

A Control-Value Theory Lens on Middle School Students' Emotions in Project-Based Learning Proje Tabanlı Öğrenmede Ortaokul Öğrencilerinin Duygularına Kontrol-Değer Teorisi Bakışı

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Abstract: This study aimed to explore the emotions of seventh-grade students engaged in Project-Based Learning (PBL) and to investigate the underlying causes of these emotions using control-value theory. Employing a descriptive case study design, the research involved three seventh-grade students from a middle school during the 2022-2023 academic year. Data were collected through semi-structured interviews focused on students' emotions related to teamwork, individual differences, understanding team roles, participation, and motivation, alongside audio recordings of group discussions. Findings indicated that seventh-grade students experienced more negative emotions than positive ones throughout the PBL process, with these negative feelings intensifying during complex tasks. Notably, different students exhibited distinct emotional responses, highlighting individual variations in how they reacted to challenges during the planning, implementation, and communication phases. Despite the prevalence of negative emotions, students reported enjoyment from collaboration, recognition of their ideas, and a sense of control over their learning. Overall, while PBL presents challenