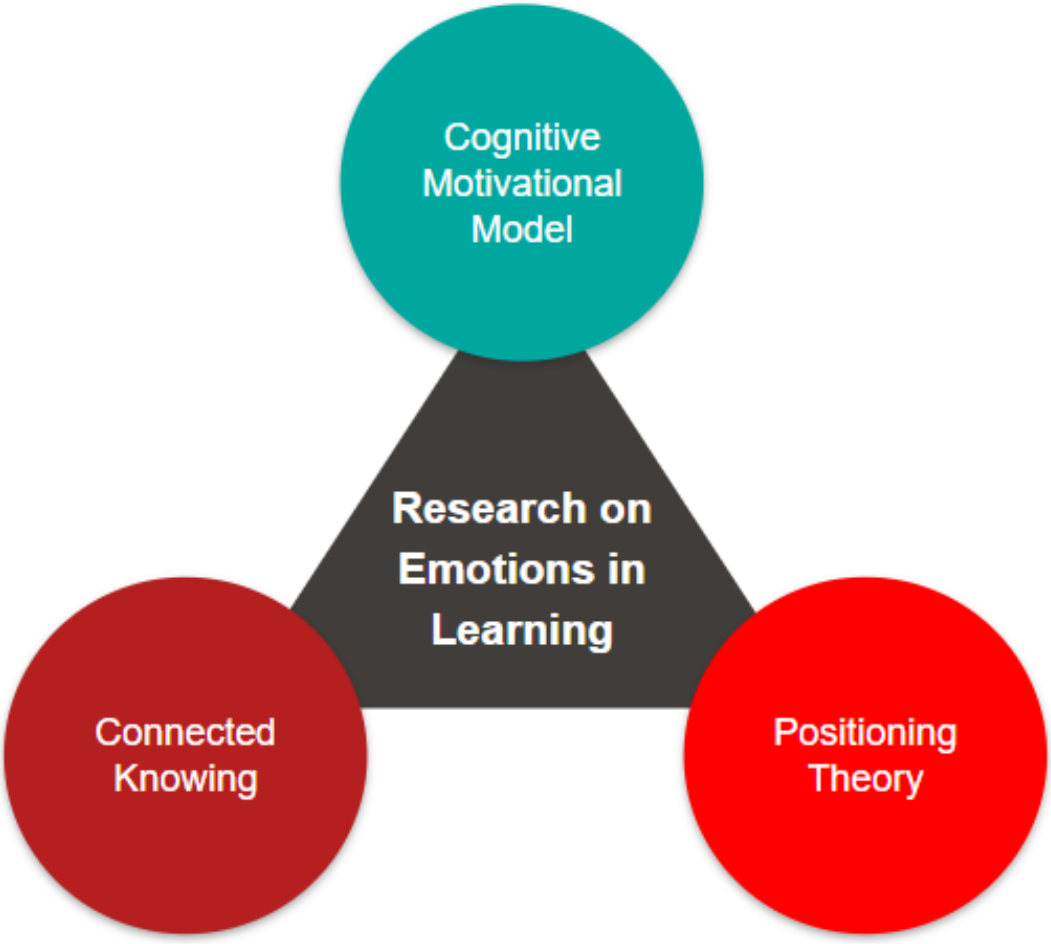


Figure 4: *Previous Research Conducted on the Role of Emotions in Learning*
Connected Knowing, Positioning Theory, and the Cognitive Motivational Model contribute unique ideas that together promote value of emotions in student learning.

Additionally, as shown in Figure 5, researchers from the EPFL Centre for Learning Sciences and Transversal Skills and Career Centre have previously examined the topic of learning in the HPL course. However, this research concerned curriculum alignment with learning objectives and did not consider student emotion. Kovacs et al. (2023) investigated the connection between the intended, taught, and learned curriculum in the HPL sequence, with a focus on teaching and learning transversal skills. Using a qualitative case-study approach, this research examined the usage of a portfolio as an assessment tool to support the learning process in the course. Course documents, interviews, and portfolio responses were analyzed to identify transversal skills across these sources to understand the interactions between the intended, taught, and learned curriculum. Although the study refrains from definitively concluding on student experiences or emotions in HPL, it suggests that guiding students to reflect on the skills they employ during their project work can foster improved alignment between the intended and acquired curriculum to enhance learning (Kovacs et al., 2023). In an effort to continuously improve the HPL course, the instructors have asked a third party for recommendations.

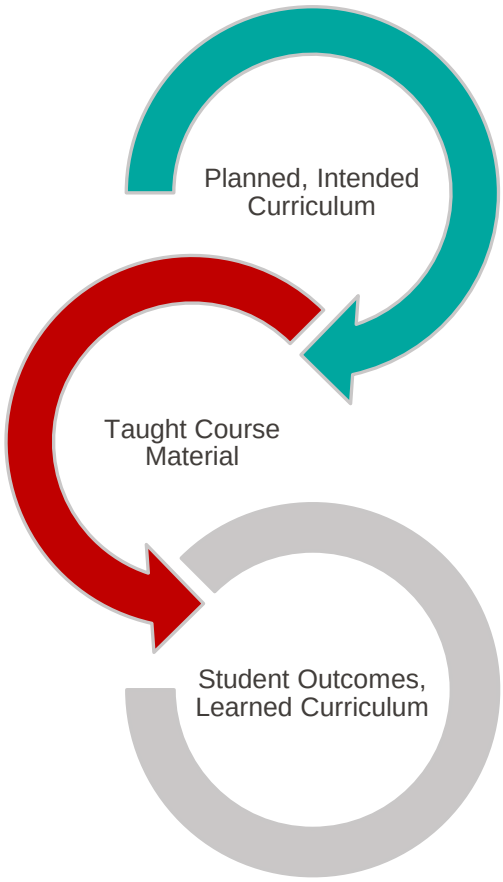


Figure 5: *Previous Research on Curriculum Alignment in "How People Learn"*
Conducted by the Transversal Skills and Career Center at EPFL, a case study-like approach was taken to understand if students were gaining transversal skills in HPL through the outlined curriculum.

1.4 Approach

Our backgrounds as students, familiar with project-based learning and engineering curricula, allowed us to have a more comprehensive understanding of student experiences and connect aspects of course design to positive and negative emotions, as expressed in Figure 6. Our approach was centered around creating genuine connections with the students in HPL based on our many commonalities. Consistent with the approach of Kovacs et al. (2023), we relied on course evaluations written by past and present students to establish an early understanding of student experiences in the course and derive further research questions. Likewise, semi-structured individual interviews were our main method of data collection. Our methods were designed to maximize student comfort, rigid in that their results could be correlated for data analysis but malleable enough to be used in a variety of situations. Aligning with the approach of Harris (2016), we opted for methods of team observations and focus group interviews with student teams to distinctly position the students in control of what information was shared.

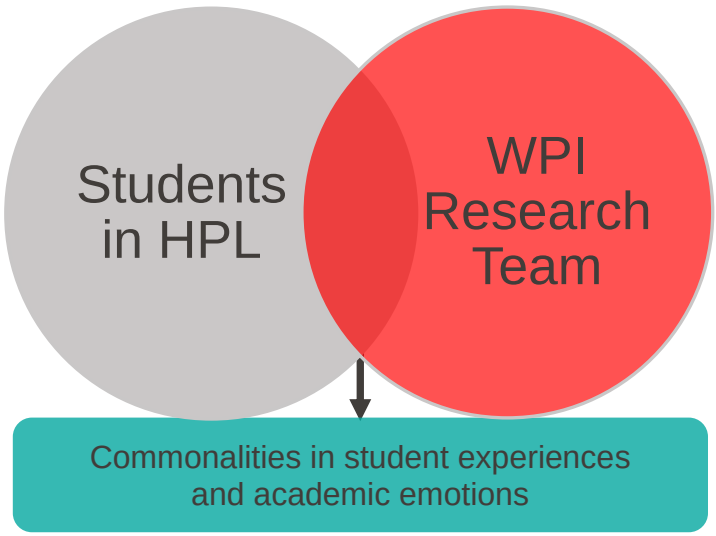


Figure 6: *Our Approach Draws on Shared Backgrounds of EPFL and WPI Students*
To provide our sponsors with useful recommendations, we prioritized forming relationships with the students to understand how they have felt during the HPL sequence.

What differentiated our approach was our emphasis on personal interaction with students and our intentions of uncovering their emotional experiences throughout the HPL sequence. This approach shifted away from methods of evaluating student learning or teaching techniques and more towards creating relationships that would allow us to acquire student sentiment. While we could not guarantee the honesty of students, we gained insights others could not by creating a greater sense of comfort for the HPL students, given our own identity as students, to understand their stories. Observation was another method of data collection we used because of the role students' body language played in understanding their emotional trajectories specifically while working with their project teams. We used Pekrun's Cognitive Motivation Model as a lens through which to view trends in student emotion and differentiate between useful and detrimental emotions. These methods, combined with triangulation techniques for analysis, allowed us to uniquely build a holistic perspective regarding the current students' experiences in HPL. Rather than concentrating on only one aspect of the course, such as organization or learning goal achievement, our understanding of student experiences guided our recommendations for future course improvement, placing their emotions at the center. By integrating current student sentiment and suggestions with our third-party insights, we identified aspects of the student experience in HPL that went beyond the findings of surveys or instructor-administered evaluations. Thorough analysis of course design and evaluation of students' perceptions of the course guided our recommendations.

2

METHODS AND APPROACH

Photo Credits: EPFL

2. Goal

Our goal for this project was to provide our sponsors with an **insider perspective** on their students' emotional experience in their project-based learning course, while making **recommendations** based on our unique perception of the **students' experiences**. We considered the students' responses through the lens of **social**, **achievement**, **topic**, and **epistemic** emotions within student learning.

To achieve our goal, we created objectives to understand the How People Learn (HPL) sequence and student emotion. Our approach can be found in Figure 7.

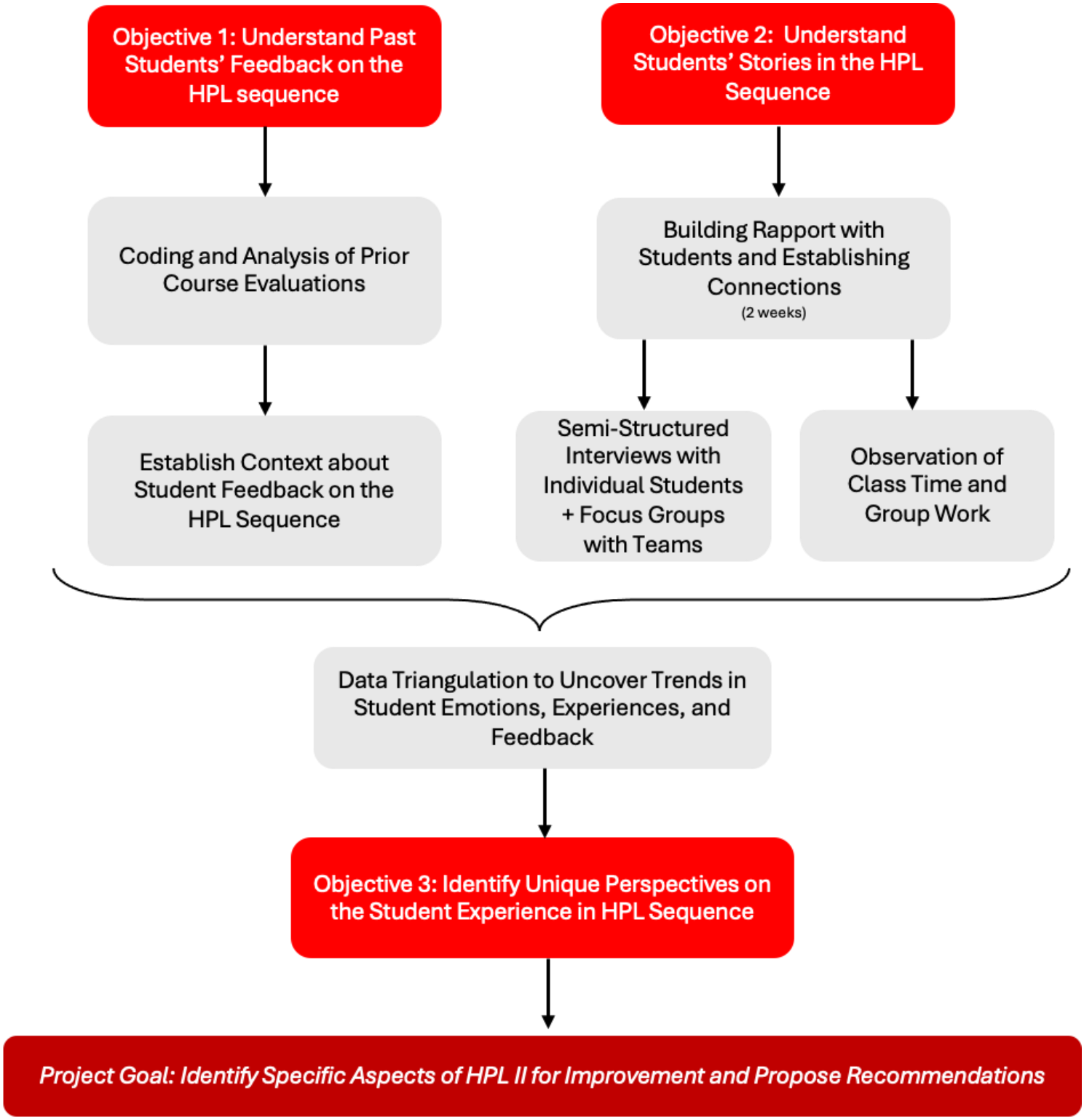


Figure 7: *Flowchart of Project Goal and Supporting Objectives*
This chart demonstrates our on-site research process, including the usage of our selected methods, which was followed to achieve our project goal. We used a threefold approach to collect our data and provide recommendations to our sponsors, combining past student feedback with current student sentiment.

2.1 Objective 1: Understand Past Students' Feedback on the HPL Sequence

Before collecting any first-hand data on student experiences in the HPL II course, we analyzed prior course evaluations to understand past student sentiment and feedback on the HPL sequence. The information from these evaluations included students' opinions, experiences, recommendations, and any other thoughts about the HPL I or II course. We studied the feedback students provided for the instructors over the past years so that we can easily identify emerging trends in emotion and areas for course improvement. Our sponsors provided us with the anonymized course evaluations from the HPL I course offered in 2022-2023 and 2023-2024, and the responses from the HPL II course offered in 2020-2021, 2021-2022 and 2022-2023. We individually read these evaluations, noting trends in student emotions and feedback, then compared notes to develop overarching categories of responses and corresponding codes. Our coding system can be seen below in Table 1. Every code fell into one of four major categories either pertaining to student emotions, complaints about the course, praises for the course, or N/A. Although not applicable to our research on the HPL sequence in 2023-2024, mentions of topics or material from previous years were identified in our coding and specified as N/A because they provide context for student feedback. Once these preliminary codes were established, we coded the qualitative course evaluations as a group. An example evaluation response, with its corresponding code(s) and categories can be seen in Table 2.

Photo Credits:
EPFL

Photo Credits:
Dominique Perrault
Architecture

Emotions	Complaints	Praises	NA
Overwhelmed (OV)	Too Much Work (TMW)	Course Content (CC)	Client (CT)
Confused / Lost (CL)	Organization (OG)	Teaching Style / Interaction (TSI)	Zoom (ZM)
Enjoys (EJ)	Classroom / Class time (CR)	Course Value (CVP)	Hybrid (HY)
Interested (IN)	Course Pacing (CP)	Usefulness (US)	Sustainability (SA)
Disappointed (DP)	Contingency between HPL 1&2 (CHPL)	Prototyping / Project (PR)	Poly-perspective axes (PPA)
Bored (BD)	Feedback (FE)	Manageable Workload (MW)	
Irritated / Frustrated / Angry / Upset (IFAU)	Process vs Project (PVP)	Organization (POG)	
Fulfillment / Appreciation / Thankful (FAT)	Course Value (CVC)	Non-Specific Appreciation (NSA)	
Unheard (UN)	Communication, Clear Expectations (Clarity) (CE)		
Surprised (SP)	Recommendations (RC)		
Anxious / Nervous (AN)	Assignment / Assessment Design (AD)		
Motivation (MV)	Group Dynamics (GD)		
Stressed (ST)			

Table 1: *Coding System Developed from Prior Course Evaluations*
We created the codes in the table above based on student responses in the course evaluations. They were organized based on whether the response corresponded to an emotion, complaint, praise, or was not applicable to the scope of this project.

Response	Emotions	Complaint	Praise	N/A
Overall, a good course. I appreciated that the teacher is always willing to take time to answer any questions. Some concepts are very helpful but I do not feel like everything we learned actually gets applied in the course. I also think that the way groups were assigned was bad, I got stuck with a bad group and a project I don't like, so the work feels like way too much for an SHS course. The Moodle could be better organized too ☺	FAT, IFAU, OV	OG, AD, GD	NSA, TSI, CVP	

Table 2: *Example of Student Evaluation Response with Coding*
This table shows a sample course evaluation featuring the highlighting and coding we used to analyze each response. The response shown above was fabricated due to the privacy policy of course evaluations and serves merely as an example.

Upon the completion of the coding as a group, we counted the frequency of each code. Using Google Sheets, we calculated the percentage of qualitative comments corresponding to each code. This allowed for a visual comparison of the themes in student responses as the total number of responses for each course evaluation varied. We used bar graphs, corresponding to the percentage of each code's occurrences in each course, to visualize trends in responses in "How People Learn I" and "How People Learn II." A limitation of this form of visual analysis of the qualitative responses is that it excludes the quantitative responses. By examining frequency and trends of a given response category, we identified particularly relevant concepts to build context for student experience in the HPL course and amended our interview questions to be posed to students.

2.2 Objective 2: Understand Students' Stories in the HPL Sequence

After sending the students of HPL an introductory email (seen in Appendix A), we chose to spend our first two weeks on-site building rapport with the students of HPL to establish genuine connections. These relationships were critical as they motivated students to participate and allowed them to feel more comfortable giving honest responses in the interviews. The secondary goals for this period were to learn what in-person class time for HPL II looks like and observe preliminary student and professor interactions. We attended the weekly HPL class sessions and informally met with students to better introduce ourselves and our project. We tailored our data collection tools, such as our interview questions, based on our experience in these early weeks and insights obtained from course evaluations so that we could extract the most important information about student emotional experiences.

During our more formal period of data collection, our goal was to build an understanding of the current students' experiences from their point of view. To help understand the students' view, we identified and utilized emic categories and terms throughout our data collection; emic terms refer to vocabulary used by the participants (Beebe, 2014). By paying closer attention to using emic terms, we further ensured that

we did not lead the participants to any answers. Before starting the data collection, we agreed upon the structure of the notes and codes for consistency. Our main methods of data collection used were individual semi-structured interviews, observations of groups, and focus group interviews, which allowed for rapid collection of rich data; we used these due to the time constraints of our project.

We conducted observations during the weekly HPL class period, on Wednesdays from 16:15 to 19:00 at EPFL to identify how academic emotions manifested in the students as they worked with their groups. We used observations because they allowed us to study student body language and provide supplemental information to their self-perception communicated in interviews. We relied on this non-dialogue setting to deduce social emotions relating to group dynamics, as well as achievement and epistemic emotions. We observed how the trajectory of emotions developed as students worked together. We also used the information from these observations to identify students of interest to potentially interview. In qualitative analysis of a sample, it is important to represent a broad range of experiences (Beebe, 2014). Consequently, students who did a lot or too little work were of particular interest to us. The emotions observed during group interactions were of special importance as they provided insight into what students perceive to be socially acceptable. The behavior observation guide which was used when conducting any on site observations can be found in Appendix B. If time allowed, we asked students the questions seen in Appendix C upon the conclusion of the

observation to gauge whether our observations were analyzable. We included memos (reflective comments) on improvements, insights, and ideas in our notes from these observations. Kaitlyn and Lauren took notes digitally while Katarzyna and Christian took notes on paper for ease before digitizing their notes. This standard ensured comparability and ease within the analysis process by framing the setting and clearly separating memos from observations. After observations, the pair that observed the students reconvened to privately discuss and summarize the results of their observation.

During semi-structured interviews, we actively engaged with students, inquiring about their experience and sentiment regarding the HPL course, as observed in Figure 8. We interviewed twenty-two individual students to learn about their personal emotional experience in the course. Appendix D contains our sample interview guide and questions. We also interviewed six student groups together to gain information on team dynamics and the process of completing their project.

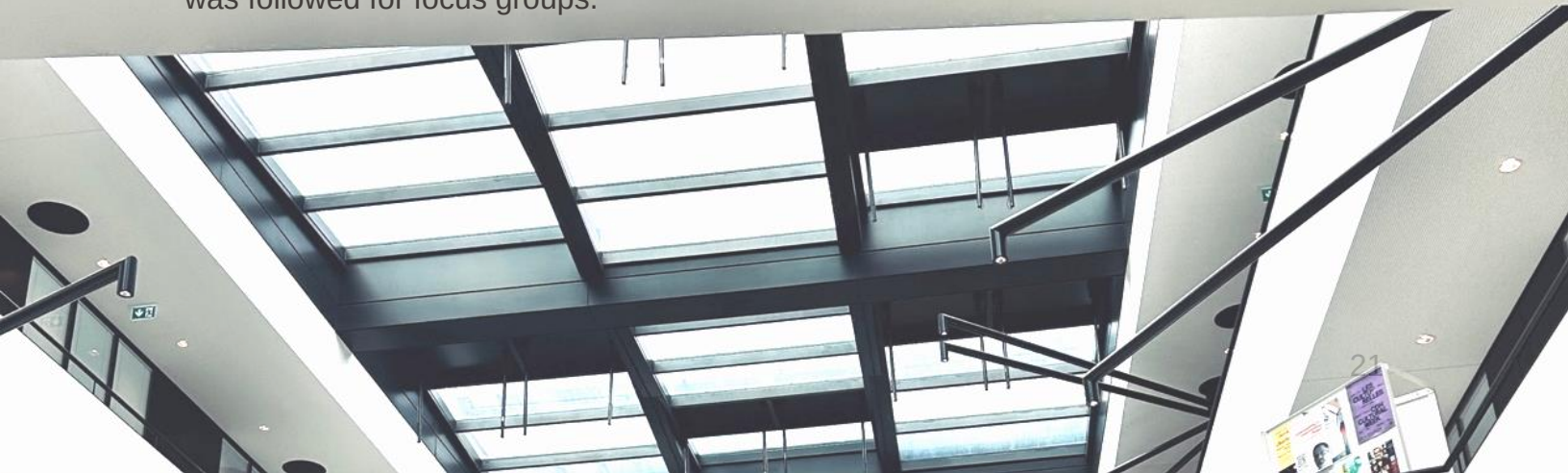
Figure 8: *Example Interview Set Up*
The image above shows team members Kaitlyn and Lauren in a sample set up for an individual interview. Such interviews occurred in a relaxed environment, with laptop screens typically faced away from the interviewee.

These focus groups revealed what students felt they could share in a group setting, highlighting social restraints regarding what was “allowed” in these settings contrary to what they actually thought or felt. They demonstrated the warmth team members felt towards each other, the safety they felt to share ideas, and the sense of authority that team members had. They also served to reach students who were not willing to participate in individual interviews. Appendix E contains our focus group interview questions and guide.

To acquire interviewees, we created a brief sign-up form for the students of HPL, which the professors sent out by email (see Appendix F) to encourage students to participate. The sign-up form that was presented to the students can be seen in Appendix, G though there were no responses. The primary method of identifying and acquiring interviewees was meeting students in class. We introduced ourselves and exchanged contact information on a personal, informal basis. After having some conversation in person or by text, we asked students if they were interested in participating in individual interviews. This encouraged a comfortable environment for interviewees and ensured that interviews were conducted in a manner that worked well for them. All twenty-two interviews were recorded and transcribed with participant consent provided. Appendix H shows the consent statement that we used as a guide to inform all participants before the start of an interview. To keep the nature of the semi-structured interviews from feeling too formal, we did not read off the consent statement word-for-

word but instead paraphrased it to obtain consent. Two members of the research team conducted each interview, with one posing the interview questions and the other recording notes and observations about interviewee body language. We did so in pairs to avoid intimidating students while also gaining multiple perspectives for analysis of student response. This also allowed concurrent data collection when students had timing restrictions. We compiled the interview notes and transcripts and then the two team members who conducted the interview coded them to simplify analysis. Afterwards, the other two team members who did not participate in the interview reviewed their work to examine potentially missed insights.

For the analysis, a transcript of each interview and focus group was created using Otter AI. The AI shortened the amount of time needed to transcribe; however, the transcriptions were imperfect. Therefore, we reviewed and edited the transcripts for improved accuracy. The codes that were used to code the transcripts can be found in Table 3. The entire transcript was organized by response using a tabular format, with codes categorized into emotions, praises, and complaints, as seen in Table 4. We read through each response to each question carefully, and highlighted words, phrases, and sentences in blue for emotions, red for complaints, and green for praises in the transcript column. The specific codes that were applicable in a response were added in the same row in the appropriate column on the right. There was no limit to the amount of codes or highlighting that was used in a response but for each response each code could only be used once. Therefore, many responses contained several codes whereas some contained none. After coding each interview, we wrote a summary at the top of the document, identifying major themes that were observed. If a new theme emerged, requiring a new code, our team would agree upon the new code, and revisit previous interviews to check if any instances of the new code were present. A similar process was followed for focus groups.



Emotions	Complaints	Praises
Overwhelmed (OV)	Too Much Work (TMW)	Course Content (CC)
Confused / Lost (CL)	Organization (OG)	Teaching Style / Interaction (TSI)
Enjoys (EJ)	Classroom / Class time (CR)	Course Value (CVP)
Interested (IN)	Course Pacing (CP)	Usefulness (US)
Disappointed (DP)	Contingency between HPL 1&2 (CHPL)	Prototyping / Project (PR)
Bored (BD)	Feedback (FE)	Manageable Workload (MW)
Irritated / Frustrated (IF)	Process vs Project (PVP)	Organization (POG)
Fulfillment / Appreciation / Thankful (FAT)	Course Value (CVC)	Non-Specific Appreciation (NSA)
Unheard (UN)	Communication, Clear expectations (Clarity) (CE)	Positive Communication and Clear Expectations (PCE)
Surprised (SP)	Recommendations (RC)	Learning New (LN)
Anxious / Nervous (AN)	Assignment / Assessment Design (AD)	Assignment / Assessment Design (ADP)
Motivation (MV)	Group Dynamics (GD)	Freedom (FR)
Stressed (ST)	Bad but Understand (BBU)	Group Dynamics (GDP)
Relaxation / Relief (RR)	Too Much Freedom Complaint (FRC)	
Uncomfortable (UC)		
Angry / Upset (AU)		
Discouraged / Disengaged (DD)		
Hope (HP)		
Indifferent (ID)		

Table 3: *Coding System Developed for Individual and Focus Group Interviews*
We created the codes shown in the table above based on student experience in the course. They were organized based on whether a student's response included feelings/emotion(s), complaint(s), or praise(s). We created this system by amending our previously developed codes from the course evaluations to include student sentiment distinctly expressed in interviews.

Transcript	Emotions	Complaints	Praises
Interviewer			
Tell me about your time in the HPL II Course.			
Example Response			
It is interesting…um I was a bit confused at first. Like there are a lot of deliverables, and we had to ask the professors when we have to turn this in. The professors are readily available to help meet with us uh…I like the project that we are working on, but we spend like, we spend way too much time reflecting on the process and like, I am worried there will not be enough time to finish the project.	IN, CL, AN	CE, PVP	TSI, PR

Table 4: *Example of Individual Semi-Structured Interview Response with Coding*
This table shows as a sample response from an interviewed student featuring the highlighting and coding used to analyze it. The response shown above was fabricated due to privacy concerns.

2.3 Objective 3: Identify Unique Perspectives on the Student Experience in HPL Sequence

Our final objective identified unique aspects of the student experience in the HPL course, which involved perspectives that professors, survey responses, or course evaluations do not consider. We used student perspectives as the basis for our deliverable as seen in Figure 9. We accomplished this by thorough review of all previous data to recognize broader trends and drew overarching conclusions regarding student experience in HPL. We created a mass spreadsheet containing a tab for each emotion that had been encountered throughout our coding. We sorted all responses from individual interviews associated with that specific emotion and identified respective reasons for those emotions as seen in Table 5. We determined the percentages of students who felt a certain emotion due to a specific cause as can be seen in Table 6. This process was repeated for every emotion observed. Furthermore, we chose to focus either on the three most prevalent causes or the causes that were expressed by over twenty percent of the students if more causes were necessary to provide a holistic perspective on sources inducing student emotion. We identified commonly expressed emotions during the interviews by recording their percentage as shown in Table 7. We then determined how uncommon emotions intertwined with those of greater frequency. Analysis of these findings uncovered subtle emotional trends and shared attitudes relating to students' course experience.

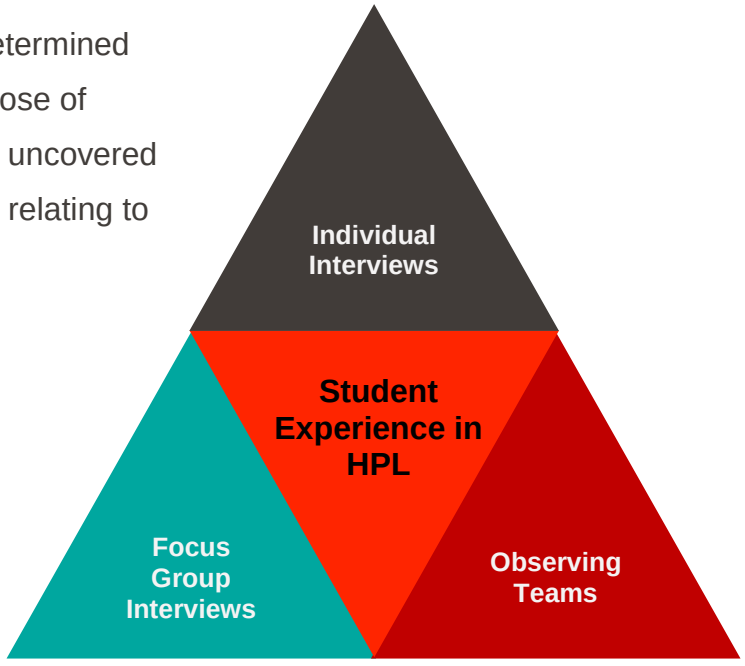


Figure 9: *Triangulation of Data to Uncover Student Experiences in HPL*
This figure demonstrates how we bridged together our three methods of data collection to obtain a clear picture about how students were feeling throughout the HPL sequence. Data from one method was considered alongside data obtained from other methods to contextualize responses especially pertaining to group dynamics.

EMOTION	ANXIOUS/NERVOUS		
Num	**Interviewee**	**Cause**	**Response(s)**
1	Example A	PR	1. I am worried there will not be enough time to finish the project.
2	Example B	GD	1. I am anxious that my group members will not produce work that lives up to my expectations. 2. One group member has not done enough work and I am worried we will not complete our work on time.

Table 5: *Example of Sorting Student Responses by Emotion and Assigning Their Causes*
This table shows how we sorted response segments identified to portray an emotion. We made tables in this format for every emotion interviewees commonly expressed. When assigning a cause to a segment, we grouped responses by the same interviewee if the cause for the emotion was the same. The response shown above was fabricated due to privacy concerns.

Tot Num Respondents:	22		
Summary			
Cause	**Num Respondents for Cause**	**Respondents**	**% Cause for Emotion**
CC	8	A, B, D, I, M, R, T, U	22.72
CVC	2	K, O	9.09
PR	12	B, C, E, F, I, J, N, M, O, R, T, V	54.54

Table 6: *Tallying Different Causes for a Common Emotion*
This is a sample organization to determine the percentage of students who expressed an emotion for a certain reason. The response above was fabricated due to privacy concerns.

Emotion Prevalence in 1-on-1 Interviews Only			
Emotion	**Respondents who mentioned it**	**Total Respondents**	**% Cause for Emotion**
AN	14	22	63.63

Table 7: *Tracking Overall Prevalence of Emotions Expressed in Individual Interviews*
In this chart we show how many individual interviewees expressed an emotion. The response shown above was fabricated due to privacy concerns.

Triangulation across all methods through group discussion identified broad messages about student experience and led to our recommendations focusing on experiences traditional evaluation methods may miss. We observed how the observations and responses from focus groups, or lack thereof, informed the group dynamics that were expressed during individual interviews. We used bubble charts to compare the prevalence of emotional experiences for three causes: concepts, project, and groups, as these three causes were major factors in the student experience of the course. Additionally, we identified emotional trajectories that spanned from the start of HPL I until now to identify the changing themes of emotions expressed by students throughout their time in the HPL sequence. There was no singular trajectory that students experienced, but a common emotional trajectory was uncovered. After coding all the interviews and observations, compiling the data with the previous course evaluations, and recognizing major themes, we formulated recommendations based on students' emotional experiences. We took inspiration from literature, students' personal recommendations, and our own experiences as polytechnic students with similar experiences. We completed this over the timeline shown in Appendix I.

2.4 Data Management

All our interview and observation notes, as well as transcripts, were stored in a shared Google file folder between our private accounts. Audio recordings were taken on a mobile phone and then transferred to the folder for transcription purposes via Otter AI before being deleted. All handwritten data was kept in our possession, which included a sheet with students' first names and contact info. We had exclusive access to the raw data collected. None of the participants' names were used in the final report or stored digitally to protect and respect their privacy. After completing the final report, we deleted all electronic data and shredded all the handwritten data to verify that the participants' identities remain anonymous after publishing the report.

2.5 Obstacles

Sampling of research subjects for qualitative research in a rigorously scientific manner is complicated, as participants need to consent to their involvement. This makes random sampling challenging. However, qualitative studies' selection criteria are more focused on increasing yield of profound information per case. Additionally, the large sample sizes that improve representation are not always feasible for qualitative studies due to time sensitivity of research (Staller, 2021). All of these restrictions in sampling could lead to biases in data; in our study we attempted to adjust by including cases at both extreme ends to obtain a more diverse representation of student experiences in HPL (Beebe, 2014).

We cannot guarantee the honesty of students and the information we learned from them. Students may be insincere in their responses, as they could fear consequences for negative sentiment on the course, feel ashamed of their opinions, or feel uncomfortable sharing them in front of others. We held all interviews in familiar and comfortable environments and continued to remind students that all data is confidential and their identity will not be shared. Nonetheless, we could not guarantee the comfort of every participant.

Further, the sample of students from the course was biased towards those who regularly attend the non-mandatory class session, as those were the students we were most likely to interact with and obtain data from. We were unable to reach those who had never attended class. The sample size of participants was also limited to the students enrolled into the course at the time of research.

Participants' perceptions of emotions or experiences are uniquely personal. When drawing conclusions, we were conscious that emotional processes vary significantly from person to person and honored these differences by minimizing generalizations about student experience in HPL. Coding forces data to become assimilated under rigid labels, therefore we were conscious to prioritize the utilization of students' own language and emotional descriptors in our results. Nevertheless, interpretation of emotions is always biased given their subjective nature even when done as a group. However, this subjectivity is inherent to qualitative research. As long as there is transparency of interpretation, objectivity is not required and the data retains its value.

This study was constrained by time due to the nature of our project. The period of our research study did not encompass the entirety of the HPL II course, nor did it coincide with the beginning or end. This may have had an effect on the types of student responses, as emotions are subject to change as the course progresses. These limitations had direct implications on our data sampling and analysis processes as these always profit from more time.

2.6 Ethical Considerations

We ensured that our research adhered to ethical guidelines as we obtained informed consent from participants, protected their privacy, and minimized any potential harm or discomfort they may experience. Our project was approved by The WPI Institutional Review Board (IRB) with record number IRB-24-0481, which confirmed that there were no harmful or negative aspects of our project which would make our data collection and on-site research unethical. This review process also ensured that our project obeyed Switzerland laws and cultural practices, given it was conducted in a country we were previously unfamiliar with.

We informed students that we were conducting research to improve the course design, but we could not guarantee that the course will be changed significantly during its current offering period or in the future. We informed students that their participation did not hold any influence on their academic standing, and they would not be penalized or rewarded in any way. We made transparency our priority in our implications and interactions with the sponsors and the students. Given that we aimed to understand students' stories not only relating to the HPL course but their academic journey more generally, it was critical that the personal lives and privacy of students were respected. We composed an email to send out to the students from their professors on our behalf, which informed them of our research, provided photos of ourselves for students to identify us, and invited them to share their experiences. Appendix H shows the draft of the email. We asked students to verbally consent to participate before answering questions.

We informed them that their answers may be drawn upon in our final report. We detached all names and data and deleted all data after finishing the report. Appendix G shows the statement of consent. No student was placed in a situation in which they felt obligated or coerced into sharing private information. Participants remained anonymous to reduce the risk of identification and any potential repercussions associated with their responses. All participants had the opportunity to skip any question or stop the interview at any time.

At EPFL, we took on a dual role as researchers and peers. We realized that we are completing a study of the students' experience; however, as people who are closely in age with the HPL students, we valued their experiences and did not want to see them simply as research participants. Therefore, we made a critical effort to know them as people. We interacted casually with them, making sure that our observations and interviews have a sentiment of a back-and-forth conversation rather than a direct questioning. We informed them that we are conducting a research study while also informally conversing with them. This process allowed us to find balance in gaining accurate data and encouraging genuine conversation.

We honored the uniqueness of each students' experience in order to provide our sponsor with reflections on the course and valuable recommendations for its improvement. We acknowledged and respected the diversity of students' backgrounds, experiences, and emotions, and avoided generalizations or stereotyping in our data interpretation.

3

RESULTS AND ANALYSIS

Photo Credits:
© Jamani Caillet

3. Results

3.1 Introduction

We analyzed and categorized emotions through the lens of academic emotions, sorting student emotions into topic, epistemic, achievement, and social emotions. Under these categories for each emotion, we elaborate on the causes for the students' emotions. Figure 10 shows a word cloud that describes the 19 most prominent words students used to describe their emotional state throughout the HPL sequence. Emotions ranged from positive to negative to neutral and had varying sizes of prevalence within student experiences.

Figure 10: *Word Cloud of Emotion Categories*
The word cloud above shows the nineteen emotional categories that we observed. The size indicates the prevalence of each emotion expressed by students. Bigger words were observed more than smaller words.

3.2 Topic Emotions

3.2.1 Course Content in HPL

Interested
Disappointed
Bored

All twenty-two students indicated interest in at least one aspect of the course. One student expressed interest in the HPL course because they desired to “learn how people learn,” and was keen to learn something different compared to their engineering coursework. Furthermore, eight other students wanted to better understand the process of learning. Students were generally intrigued by many concepts presented during the lecture in HPL I, including the memory model, Gantt charts, emotions’ effect on cognition, and efficient learning. Two students found that these concepts had previous overlap from their fields of interest or passions including psychology and teaching. One student was curious to learn the theory behind what they do every day and another student wanted to dive into concepts that not everyone is familiar with.

However, three students reported that they did not intend on taking the course but had to because their course of choice was not available to them. Three other students explained that they expected the course to focus on studying techniques that they could apply to other courses. Those students described that they felt not fully engaged and were disappointed as a result too. Of the students that expressed boredom, the leading cause given was that the lecture content was repetitive and at times superficial; they felt the lessons were too slow. Four students explained that they felt disappointed by the concepts and the information presented lacking depth. They reasoned that the teachings would feel more valuable if they provided more detail; individual students proposed that including more research findings on concepts taught could aid with this.

3.2.2 Project Topic

Interested
Motivated
Disengaged

Five students also expressed interest in the project topic they chose, and two other students conveyed passion for the subject matter. They enjoyed digging deeper into an unfamiliar subject through research. Furthermore, two students conveyed interest in learning from experts in their respective fields by visiting specific centers that were closely related to their chosen topic. In addition, three students were intrigued by the ethical considerations that came from their topic as they explored user and employee biases and the formation of opinions regarding right versus wrong. As a result, one student was attentive to the responses of other students' their age regarding these ethical considerations.

Five students mentioned feeling motivated particularly due to the topic of their project. In these cases, this motivation was determined to have occurred because these students possessed a personal connection, usage for, or any other relation to the project topic itself. Examples of such a connection were seen with students feeling motivated due to their project deliverable concerning EPFL specifically or their own field of study.

As opposed to students being motivated, multiple interviews revealed that students were not always happy with the project their group chose and did not feel engaged by it. Some students expressed that they felt disengaged from the project as it was limited to the ethics in engineering. They often added that it was not relevant to them as it did not relate to their degree. Some students expressed feeling discouraged by their project topic as they knew little about it and felt ill-equipped.

Photo Credits: Dominik Gehl Photography

3.3 Epistemic Emotions

3.3.1 Working on the Project

Enjoying Anxious Hopeful

Four students enjoyed applying the concepts from HPL I to their practical, hands-on project in HPL II. In turn, one student valued the opportunity to challenge themselves as the project pushed them out of their comfort zones. Seven students wanted to work on the project because they found it fun. In fact, two students mentioned finding working on the project to be a calming break from the other engineering projects they have. In regards to working on the project, motivation was also a commonly expressed experience. Three students directly conveyed an eagerness towards the freedom of the project process, while others alluded to it more indirectly while reflecting on their project's process or group dynamic. HPL II required students to manage a long-term team-based project with elements of research, design, and prototyping. The project entailed utilizing concepts from the previous semester and some students conveyed that this immersive nature made them jump into the process. This uncertainty and the thought which it provoked seemed to motivate them forward. There appeared to be an understanding from these students that this may be a more irregular and nontraditional project experience, and this fact motivated them to make progress on their project rather than shy away. One student reflected that they were “sure they will manage it” in regards to the daunting nature of the project process, especially because they possessed experience with larger projects.

Similarly, one student was excited about iterating through the design process to improve their learning tool. Three other students who expressed motivation related to working on the project explained that it was due to the opportunity to obtain differing viewpoints and skills from other group members during the process. The diversity in thought which arose from completing the project in a group setting motivated such students to collaborate with others and work on the project because they valued hearing differing ideas. We observed this specifically in one focus group, where one team

member expressed feeling distinctly motivated by the thought process evoked from other members offering their own research and perspectives.

Finally, two students were greatly motivated by the opportunity to apply the concepts of the first HPL course to the project, particularly the conversion of theoretical knowledge into something more physical. As seen above, a bit less than half of students derived motivation through the *process* of designing a learning tool, rather than from what their project could achieve. Nevertheless, in contrast to motivation on the project, eight students have indicated that they were not engaged by their project because they had a limited amount of time and would prefer allocating it for courses that are more important to their field of study. Additionally, three students have explained that they feel disappointed as they cannot apply all the concepts learned in the previous semester, again citing time constraints.

Whereas two students came to the conclusion of not being able to apply many concepts, four students were confused about how to apply the concepts learned to their project, citing the gap between the theoretical and the practical. Two students mentioned feeling overwhelmed while working on the project because of the need to change their prototype often, “iterating” through the design process an uncertain number of times based on feedback. Integrating new information with previous beliefs was the believed cause behind such overwhelm. Two other students highlighted how their overwhelming emotions were derived from integrating together individual project research as a team. With so many different ideas overpowering team members, they felt like there was too much information being presented at once. The uncertainty which arose from thinking of how to sort or organize such information was the root cause of these other feelings of overwhelm.

At least ten students mentioned feelings of stress as they struggled to find time to dedicate to the project. They feel stressed because they lack additional time to dedicate to their project, as they must focus on their other classes and projects. The planning and deadlines of the HPL project could become stressful when groups fell behind and pressure to catch up arose, especially as the process to do so often takes additional thinking and planning for future time management. This stress was exacerbated around

breaks and exam periods as students had to figure out how to manage and progress on this project around their other projects.

The uniqueness of the HPL project caused three students to feel anxious as they had never done anything like this before. The freedom meant that they must thoroughly consider every part of the project and possibly embrace new methods of project management. These students worried as they struggled to figure out how they would execute the project in general in addition to the project specifics. This uncertainty led the students to anticipate future difficulties in project implementation that could block their progress. This was a concern for them as they had to produce several iterations of prototypes that could be tested. Seven students mentioned stressing or worrying over balancing project contemplation, implementation, and testing while effectively managing their time for HPL.

Despite feeling anxious, two students also signaled that they had felt hopeful that through the process of their project, anything that was unclear would become understandable and they could relax. These responses indicated that students were thinking about how the more progress they made, the more they could consider the reasoning behind both their own decisions and those of the professors due to the context their project would provide. The guidelines for the project did not make sense until the students were working through them.

Five students conveyed feelings of hope stemming from working on the project and all the epistemic experiences which it entailed. Three of these students explained that they felt hopeful about the process of developing their project. This was especially true for students who had experienced setbacks in working on their project. For example, after falling behind on the project, two students reflected that they felt hopeful that they would catch up on work and make substantial progress on the project in the future, having a positive experience in the process.

3.3.2 Course Organization

Overwhelmed Confused

More than a fourth of students interviewed indicated that they felt overwhelmed due to the organization of either the HPL I or II course. Two students explained that they were overwhelmed specifically because of the way course materials were presented in the first HPL course. Examples such as continuous difficulty accessing course materials on the Moodle, high numbers of PDF links, and other persistent issues following the course's organization were mentioned. The term "chaotic" was utilized by many of the respondents who mentioned feeling this way because of HPL I's organization.

Another student attributed this emotion to the organization of the second HPL course, with the class time being organized into one three-hour session. On the other hand, four students mentioned that the reason they felt overwhelmed was the organization of HPL II, with smaller assignments mixed alongside larger reports. When these students thought about HPL II's individual assignments such as reflections, they felt overwhelmed as they were also planning and working on their project. As a result, these small tasks were sometimes neglected by the students, who stated things such as, "Because of difficulty having a lot of small things to focus on that are…very dispersed. And maybe they are well documented. But it's true that…for example, in… during the first weeks, especially, I have to go each week to the Moodle to understand, okay, so we have to do 'This, this, this, this, this.'" This student explained that the small tasks were well explained, but their organization contributed to the class's cognitive load and caused overwhelm by being mixed within larger, more important deadlines.

Three students have expressed some confusion about the time plan for the course, specifically for the first semester. They struggled with keeping track of all the assignments they have to do each week and felt uninformed about the organization of the course in a comprehensible manner. Two noted a calendar or time plan of all the assignments for the course could prove useful.

3.3.3 Course Clarity and Expectations

Confused Frustrated Overwhelmed

Eight students expressed confusion about or lost on what they had to do. The main cause of confusion for students was unclear instructions and expectations. Ten students explained how various assignments and activities from the first semester were confusing as they did not know what to actually do and could not identify the reason or value of the exercise. However, these feelings of confusion on what to do persisted into the second semester. Fourteen students stated that they were unsure of instructors' expectations or questioned whether or not they were on the right track. Five students stated that this confusion led to feeling overwhelmed, hindering their progress on the project. In fact, three students were caught by surprise when they suddenly realized the professors' expectations differed from their original perceptions of the task at hand. The lack of clarity and the confusion contributed to feelings of frustration for four students as they struggled to understand what they were expected to deliver, especially in the first few weeks of the course. One wished that the expectations were clarified earlier so that they could have had a better understanding of how much work was required and could have prepared accordingly. Another student experienced additional frustrations as they would have to repeatedly meet with the professors to clarify project expectations, which became more annoying to them when they realized they forgot to ask a question. All in all, these four students experienced frustration as they were unable to realize their skills or make project progress due to the lack of clarity.

When course clarity was lacking, more than a fourth of the interviewed students agreed that the project appeared extremely daunting as they became wrapped up in their own negative thoughts, ideas, and questions, which built to a point that greatly overwhelmed them. Using descriptors such as "being thrown into the ocean and taught to swim without instructions or a safety boat," the students detailed that it was typically a lack of clear expectations or examples regarding how the theory should be implemented into their project that resulted in feelings of overwhelm when they were "tossed" into the project of HPL II.

3.3.4 Assignment Design

Irritated Disengaged

Eight students explicitly expressed irritation over course and assignment design. Of these, three were annoyed that they had to work in groups that they did not choose. They would have preferred to work alone or would have liked to choose their own groups, or at least choose one group member. The design of specific assignments caused five students to become mildly irritated, though the assignment itself varied between individual students. Examples of assignment design that caused some irritation included the class readings, exam question difficulty, use of paper in class, recording assignments, shallow incorporation of theoretics, and the time taken for reflection assignments.

Four students contended that they may have felt disengaged from their project by the writing assignments they have to do during the second semester as these assignments reduced their engagement. Two students directly admitted to not having participated in all class activities and skipping some of the self-reflecting assignments because they doubted the value of these tasks and did not see them as useful for their project.

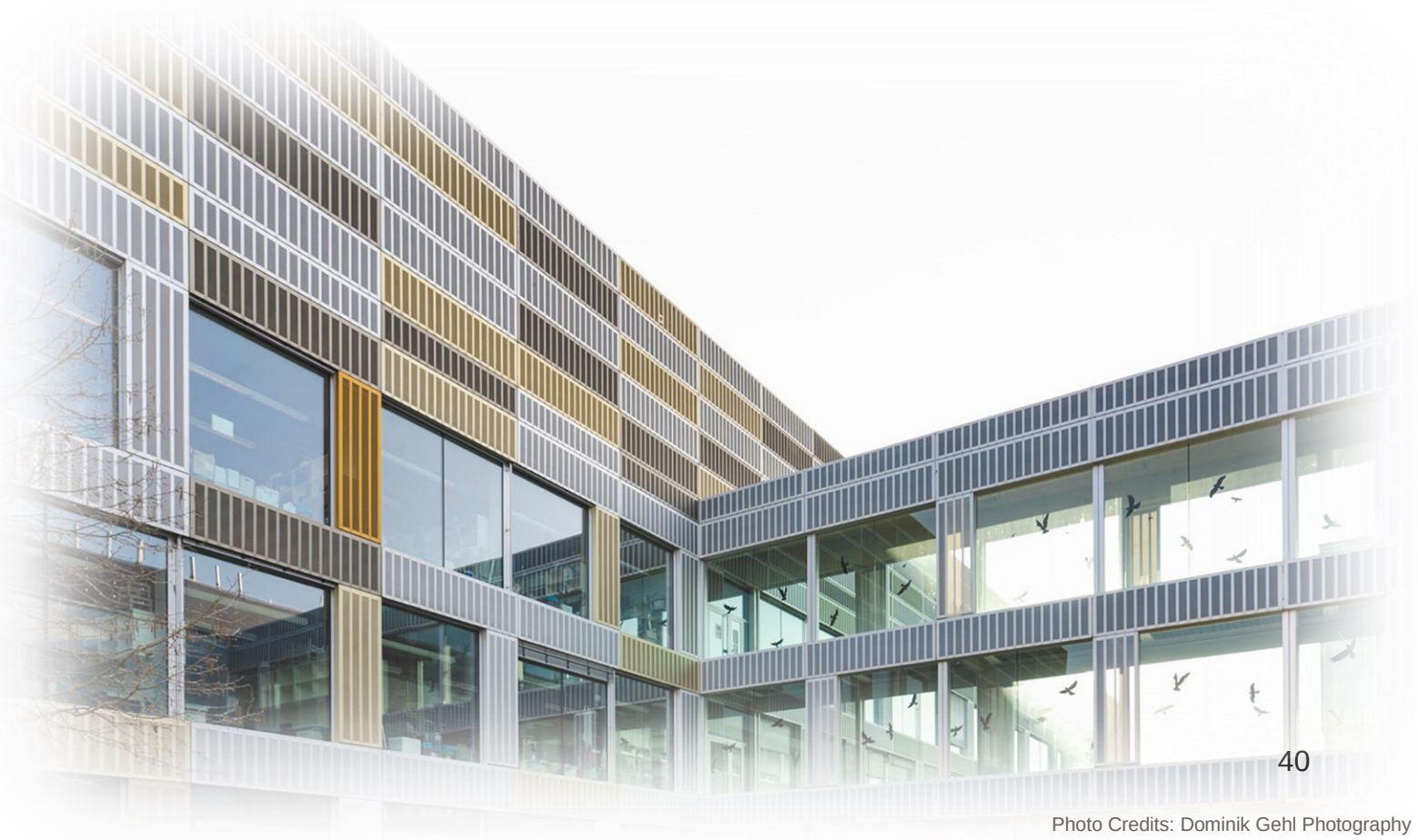


Photo Credits: Dominik Gehl Photography

3.4 Achievement Emotions

3.4.1 High Course Value - Usefulness and Applicability of HPL I

Appreciative Motivated

Five students appreciated the opportunity of learning how to teach others. Three students valued that their learning tool could be oriented towards people with actual problems, and another student felt they could make an impact on society. Additionally, ten students viewed the HPL experience as useful in their futures as they could reflect and gain retrospective insights into their own learning. They conveyed appreciation for the opportunity to better themselves as the HPL sequence taught them to learn more efficiently, maximize their brain impact, and increase their learning skills. Furthermore, they felt they could apply this knowledge to taking exams, tutoring, and teaching. Three students also expressed comfort and relief when they found that their time was not wasted and the knowledge, they learned in HPL I, was useful in improving their own learning or when it was applicable for their work in HPL II.

Course content being useful now or in the future was the second most frequent motivating factor, as expressed by six students. This motivation was interpreted to be so prevalent among the students because it outweighed negative emotions associated with the course. It provided a plausible explanation as to why many students were motivated to take HPL in the first place, despite negative comments they may have heard about it or other issues such as scheduling conflicts with the times the lecture was offered. The value in learning these concepts which were relevant to the students' lives was more important than negative perceptions or experiences the students may have had about the course, and motivated them to participate, nonetheless.

Photo Credits: Dominik Gehl Photography

3.4.2 Low Course Value – Did Not See the Value of Course Concepts, Topics, or Assignments

Confused
Indifferent
Disappointed

Nine students expressed confusion regarding the purpose of certain assignments, questioning their value. The planning of the project activities specifically caused confusion for many as they reasoned that the scale of the project did not necessitate the amount of planning done. As a result, students found the "planning of planning" particularly perplexing and redundant.

Eighteen students expressed feeling indifferent about this course at some point. Four felt the concepts could not be applied outside of this course, while two others felt indifferent simply because they did not get the course they wanted, and this course was only a second choice. Three students communicated feelings of disappointment. Nine students have shown that the project was disappointing for them. Two students would have liked both semesters to have been theoretical, whereas three were disappointed because they did not learn anything from applying the theories to the project.

Nonetheless, given that HPL is an SHS course worth only 3 credits, the HPL course and its associated work was a low priority for a third of interviewed students as they must focus on their other major-specific classes and projects. Four students perceived HPL to be intense because their engineering courses already lead to a high workload and stress, and the addition of this "smaller," "less important" course contributes to this stress. One student said, "The [engineering] courses already contain a lot of workload…. we just need to like control the workload of SHS course." While the average student has a course load of about 30 credits per semester, some may take more. Consequently, when some students became overwhelmed by their other coursework, they neglected HPL. The course held varying value to different students, especially when compared to their other courses, so some did not care about successfully completing the project. This means that these students often put off tasks, which led to stress and feeling overwhelmed when a deadline approached.

“But since this is not our, it's not a major class, right? Because we're engineering students not, um you know, social humanity students. Everyone puts this as last priority. So I feel like, at least in my group, we kind of rushed to have an idea. It would have been maybe nice to have more time to have the groups prepared more in advance so that we could, even if it's last priority, we had more time to develop a correct idea.”

-HPL Student, 2024

3.4.3 Fulfillment of Project Deliverables

Calm
Motivated
Discouraged
Disappointed
Hopeful

Eight students experienced feelings of relaxation and relief as their project progressed. When these students saw that their project progress was not stagnant or that their project was going well, they were calm. Positive feedback from the professors and the realization of the impact of their project reassured three students. Some of this relaxation also resulted from confidence that the project would go well due to students' own reliability or ability to rely on their team. Five students also expressed feelings of relief after assignments were submitted, as they had less to worry or stress about. One student felt especially hopeful about their group's progress, stating things such as "Uhmm maybe, about the … final result, I think I'm optimistic because I think so far we have done pretty good."

The most frequent motivator which students expressed was the fulfillment of project deliverables. The diverse reasons students offered to define achievement of the product supported this claim. Three students reflected that they were motivated greatly by their end goal of producing something "good." If students were passionate towards the format of the learning tool, they may have experienced this achievement emotion. For example, three students expressed a strong connection between the creation of a board game, computer program, or magazine and their own motivation, rather than the topic of their project. These students were motivated to work on the project in order to produce something in a form they were experienced with or drawn to.

Other students, such as the three who mentioned it during individual interviews, felt incentivized to achieve the creation of something that had purpose and was useful for others. Students mentioned things such as "I mean, it's not just random calculations and equations or code, like you're actually trying to build a tool or imagine something that could benefit someone else. And that's a really nice motivation," to illustrate this push to achieve a beneficial project outcome. Two students were motivated from the final deliverable being a reflection of all group members, especially in a grading sense. Another two students who identified group dynamics as promoting motivation for the

project outcome explained in a similar manner that they felt motivated to do their best in creating the learning tool because individual grading is only reflective of oneself. However, in the case of the project deliverable, motivation arose to control the outcome as more than one person was involved.

Looking at the project as a whole, a final cause for motivation was revealed, the satisfaction of plans finally coming to life. Three students used words like “concretely” to describe the motivation they felt from the achievement of the project acting as physical “proof” of their learning in the course.

However, four students also experienced stress and anxiousness over the fact that the project had to be completed and “brought to life” in some way. Even if things in the course were going well, some students worried about how to implement their project in a way that would allow it to be successful or impactful. They pondered if their final product would be “good or not,” if it would be “thrown to the bin,” or if “some people are still going to find interest in it.” Three students stressed about the perceived lack of progress as they struggled to manage their project work when they had “no deadlines, no feedback, “[and it was] up to you.”

In the interviews, the nine students voiced feeling discouraged and disengaged with respect to the project. Students explained the project work lacked something to look forward to; they believed upon completion it would not feel rewarding as their product would see no use.

Eleven students described being indifferent regarding their project deliverables because they did not learn anything of value to them, while others elaborated that the new information, they learned during the project, to create this ethical tool was not interesting to them.

Of the six students who expressed boredom, three attributed some of it to the project, specifically because of the small scale of the project and the fact that their artifact would not see use. On a similar note, four students conveyed feeling disappointed about the disparity between the potential their project had and the final product their group would put forward; they wished their group had the time or motivation to create something grander. Four students have expressed they were

disappointed because they believed their artifact would not be something they could be proud of.

However, on a more positive note, many students also voiced feelings of hope in the context of producing successful project deliverables. In focus groups, this sentiment was observed when two team members mentioned their hope that the decisions they made regarding their prototypes, would be beneficial and lead to the achievement of a well-designed learning tool. Some students were curious about what they would produce at the end of the semester. Given that students had to test their prototype and verify that it would achieve its intended goal, two stated that they looked to the future with hope that these tests would be successful. During individual interviews, three other students explained that they hoped their project would provide their intended audience with a valuable learning experience and achieve the learning outcomes they had identified. One student associated hope with the creation of a unique learning tool and anticipated the chance to make something “that no one had ever thought of before.”

3.4.4 Manageable Workload

Calm
Motivated
Discouraged
Disappointed
Hopeful

Five students were pleasantly surprised by the manageable workload during the HPL course sequence. During HPL I, at least two students had originally expected to have too much work given what they had heard from students who had taken the course during previous years. However, seven students then expressed relief when this was not the case. Those students found the class's workload to be rather manageable and “chill.” Four students expressed that attending lectures was effective enough to learn the material. Two said that it was still manageable, even with the additional readings and videos. Two students found the pacing of the course to be a bit on the slower side but had little problem with this fact because it reduced the stress they had when working. Of the students who found the workload of HPL I manageable, most felt relaxed because they did not have to do much studying until the exam.

In regards to HPL II, there were originally concerns about having a lot of work given the project-based nature of the course, yet two students, to their surprise and relief, found the amount of work required each week to be reasonable. These students felt comfortable with the amount of work they had, feeling confident in their ability to manage it with the time they had.

However, some students experienced anxious feelings surrounding their thoughts on the workload. Nearly seven students said that the workload level at the time of the interviews was a bit more than expected, which made them a bit worried or stressed, particularly with managing their time around deadlines. Some students expressed concerns over the workload in the future. They feared that the workload would increase in the future to a level that would be unmanageable. They worried that when the workload of their other courses also would increase, they would be unable to devote as much time as they would like towards HPL because they would have to prioritize their other courses.

3.5 Social Emotions

3.5.1 General Student Interactions

Anxious Motivated

Seven students experienced anxious feelings while interacting with their groups, regardless of the overall efficacy of the group. The students were given assignments where they recorded their group working and gave the group feedback after reflection. Students were sometimes hesitant to give their peers feedback as they were unsure how their input would be received. This made four students slightly wary of their interactions with their group members, especially when language barriers were involved.

However, this resulted in motivation, as four students explained in individual interviews that due to the collaborative nature of the project, they felt incentivized to progress towards personal goals such as speaking more if they were shy. Collaboration with students from differing backgrounds, as was intended with the professor's randomization of groups, also motivated three students as they were pushed out of their

comfort zones and given the chance to experience new situations. Neither this anxiousness nor motivation was mentioned during focus groups or seen during observations, which emphasized its personal nature to the students as something they may have felt less comfortable sharing with team members.

Three students also expressed concerns of feeling like they had not contributed enough. One, seeing a group member's leadership, felt they should work on themselves more. Others, even if they understood that it was normal, worried that they did less work than others or were slower or less efficient than others. These feelings pushed those students to contribute more to their groups. These concerns arose from members of groups that were said to or were observed to have productive, relaxed working atmospheres. However, these anxious feelings were only mentioned in individual interviews, which may have been due to the personal nature of these worries opposing the professional or lighthearted group dynamic.

3.5.2 Positive Emotions Evoked by Group Dynamics

Enjoying
Appreciative
Comfortable
Motivated

Students enjoyed the time they spent meeting in groups together. Generally, multiple groups felt comfortable working together and felt they had good camaraderie as they laughed and joked together during meetings. We especially observed this in three focus groups and observations. There appeared to be a quick and playful banter between the team members as they worked on the project together. When directly asking them about their team dynamics, they often laughed and sometimes jokingly threw another team member under the bus. Six students expressed having fun together, and two of those students felt like they could be friends with their team members. Additionally, three focus groups showed an interest in doing something fun outside of the project such as grabbing a beer together.

Furthermore, the positive group dynamics between teams allowed students to feel appreciation for their group members. One student viewed them as good people, and another student felt compassion for their group members. They were thankful that

others in the group felt passionate about their project, and one student expressed being "on the same wavelength" and having a "student to student feeling." They were appreciative that group members completed their individual work on time with consideration to the deadlines the team put into place, allowing the team to continually progress. Two students expressed they could trust and rely on their team members, and a third student did not see a need to double check teammate's work. Consequently, members of these teams felt more relaxed. They also appreciated that the workload was split up evenly. Additionally, the students were grateful to the team members for being cognizant of them having a lot of work in other courses. Therefore, one student mentioned their team's agreement that a particular team member could take on less work one week and agree to compensate by putting additional work in later.

Additionally, there were four cases where we observed a leader in a group. In these cases, other group members appreciated the leader as they organized the thoughts, distributed work, concentrated on the task at hand, and managed the time spent in the meetings. One student mentioned that they felt like they were learning from the group leader.

Sixteen students mentioned feeling comfortable and relaxed while working with their teams, allowing them to feel safe to openly share and discuss their ideas. Conducting observations and focus groups with student teams indicated that more than three-fourths of the students felt comfortable with their teams. Students also appreciated that openness as it allowed members to feel accepted while sharing their honest thoughts regardless of whether they agreed or disagreed with the other team members. They respected and listened to other people's ideas which provoked a healthy group atmosphere and "fruitful" discussion between the group members. As a result, group members were motivated as each person brought unique added value to the project.

Positive group interactions caused some students to feel motivated, which was expressed during individual interviews and observed during class time. In a more private setting, four students expressed to us that they understood (and more importantly, cared) that during group work, their strengths and weaknesses could influence their group members and project. Therefore, they felt motivated to reflect upon

their weaknesses with the intention of promoting a positive dynamic. For example, one student referred to an experience in which they received feedback from teammates on a reflection assignment. Rather than feeling targeted or called out by the information, the student felt motivated to change. “It m[ade] me feel like I should work on myself more,” they stated, detailing how they reacted positively as a result of their comfort with the other group members. Similarly, two other students mentioned that because they felt respected and valued by their group members, they felt inspired to make progress on the project rather than becoming disengaged, almost as an obligation to their group.

Comparatively, positive group dynamics were identified as the cause for motivation by two students as they were driven by learning from their group mates. These students made statements such as “I'm learning… I mean, I'm not really like learning, but I'm seeing [them],” which referred to the student observing another team member who was especially competent at time management in an effort to improve their own. If the group had overcome prior negative dynamics, the students expressed feeling motivated to maintain a respectful relationship. Lastly, three students emphasized how a positive group dynamic motivated them to take risks in the project, as they felt supported by their group mates and would not risk isolation if failure occurred.

Two students in individual interviews and half the focus groups commented that they hoped to pursue more social activities with their teammates and aspired to get to know each other more personably. Three students explained in individual interviews, possibly because of their intimate setting, that because their teams had overcome teamwork issues such as a lack of communication, they were hopeful that they would continue to build a positive relationship with one another and improve their dynamic further. When a group was working well together and group members were contributing to the project and its success, two students mentioned feeding off this positivity and feeling hopeful about the process to come. When trying to implement strategies to promote more positive group dynamics, it was typically those students who were spearheading these tactics that felt the most hopeful for the outcome they would have.

3.5.3 Negative Emotions Evoked by Group Dynamics

Stressed
Anxious
Irritated
Disappointed

It can be hard to delegate tasks and manage the project workload effectively - organizing who, what, where, when, and why had to be determined and shared effectively with all group members. Time and thought were needed for everything from idea sharing to planning, alongside individual research on the project. This organization was especially overwhelming and stressful for four students who took on leadership positions in their group, who expressed these feelings directly in individual interviews. Two students in these leadership positions felt uncomfortable being “forced” into this role due to others’ inaction.

The group’s efficacy in completing work could result in anxious feelings for group members. Four students experienced anxious feelings as time ran out, yet work was not progressing. One expressed worry about failure explicitly because of how their group functioned. Two students who appeared not to hold a “leader” role also expressed feeling overwhelmed from constantly needing to keep track if all members were on the same page. When certain team members had lower participation levels, were not completing work on time, or did not attend meetings, six students relayed that they felt additional levels of stress and irritation as they had to take on managerial tasks such as creating schedules, sending notes, or completing neglected work. Three students felt discomfort if they had to confront their team members about disagreements or frustrations. One student was nervous whether their discussion would actually lead to improvement. Five students conveyed in individual interviews that they felt stressed as they balanced their frustrations with their empathetic feelings for their struggling group members. Different levels of understanding about the project and difficulties in communication with team members, whether due to language barriers or a lack of responsiveness, has also led to irritation for four students. Three students were uncomfortable when they noticed they were causing frustration for others.

However, there were two instances of outright anger from the team members who were doing the work by themselves. In observations and focus group interviews

with teams featuring this type of dynamic, the students experiencing these feelings of irritation or frustration towards their group members did not mention them. However, they did mention them in individual interviews. We surmise that this may be because students felt safer to be critical of their teammates privately, especially because their group members often felt appreciative of them.

Additionally, as a team project, many decisions had to be made as a team before they could progress. One student explicitly explained their stress when their teams struggled with compromising on such decisions. Four others worried about whether their group members would do the work in a way that would meet their expectations or whether the work of individual members would fit together. Even in teams where the atmosphere was mostly light-hearted and amiable, three students expressed having occasional frustrations when disagreements or the like arose. In one team, someone felt comfortable enough to mention this frustration in a focus group, though in a joking manner, just as mentioned in their individual interview. This indicated a healthy group atmosphere in which team members felt safe to share negative feelings.

While some students who experienced issues with their groups had negative feelings, three mentioned not being affected by their group members doing less. Two students described how they did not mind doing a bit more work.

Conversely, three students also reported that they initially were motivated for the project but started feeling disengaged later on as they noticed their group members did not feel interested or had other priorities. Nine students communicated some form of disappointment as a result of group members being inattentive, being unavailable, doing their work indolently, being tardy, or contributing little. Some felt let down by the others. However, on a more positive note, three groups expressed that they were disappointed in not being able to spend more time together socially outside of class.

3.5.4 Teaching Style

Stressed
Anxious
Irritated
Disappointed

When first coming to the HPL I class, nine students were initially surprised by and estranged by Nihat's interactive teaching style and his ability to memorize every student's name before the class had started. Nihat would greet students by their first names as they arrived at the classroom, and he would cold call on students to answer questions during class. Eight students found this uncomfortable initially as they were not used to the gap between professor and student closing like this. One student felt driven to understand why the course was being taught in such a way and sought to uncover the reasoning behind what appeared to them as a jarring class style. Two others offered that cold-calling actually provided a fun challenge to them, as they felt like the chance of being selected motivated them to learn course content and pay attention. Nine students soon came to enjoy his active method of lecturing as his teachings were entertaining. Students conveyed he had strong skills to get people's attention and keep the class focused. The students enjoyed his questions as the concepts became more relevant to them, and they felt their opinions were valued. Two students felt engaged by the treats of oranges and apples that he would give out for correct answers. Furthermore, they appreciated the opportunity to share their thoughts with not only their classmates but also their professors.

The students also appreciated the professors' passion for and effort they put into the course. One student expressed that using their own styles of teaching, each professor brought something unique to the table. In turn, most students felt respected, valued, and heard by the professors, and they expressed that the professors genuinely cared about their learning. There have been instances where groups discussed their difficulties with each other and resolved them with each other or with the help of their professors, leading to feelings of relief. For example, one student appreciated that a global email had been sent out reminding group members to come to class after sitting alone in the class. Additionally, students valued the opportunity to develop a relationship with the professors that evolved over the course of the HPL sequence. The students

were thankful that they could openly talk with the professors. One student appreciated that the professors would clarify their comprehension if they misunderstood certain concepts.

Specifically during the HPL II course, students were thankful for the availability of both professors during the class time. They valued the opportunity to book a meeting with them to receive firsthand assistance and ask questions while in the process of developing their learning tool. One student also noted that they appreciated that each group was assigned to a specific professor as it allowed the assigned professor to better remember each group's project. Almost all students felt comfortable with the professors and felt open to sharing feedback with them.

As briefly mentioned above, eight students experienced feeling uncomfortable with the professor's teaching style at times. While much of the discomfort eased for a few students as they came to understand Nihat's teaching style, feelings of discomfort persisted for several others. Two students clarified that they felt that the professor's volume could be too loud at times, which resonated in an overwhelming way that made their head hurt or made "everything more confusing." Additionally, randomly being chosen to answer questions induced uncomfortable and anxious feelings for three students. One such student says that "[their] brain was like frozen." One student also feared the judgment of their classmates if they said something stupid. Another said that they simply prefer to not interact while learning. These types of feelings could be highly counterproductive towards a student's learning experience.

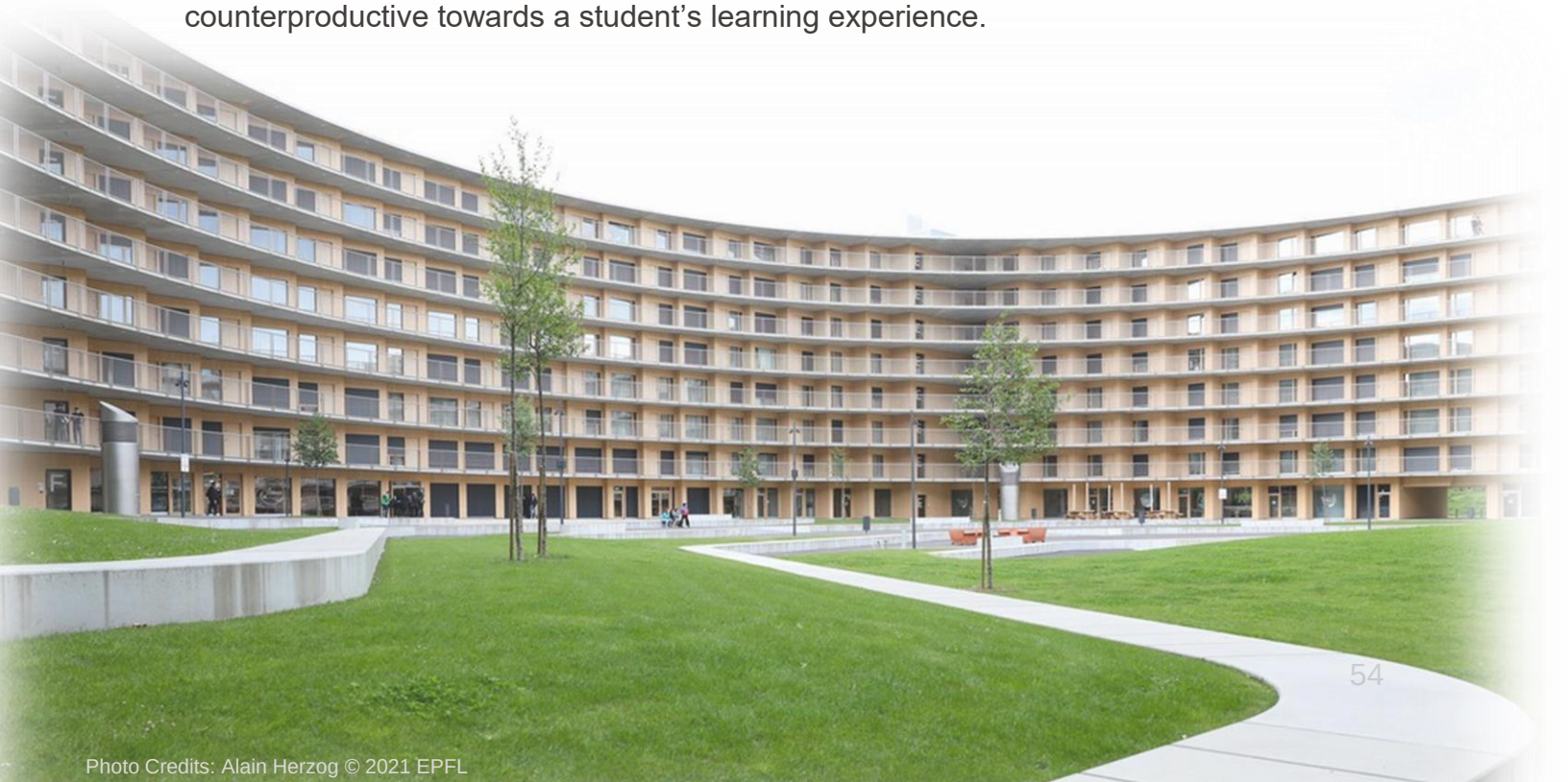


Photo Credits: Alain Herzog © 2021 EPFL

3.6 Prevalence of Emotions in HPL

As we obtained data for student feelings on the course content, project, and their group, we prepared visual representations of the prevalence of emotions from individual interviewees in these three different aspects of the course. The size of the circles in the bubble charts represent the prevalence of an emotion, whereas the color indicates valence and activation, as shown in Figure 11.

Figure 11: *Legend for the Bubble Chart Color Coding*
Figure 11 explains the color coding for the following visuals where each color represents a unique category of emotion, distinguished by different valence and activation.

Photo Credits:
Ariel Huber

3.6.1 The Concepts

As seen in Figure 12, for the concepts covered in the course the positive activating feelings of interest, enjoyment, and feeling motivated dominate, but students still expressed negative deactivating emotions such as disappointment, disengagement, and boredom with high prevalence.

Figure 12: *Bubble Chart for the Content*
Figure 12 represents how prevalently different emotions were expressed in individual interviews regarding the concepts covered in the first semester. Positive activating feelings, depicted in bright red, such as interest, motivation, and enjoyment stand out.

3.6.2 The Project

Figure 13 shows that for the project they still felt more positive activating emotions compared to others, but interest does not stand out as much as before. For the negative deactivating emotions, disengagements and disappointment are still prevalent but students now also expressed feeling anxious. Additionally, negative activating emotions such as confusion and stress gained prevalence.

Figure 13: *Bubble Chart for the Project*
Figure 13 illustrates the sentiment of the individual interviewees on their project. Positive feelings, in bright red and turquoise, are represented almost equally to negative feelings, in dark red and black. Indifference, a feeling of neutral valence is also apparent.

3.6.3 The Group

The next bubble chart, seen below in Figure 14 shows that the positive deactivating emotion relaxation was expressed with high prevalence when discussing the topic of interviewees' project groups. Also noticeable is the shift from interest to enjoyment and appreciation.

Figure 14: *Bubble Chart for the Group*
Figure 14 represents how prevalently individual interviewees expressed different feelings about their project group. Positive feelings, in bright red and turquoise, have been consistently expressed, however, a wide range of negative emotions, in dark red and black, have been stated.

3.6.4 The Instructors

The final bubble chart, seen below in Figure 15 shows that many students experienced the positive activating emotions enjoyment and appreciation around the instructors teaching style and the interaction with them. Contrarily, students also prevalently mentioned discomfort and surprise.

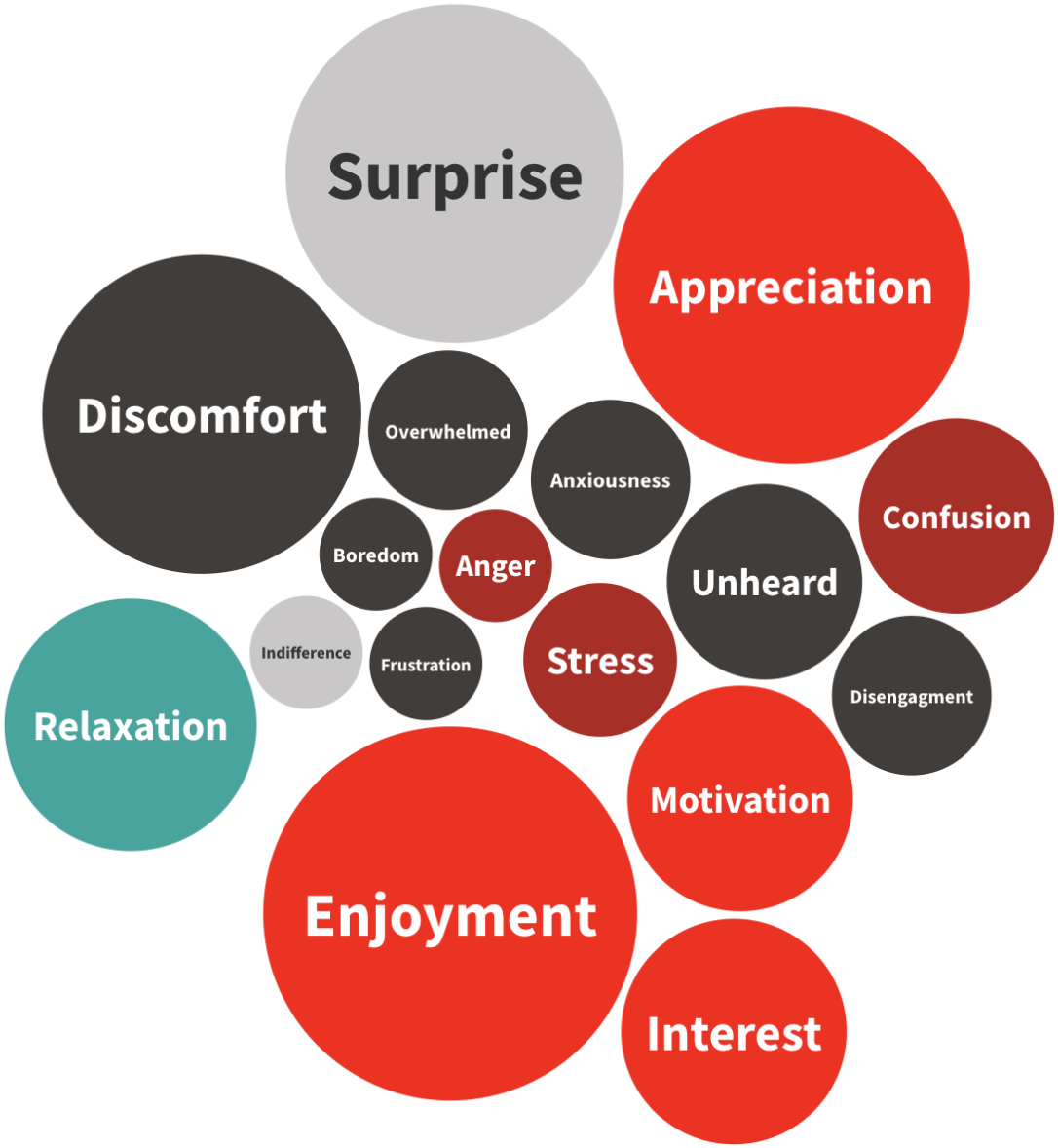


Figure 15: *Bubble Chart for the Instructors*
Figure 15 illustrates the sentiment of the individual interviewees on the instructors. Positive feelings, depicted in bright red and turquoise, were strongly represented. But the student also expressed a variety of neutral, in grey, and negative feelings, in dark red and black.

3.8 Emotional Trajectories

The HPL course sequence evokes a unique emotional experience for each student; however, we observed a general emotional trajectory that characterized the causes and their associated feelings.

Before arriving in the course, students expressed interest specifically because of the course subject and its applicability to their lives. Nonetheless, other students felt disengaged from the start if they enrolled in the HPL course as a substitute for a more intriguing course that filled quickly.

Upon their first experiences in HPL I, many students felt jarred and uncomfortable because of the professor's teaching style. The unexpected interactivity of the professor's lectures shocked students, especially shyer students, who were uncomfortable with being randomly called on. Relatively quickly, most students began to appreciate this teaching style due to its engaging nature and were grateful for the opportunity to build a personal relationship with the professor.

This trajectory split as the professor introduced more course content. Some students felt disengaged due to the slow pace at which information was presented or a misunderstanding that the content would be more focused on self-improvement rather than teaching other people. Contrarily, other students appreciated the review to verify their comprehension of concepts and the course's focus on learning techniques which they viewed as useful. The manageable workload of the course permitted most students to feel relaxation because it did not contribute to an excessive cognitive load. Despite the later timing and long duration of the class period, students found it enjoyable to attend and engage in course activities. This positivity was balanced by other students' indifference towards the course given that it was an SHS course rather than an engineering course. Furthermore, given its field and attributed credits, those students prioritized it less through low class attendance or minimal effort on assignments.

Some students were caught off guard and surprised when assigned their group for the project whether this be because they were unable to choose their group members or these groups differed from those with whom they had performed the initial learning activities early in the semester. Students who had friends in the class conveyed

frustration that the professors randomized groups rather than allowing them form groups themselves. Since attendance in class was not mandatory, some students could not benefit from the initial team bonding and planning activities as group members were absent. However, widespread appreciation was evoked among the students when the professors encouraged attendance in class. Students who experienced emerging negative group dynamics were particularly grateful to the professors for their support as they felt heard and hopeful that this would lead to greater group participation. Nearing the end of the first semester, several students felt appreciative and relaxed due to the early exam timing which did not conflict with other end of semester projects and exams. Figure 16 shows the emotional trajectory that students generally experienced during HPL I.

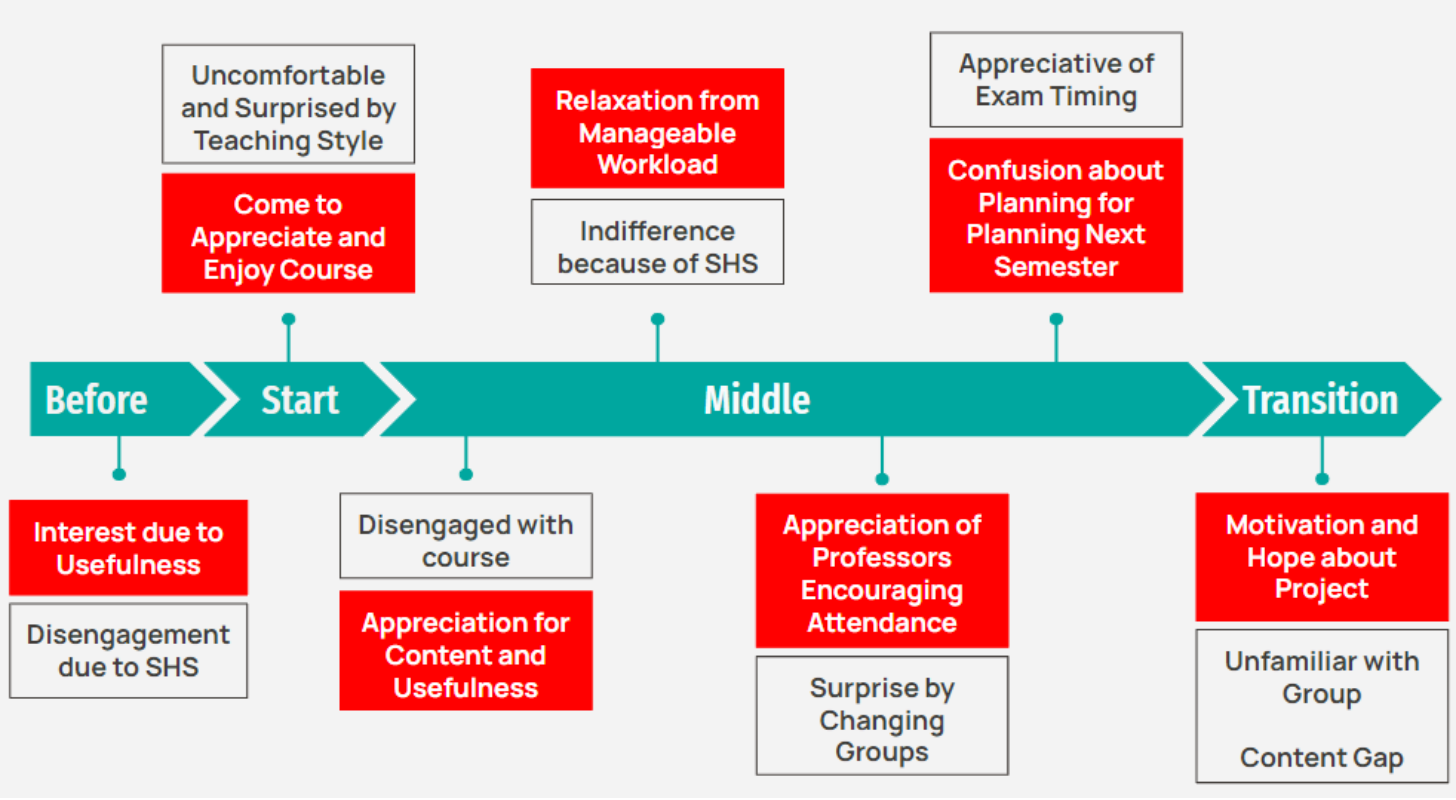


Figure 16: *Emotional Trajectory of Students in HPL I*
This figure shows the timeline of emotional themes that students experienced over the course of HPL I. The red boxes indicate emotions that were prevalent among a great number of students. The black outlined boxes indicate still prevalent themes that were less common.

As students began to prepare for the second semester's project, confusion emerged from students as they struggled to understand why they were "planning about planning" given that next semester was entirely dedicated to the planning and execution of the project. As the students concluded the first semester and transitioned into the next, students felt a broad sentiment of motivation and hope for the project. However, some uncertainty still lingered as students were not fully familiar with their group members yet, and students felt confusion as they struggled to form a seamless connection between the concepts introduced in HPL I and their application in HPL II.

Upon beginning the project in HPL II, students expressed extensive confusion due to a lack of rigid guidelines and comprehensive deadlines. As they began working on their project, initial group dynamics emerged as students took on differing roles within their group. These ranged from positive to negative to neutral dynamics which were brought about by initial project planning and pressure to submit the first report. At this point, some students felt a wave of relaxation and relief as they identified ways to apply the concepts learned in HPL I to HPL II, validating their learning of the theory during the first semester.

Continuing into the project process, negative emotions arose as students preferred to progress on their project deliverables rather than complete process focused assignments. Whether simply more interested in creating their product or overwhelmed by its design and implementation, students felt irritated from assignments requiring them to reflect on group dynamics or explain the development process in depth. They could not see the value of retrospective thinking as students did not commonly encounter this in typical engineering curricula. These negative emotions were balanced by positive sentiment during the project process. Even if they were hesitant to admit it, students enjoyed watching the project come to life and producing a tool that could be of use to others. These emotions were complemented by the students' interest in their project topic and this unique process they would not traditionally encounter in engineering.

As students reached a midpoint in the project, group dynamics solidified since some groups settled further into their initial dynamic while others developed a new dynamic. This trajectory could involve negative emotions like irritation, disengagement, and anger due to problems regarding team communication, organization, or completion

of tasks. On the other hand, a diverse set of positive experiences ranging from feeling relief to appreciation to motivation were also expressed as a result of open group interactions and successful completion of work. Commonly within groups, one student assumed a leadership role which was attributed to positive and negative emotions for them and their group. Some students felt grateful to have a figure of authority to promote guidance and organization. Other students felt forced into this overwhelming role because of other students' unwillingness to take initiative and struggled to manage the associated responsibilities. The professors' decision to assign diverse teams evoked positive sentiment as they appreciated the opportunity to interact with students of varying backgrounds. This choice concurrently provoked negative emotions such as discomfort and frustration as students experienced new situations outside their comfort zone.

Throughout the entire project process, students felt vastly thankful to the professors for their availability during the class time to answer questions and discuss their project progress. Similarly, students were motivated and grateful when receiving feedback on these assignments as it clarified the expectations for the group and gave students hope regarding the tool they would design. As students began assembling prototypes, disappointment and disengagement emerged as they realized that despite being designed to teach others, their tool would never hold value beyond the classroom doors. Moving into the final weeks of the project, the trajectory consisted of both anxiousness in response to the end of the semester rapidly approaching and hope regarding the project coming into fruition. Students acknowledged that they may be pressed with time given the buildup of exams and projects for other courses. Nonetheless, students were optimistic to see their hard work come together and reflect on their learning throughout the HPL sequence. Figure 17 represents the common emotional trajectory the students experienced during HPL II.

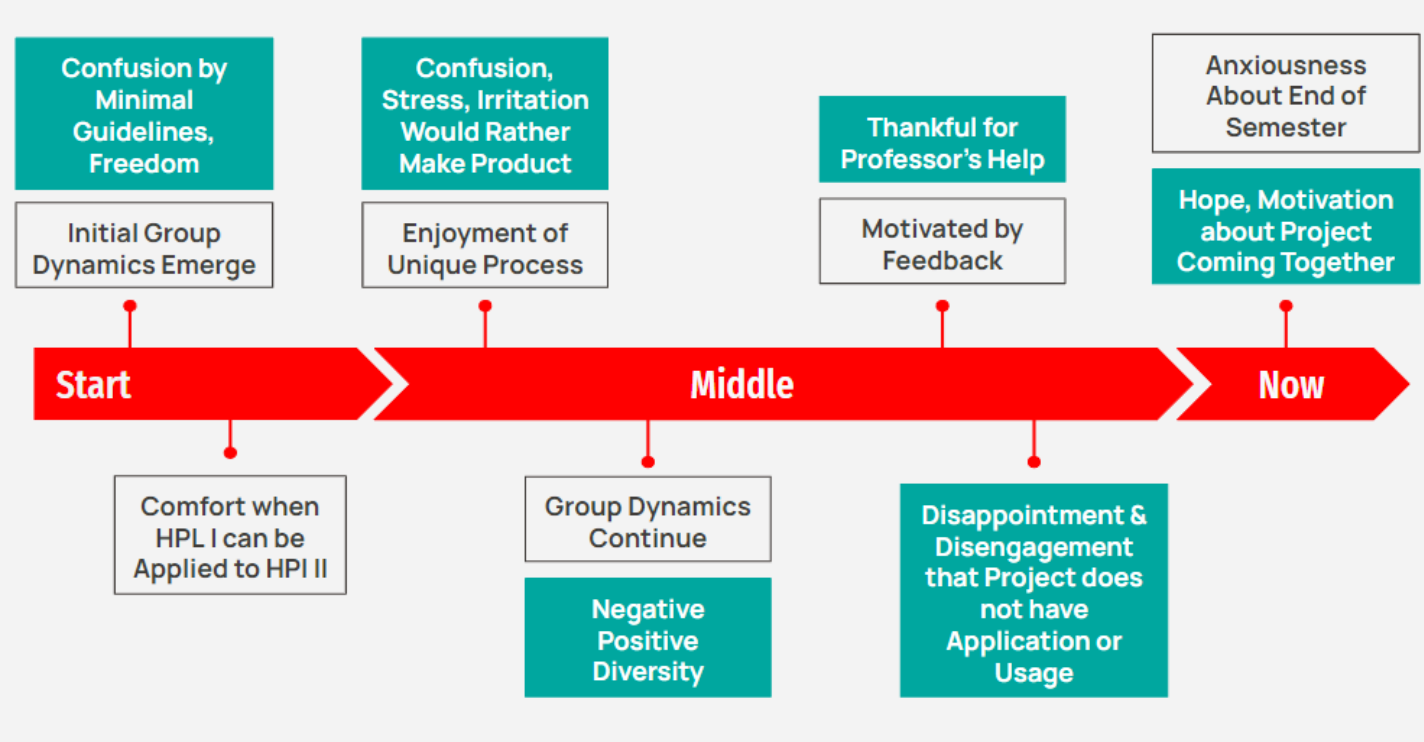


Figure 17: *Emotional Trajectory of Students in HPL II*
This figure shows the timeline of emotional themes that students experienced from the start of HPL II until now. The blue boxes indicate emotions that were prevalent among a great number of students. The black outlined boxes indicate still prevalent themes that were less common.

4

RECOMMENDATIONS AND CONCLUSION

Photo Credits: Dominik Gehl Photography

4. Recommendations

Based on the student sentiment we gathered and overarching emotional trajectory observed, we formulated recommendations to improve the HPL course in its future offerings. We drew upon the academic emotions of students, their causes, and recommendations from interviews to propose these five recommendations.

4.1 Make Projects More Applicable to Help Motivate Students

Across the class and throughout past years, students expressed their continuous passion for the project in HPL II. Our first recommendation is to expand the scope of the project students complete in HPL II, which can be done through having students work on real-world problems, encouraging the project to actually be "tested," or organizing showcase-like opportunities for students to present their results.

The first way the project could be altered is by identifying local or community problems students can design tools to solve, which will help them see the project's applicability. By presenting issues found at EPFL or in the local community, students could create learning tools that they know have real-world usage and therefore hold value. The ethical aspect of the project is interesting to many students, and we do not propose removing it entirely, but rather have it supplement the project focus on an existing knowledge gap or deficit of information that students can attempt to "solve." Boss (2015) explains the importance of students working on relevant projects in PBL courses, and that "relevance" doesn't necessarily mean that the project is about the student's life. "Relevance" is more important in the sense that students form a connection between what they are doing and the people, place, or thing their project concerns, which can promote feelings of belonging as they know their efforts will improve aspects of their community. Proposing projects which are local or familiar to the students is critical to the formation of this connection so that they can easily be reminded of who benefits from the project process (Boss, 2015). "When projects are

relevant, students understand why learning is worth the effort" she states. "They can see how others might benefit from their research or creativity. They feel motivated to put forward their best effort" (Boss, 2015, pg. 13).

Understanding that this is not a project management class or long-term research endeavor, real-world projects should be evaluated as applicable in some way to the students of HPL, but also not too large that they require a higher workload than students are willing to take on, especially for an SHS course. Students could prepare a learning tool to be utilized by another class offered at EPFL or develop a training program to be offered in the community regarding ethical decision making. Maintaining the freedom for students to choose the format of their project (such as a guidebook) was motivating to many and should be incorporated into these projects, however the real-world usage of the project could be presented to the students more rigidly to ensure they select a practical issue which could benefit from such work in the community. Hanney (2021) details how identifying practical issues which students can engage with in PBL leads to a greater feeling of community engagement and authenticity throughout the learning process. Drawing on works of other scholars about what projects students do and how they should complete them, he highlights "...A shift from projects as models of management and a rethinking of projects as forms of social practice" as critical to identifying ideal PBL projects that are both real-world based and manageable for students in higher education (Hanney, 2021, pg. 170). Real-world projects are not just more engaging to students because they know their final product will be used but can provide experiences and necessary skills for postgraduate life such as professional writing, graphic design and oral presentations (Hanney, 2021).

A second way in which the project of HPL II could be altered so students feel as if their work is valuable and reassured that their end product will be used is to encourage or mandate their learning tools to be tested with a target audience. In order to implement "real world projects", students must not only *feel* like their project will benefit others but observe it directly. If students are designing a learning tool for children, having a requirement that their prototype is tested with at least one child could provide valuable information about the project design but also a beneficial experience for students to see their tool in action. It is important to note that although not all

projects can be realistically tested with their target audience, this factor could be considered when creating the project idea and selection of project topic. Furthermore, if the projects were constrained to the EPFL campus and community, the instructors could assist in identifying possible faculty to test the learning tool based on its respective field. Students could also draw upon their own connections to identify other students who could benefit from using the learning tool or were knowledgeable about its field.

Finally, incorporating ways for students to demonstrate or showcase their projects was widely recommended by the HPL students during individual interviews. By presenting their learning tool and project journey to others, the students would have the opportunity to explain their design and decision-making process which would add emphasis to assignments about documenting those concepts in the class. This presentation of projects could take the form of a poster session at the end of the course, or class presentation where students briefly discuss their process and then demonstrate how to use their learning tool. More informally, a final class session could be converted into a tool-testing day in which the campus is invited to see the students' projects and provide feedback about their prototypes. Any of these formats would allow the students to feel as if there was a definitive time in which their projects would be showcased, reiterating that their final tool was not "going in the bin". Not only are these opportunities necessary for students to demonstrate their understanding of the subject matter, but also their creativity and problem-solving skills in developing the learning tool. Further, many of these formats such as presentations and poster sessions foster peer learning and collaboration. When students present their projects to others, they receive feedback and learn from obtaining differing ideas and approaches. This exchange of knowledge and perspectives enriches the learning experience for everyone involved and can provide a platform for students to receive recognition for their hard work and acknowledge their dedication to the project.

4.2 Communicate Clear Expectations to Students

Our next recommendation focuses on making expectations clearer to students. To make assignments more comprehensible more than a third of the interviewed students have asked to include examples for them as currently students may have to ask for clarification multiple times before they understand the task at hand.

One of the sources of confusion about the project came from picking the project initially. Eight students explained that they were not sure what they could make for their artifact. One student suggested viewing what groups from past years have made could help groups design a learning tool.

Another major source of uncertainty for the students was not having a clear time plan, this problem was expressed for both semesters. For the first semester, three students complained that they did not always know what they had to do every week as there were too many small assignments to keep track of. Two students proposed having a day-by-day calendar available for students to check what has to be done when.

For the second semester two students felt that they did not know if they were making good progress on the project and if the plan set by the group was realistic and wished there was more instructor feedback for assurance. Four students have explicitly stated they feel there is “too much freedom,” since they were lost on what their final goal was. As a means of striking a balance between providing more guidance for the student as requested and providing some learning opportunity, we propose to implement a back-planning assignment. This assignment would be completed by the project group for the duration of their project and turned in for review so that the students still get to practice planning but also do not feel unsure of their own organization. Such an assignment could be repeated as the semester progresses and the project goal may shift. Though there are multiple methods of execution, improved course structure and clarity would prevent students from feeling overwhelmed.

4.3 Provide Structured Support for Group Functioning

Most of the students would like more involvement and structure from the professors to support their own functioning as a group. We recommend starting this in the first HPL course, where upon receiving their groups, students have an assignment that requires them to develop a team charter together. A team charter is (include an explanation). Research has shown that a team charter, “identifies both individual and group learning needs, resources to be used and evidences that learning needs have been met,” (Seymour, 2010, pg. 74). Furthermore, the team charter can provide structure and organization for the group (Seymour, 2010). A team charter will allow students to become familiar with their teammates and define expectations for the group before starting the project. By having set standards, the group can make an effort to minimize negative dynamics when conflict comes up by referencing agreements made through the team charter.

Afterwards, we recommend using a portion of a scheduled course time where students spend time together doing something enjoyable with their group. This could function as a time to let groups interact in a non-academic manner, encouraging them to foster friendly relationships. This recommendation has arisen due to a common sentiment seen in focus group discussions, where students express a wish to spend time together outside of class. One such group mentions vague disappointment as their plans to spend time together would get repeatedly pushed off due to a lack of time and, only half-jokingly, money. Having one instance of class time used for an activity of their choice towards the end of the first semester could benefit the bonds between team members and encourage positive group dynamics.

Additionally, for the second semester, many students request regular mandatory check-in meetings. A few students suggested “For some teams, maybe [the professors] don't even know what's going on.” Others mentioned that they would like to have their entire group on the same page and “forced” to attend class from time to time, even if they all work well together. The check-ins would compel group members to participate in the course in a way that is fair to the other group members. If an issue does arise in a

team, meetings in person with the professors could help the professors “see faces and see reactions rather than just a… a survey on Moodle,” especially in cases where a student is not the type to reach out for help. These mandatory check-ins would manage both the overall progress of the group as well as their ability to work as a group.

4.4 State Learning Objectives Emphasizing the Value of the Process

Students have trouble understanding the value in reflecting on the process during the course of designing their learning tool. Therefore, they do not understand why they are being asked questions like *What is your initial plan?* and *How will you achieve your goal?* The students’ focus on the project means they miss the course’s learning goal of experiencing an iterative design process consisting of reflection on aspects such as group functioning or prototype failures. By stating clear learning objectives and emphasizing the importance of the project process, students will more easily see why the process (and not just the final product) is valuable to them. It is important to state the objectives of an assignment explicitly, so students can understand its purpose (Ferguson, 2007). Furthermore, students will view these assignments as a necessary part of their learning tool development. These objectives could be explained in class as Ferguson (2007) explains that students can have an informed understanding of their learning through student-teacher collaboration. Additionally, these objectives can be put directly at the top of assignments and on Moodle, so students have access to look back on them. Ferguson (2007) further explains that students’ access to these objectives help them to understand how a specific assignment contributes to the overarching objectives.

These learning objectives could be supplemented by examples of how the skills acquired from process focused assignment could apply to them in the real world. Students need to understand that reflection can increase the efficiency of a group’s combined learning. Students have expressed dislike towards their existing reflection assignments. They did not see these assignments being helpful for their project. Students must comprehend that reflection is invaluable specifically within the PBL

process. In a discussion about group dynamics in PBL, Alison Seymour draws upon Sue Baptiste's thoughts on PBL when explaining,

> "It is important that students and facilitators become comfortable at reflecting on the impact of the self within PBL groups and are able to utilise this knowledge to manage themselves and others within the group environment. These transferable skills will prove to be invaluable in all work-based teams in the future," (Seymour, 2010, pg. 73).

In reflecting on the process, students can understand how they can improve one's own learning and their team dynamics as a group, allowing them to more easily progress on their project. By explicitly explaining the importance of reflections, students will better understand how the process is an integral aspect not only of course but also in learning beyond.

4.5 Keep Strong Interactions with Students but Be Mindful of Shyer Students

As described above, the majority of the students greatly enjoy and are appreciative of their professors, which is beneficial to their learning. This is a wonderful thing, so we encourage the professors of this course to keep doing what they're doing. However, as also described earlier, eight students experience feelings of discomfort and four experience anxiousness, which has a negative impact on how they learn. We recommend being mindful of these students and being conscious of speech volume. While many students already feel comfortable sharing feedback with the professors, the professors should remain open to them and ask the students to reach out if the cold-calling made some feel anxious. It is important to understand that instructors may not be able to connect with every student.

5. Conclusion

Stress, anxiousness, hope, inspiration, pride - students shared their experiences with us which spanned the range of academic emotions and everything in between. After analyzing the emotions students experienced and their causes, we came to understand that there exists a wide overlap between academic emotions such as social achievement or epistemic emotions. These overlaps indicated the congruity between student experiences and that these emotions are not experienced in isolation but influence one another. For example, a student may feel both excitement and anxiousness when beginning the project, or pride and satisfaction after completing a submitting a report. Similarly, boredom with course content may spill over and affect motivation and engagement with their teammates. The emotional trajectory of students in HPL illuminated how not all negative emotions are “bad”, but some, such as anxiousness or stress, can act as a motivator in limited amounts. We observed how positive and negative emotions stemming from project group interactions vastly influenced the emotional experiences of students.

Our research on the How People Learn course exemplified that PBL can be a confusing, complex experience for students and may be accompanied by emotions they are not used to feeling such as discomfort or socially-induced irritation. However, students should rest assured that these emotions are normal to feel, and part of the PBL process given its vast differences from traditional learning. In a global sense, we observed that emotions serve as a bridge connecting individuals—especially students—and recognizing them reveals the common threads of experience between people.

6. References

Beebe, J. (2014). Rapid Qualitative Inquiry: A field guide to Team-Based Assessment. Rowman & Littlefield.

Boss, S. (2015). Real-World Projects: How Do I Design Relevant and Engaging Learning Experiences? (ASCD Arias). (n.p.): ASCD.

EPFL. (2024). *How People Learn: Designing Learning Tools I*. EPFL. https://edu.epfl.ch/coursebook/en/how-people-learn-designing-learning-tools-i-HUM-432

EPFL. (2024). *How People Learn: Designing Learning Tools II*. EPFL. https://edu.epfl.ch/studyplan/en/master/humanities-and-social-sciences-program/coursebook/how-people-learn-designing-learning-tools-ii-HUM-433

Ferguson, B. (2007). Integrating Learning Outcomes and Assessment into the Curriculum: A Case Study. *On the Horizon*, *15*(2), 80–88. https://doi.org/10.1108/10748120710757316

Hanney, R. (2021). Making Projects Real in a Higher Education Context. In: Morley, D.A., Jamil, M.G. (eds) Applied Pedagogies for Higher Education. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-46951-1_8

Harris, J. (2016). Utilizing the Walking Interview to Explore Campus Climate for Students of color. *Journal of Student Affairs Research and Practice*, 53(4), 365–377. https://doi.org/10.1080/19496591.2016.1194284

Heinricher, A. C., Quinn, P., Vaz, R. F., & Rissmiller, K. J. (2013). Long-Term Impacts of Project-Based Learning in Science and Engineering. *2013 ASEE Annual Conference & Exposition Proceedings*, 23.874.1-23.874.25. https://doi.org/10.18260/1-2--19888

Johnson, B., Ulseth, R., Smith, C., & Fox, D. (2015). The Impacts of Project Based Learning on Self-Directed Learning and Professional Skill Attainment: A Comparison of Project Based Learning to Traditional Engineering Education. *2015 IEEE Frontiers in Education Conference (FIE)*, 1-5. https://doi.org/10.1109/fie.2015.7344028

Kovacs, H., Milosevic, T., & Niculescu, A. (2023). Planned, Taught, Learnt: Analysis Of Transversal Skills Through Curriculum Using Portfolio. *European Society for Engineering Education (SEFI)*. https://doi.org/10.21427/R0JP-8277

Kellam, N., Gerow, K., Wilson, G., Walther, J., & Cruz, J. (2018). Exploring Emotional Trajectories of Engineering Students: A Narrative Research Approach. International Journal of Engineering Education, 34(6), 1726–1740. Retrieved from https://www.ijee.ie/latestissues/Vol34-6/02_ijee3672.pdf

Lönngren, J., Adawi, T., & Berge, M. (2021). Using Positioning Theory to Study the Role of Emotions in Engineering Problem Solving: Methodological Issues and Recommendations for Future Research. *Studies in Engineering Education, 2(1)*, 53–79. https://doi.org/10.21061/see.50

Movahedzadeh, F., Patwell, R., Rieker, J. E., & Gonzalez, T. (2012). Project-Based Learning to Promote Effective Learning in Biotechnology Courses. Education Research International, 2012, 1–8. https://doi.org/10.1155/2012/536024

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research. *Educational Psychologist*, *37*(2), 91–105. https://doi.org/10.1207/s15326985ep3702_4

Pekrun, R., & Linnenbrink-Garcia, L. (Eds.). (2014). *International Handbook of Emotions in Education* (1st ed.). Routledge. https://doi.org/10.4324/9780203148211

Pekrun, R., & Stephens, E. J. (2012). Academic emotions. In K. R. Harris, S. Graham, T. Urdan, S. Graham, J. M. Royer, & M. Zeidner (Eds.), *APA Educational Psychology Handbook, Vol. 2. Individual Differences and Cultural and Contextual Factors* (pp. 3–31). American Psychological Association. https://doi.org/10.1037/13274-001

Seymour, A. (2010). Managing Group Dynamics and Developing Team Working in Problem-Based Learning. In Problem-Based Learning in Health and Social Care (pp. 67–78). Wiley-Blackwell. https://doi.org/10.1002/9781444320541.ch6

Sunderland M. E. (2014). Taking Emotion Seriously: Meeting Students Where They Are. *Science and Engineering Ethics*, *20*(1), 183–195. https://doi.org/10.1007/s11948-012-9427-y

7. Appendices

Appendix A: Preliminary Email Introducing WPI Students to the HPL Students

The professors sent an email to the students on our behalf, which informed them of our research, provided photos of ourselves for students to identify us, and invited them to share their experiences.

-

As some of you may know, some students are visiting from the U.S.A., who arrived here in Lausanne this week. They wanted us to forward a message to all of you, especially if you have not met them yet. Their message is included below.

Dear students of *How People Learn II:*

Bonjour!

We are students at Worcester Polytechnic Institute (WPI), a small engineering college in the northeast United States. We will be joining you in the *How People Learn* course every Wednesday for the coming weeks. We enjoyed meeting some of you in class this week and are looking forward to meeting more of you soon!

We have a project, similar to your own, which investigates the influence of emotions on project-based learning and aims to understand the experiences and perspectives of students like you. We would greatly appreciate it if *you* could share your experiences with us. This opportunity will also be useful to reflect on your skill development in the course. Additionally, it may be interesting to compare each other's experiences. As students, we hope to empathize with you to gain feedback that you might not ordinarily share with your professors. Your direct responses will not be shared with anyone except the four of us.

After learning more about your projects to design a learning tool, we became interested, so we'd like to learn more about your own projects as well. We would also love to contribute to your prototype testing as participants.

For our project we rely on you sharing your experiences, impressions, and thoughts about the How People Learn course, so that the analyzed results can be used to improve the course. However, we want to emphasize that your participation is completely voluntary. Depending on your willingness, we offer different ways to contribute to our project. You could meet with us for informal interviews individually or

as a group. You may also volunteer for us to observe your group work, so we can understand your process of developing the learning tool. We would also love to just chat with you while walking across campus.

If you would like to participate or have any questions about our project, please do not hesitate to reach out to us. Since we will be attending the next several class sessions, feel free to meet with us then, as part of our project or just to talk. Additionally, if you would prefer to meet outside of class time, we would be happy to find a time that works for you and us, at any location you feel convenient. You can contact us at our group email of example@wpi.edu or reach out to us via SMS or WhatsApp at +X XXX-XXX-XXXX. We have also attached a picture of ourselves to help you identify us.

Sincerely,
Kate Saidy
Kasia Racka
Lauren McIlhenny
Christian Wagener

Appendix B: Behavior Observation Guide

We used this guide as a basis for formatting observation notes. We differentiated between raw data and individual reflections using a “(MEMO:)” tag.

Base Information:	Name:	Date:	Time:
	Location:	Observing What:	Consent Received:
Setting & Context: Describe the surroundings and environment. Anything preceding the observed session			
Summary:			
Narrative: An account of the observed events (as a bulleted list)			

Appendix C: Post Observation Group Questions

Did our presence influence your group work? How so?

How would you describe the mood of this meeting compared to other meetings?

What would you have done differently about this meeting?

Appendix D: Interview Questions & Guide

*Note: Yellow highlighted questions denote higher importance. If the student indicated having a limited amount of time, we prioritized those questions.

I'd like to preface this interview by confirming that your responses will be anonymized and that they will have no effect on your grade.

How much time do you have for us today?

Let's try an exercise. In the next 30 seconds, please list the first 5 things you think of, in order, when you hear the term "project-based learning."

---

1. Why did you choose to take this course?

Now, I'd like to ask about your experience in HPL 1:

2. Tell me about your time in the HPL1 course.
    1. How did you feel during the course?
    2. How do you feel about the course now that you have finished it?
    3. What did you like about the course and why?
    4. What did you dislike about the course and why?
    5. How would you improve the course?
    6. Is there anything you would change but felt like you couldn't tell the professors?

Now, I'm going to ask some similar questions regarding your experience in HPL II:

3. Tell me about your time in the HPL II course.
    1. How do you feel during this course?
    2. What have you learned, or what are you learning, in HPL II?
    3. What do you like about HPL2 and why?
    4. What do you dislike about HPL2 and why?
    5. How would you improve HPL2?
    6. Is there anything you would change but felt like you couldn't tell the professors?
    7. How would you describe the professor's organization of the HPL II course?
        1. How did it compare to their organization of HPL I?
    8. How do you feel about the amount of time and work you spend on the course?
        1. Compared to HPL1?
    9. How do you feel about the split/distribution of your group work?
    10. How do you feel about the work that you complete individually? Project vs process vs reflection?

11. Could you describe for me what this process of collaborating with other students has been like?
12. What emotions have you experienced while working with your team?

Now we'd like to hear more about your experience working on the project of developing a learning tool with your team:

4. Can you tell me a little bit about your project, so I can understand the learning tool you are developing?
    1. How do you feel about your project? (Any specific emotions that you felt often?)
    2. How relevant are the concepts of HPL I to HPL II?

Potential Follow-up Questions:

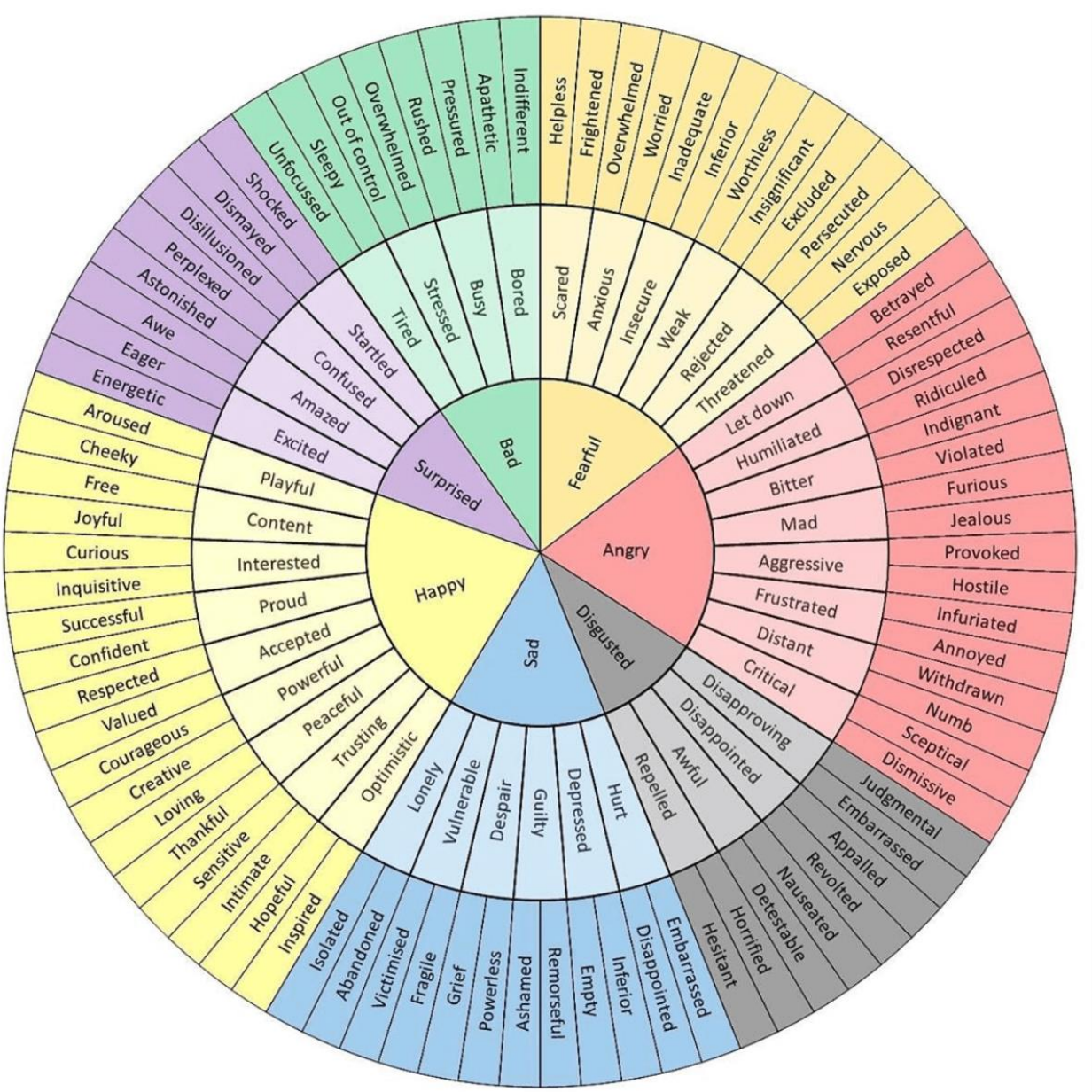
5. Has your perspective changed compared to when you started your project? Why or why not?
    1. Earlier, you mentioned feeling _____. Can you describe it?
    2. Did this affect your motivation? If yes, how?
    3. What was the cause of your _____?
    4. Are there any ways you see _____ being changed or improved to better support your experience in HPL? If so, how?
6. Anything you would like to add or clarify?

This is the guide that will be used to take notes during our interview. Notes will be taken in a spreadsheet document, which is represented below.

Date:	Interviewer:		
Time:	Notetaker:	Setting:	FUQ: Follow Up Question
Questions	Response/Dialog	Nonverbal	Reflections
How much time do you have for us today?			
Let's try an exercise. In the next 30 seconds, please list the first 5 things you think of, in order, when you hear the term "project-based learning."			
Why did you choose to take this course?			

Now, I'd like to ask about your experience in HPL 1:			
Tell me about your time in the HPL1 course.			
How did you feel during the course?			
How do you feel about the course now that you have finished it?			
What did you like about the course and why?			
What did you dislike about the course and why?			
How would you improve the course?			
Is there anything you would change but felt like you couldn't tell the professors?			
Now, I'm going to ask some similar questions regarding your experience in HPL II:			
Tell me about your time in the HPL II course.			
How do you feel during this course?			
What have you learned, or what are you learning, in HPL II?			
What do you like about HPL2 and why?			
What do you dislike about HPL2 and why?			
How would you improve HPL2?			
Is there anything you would change but felt like you couldn't tell the professors?			
How would you describe the professor's organization of the HPL II course?			
How did it compare to their organization of HPL I?			
How do you feel about the amount of time and work you spend on the course?			

Compared to HPL1?			
How do you feel about the split/distribution of your group work?			
How do you feel about the work that you complete individually? Project vs process vs reflection?			
Could you describe for me what this process of collaborating with other students has been like?			
What emotions have you experienced while working with your team?			
Now we'd like to hear more about your experience working on the project of developing a learning tool with your team:			
Can you tell me a little bit about your project, so I can understand the learning tool you are developing?			
How do you feel about your project? (Any specific emotions that you felt often?)			
How relevant are the concepts of HPL I to HPL II?			
Anything else you'd like to add or clarify?			



Emotion Wheel [PNG]. Fairygodboss. https://fairygodboss.com/career-topics/emotion-wheel

Appendix E: Focus Group Interview Guide

Questions:

1. IF UNKNOWN: Can you tell me a little bit about your project, so I can understand the learning tool you are developing?
2. How do you feel about the project?
3. Tell me about how your team works together on the project.
    1. IF BRIEF: How is it going?
    2. What is most effective?
    3. What is most challenging?
4. Have you encountered any issues/ faced any difficulties?
    1. IF YES: how do you resolve these conflicts?
    2. How might that impact feelings of inclusion and equity on the team?
5. How do you feel during group work?
6. How do you think you can improve your teamwork?

We used this guide to take notes during our focus group interviews. We took notes in a spreadsheet document, which is represented below.

Date:	Interviewer:		
Time:	Notetaker:	Setting:	FUQ: Follow Up Question
Questions	Response/Dialog	Nonverbal	Reflections
IF UNKNOWN: Can you tell me a little bit about your project, so I can understand the learning tool you are developing?			
How do you feel about the project?			
Tell me about how your team works together on the project.			
IF BRIEF: How is it going?			
What is most effective?			
What is most challenging?			
Have you encountered any issues/ faced any difficulties?			

IF YES: how do you resolve these conflicts?			
How might that impact feelings of inclusion and equity on the team?			
How do you feel during group work?			
How do you think you can improve your teamwork?			

Appendix F: Email to Send Out Survey

Hello again students of *How People Learn II:*

We are the students visiting from the U.S. We'd love to talk to more of you in the next two weeks.

We have a project, similar to your own, which investigates the influence of emotions on project-based learning and aims to understand the experiences and perspectives of students like you. For our project we rely on you sharing your experiences, impressions, and thoughts about the How People Learn course, so that the analyzed results can be used to improve the course.

We want to emphasize that your participation is completely voluntary. Depending on your willingness, we offer different ways to contribute to our project. You could meet with us for informal interviews individually or as a group. If you're interested, you can sign up for an interview with this form: https://qualtricsxmgygnhfkbv.qualtrics.com/jfe/form/SV_eKDUSKBpHydZmlg.

We'd like to learn more about your own projects as well and would love to contribute to your prototype testing as participants.

You can also reach us directly via example@wpi.edu or WhatsApp +X XXX-XXX-XXXX.

Thank you!
Lauren McIlhenny
Kasia Racka
Kate Saidy
Christian Wagener

Appendix G: Interview Sign-up Survey

This was the Qualtrics survey sent out to students to sign up for interviews.

Hello! We are WPI students studying how emotions impact project-based learning. We'd love the chance to interview you to learn your experience of the How People Learn course.

If you are interested, please fill out this form.

What's your name?

What is your email or WhatsApp information?

When are you available before April 19th?

Appendix H: Consent Statement

Thank you for your willingness to participate in our research. Before we begin, we just want to make sure you understand our project.

Purpose:

The purpose of our research is to gather information regarding emotions in education, project-based learning, and the “How People Learn” course. Your insights and experiences are valuable and will contribute to our understanding of how student experiences can be improved in the future.

Procedure:

Procedure for Interviews:

> We will ask you about your time in the “How People Learn” sequence at EPFL. Can we do an audio recording of this interview? We will use the recording to make a transcript. It will not be shared with others.

Procedure for Observation:

> By agreeing to participate, you are allowing us to take confidential notes on your group work. You may ask us to leave at any time.

Procedure for Focus Groups:

> We will be asking you about your time working as a group. Do we have the consent of every member of the group to create a recording for note-keeping & analysis purposes?

Voluntary Participation:

Your participation in this research is completely voluntary. You have the right to refuse to answer any questions or to withdraw at any time without any penalty or consequence.

Confidentiality:

All information collected during the interview will be kept confidential and will only be accessible to us, the researchers involved in the study and our project advisors. No names or contact information of participants will be published. Audio recordings and documents with contact information will be destroyed on May 31st, 2024.

Do you consent to these terms?

Appendix I: Timeline for On-Site Research Methods and Tasks

We designed this timeline to plan when certain methods would be used on-site and to track our research progress while in Lausanne. This was a general guide that was revised as needed.

Timeline									
Obj.	Task	Week							
		1	2	3	4	5	6	7	8
1	Revise interview questions, mock interviews								
1	Obtain & read course evaluations								
1	Code & analyze evaluations								
2	Building rapport								
2	Interview individual students								
2	Course time - observe group dynamics								
2	Group interview - student teams								
3	Compare key findings								
3	Identify themes in student experience								
3	Create recommendations for the course								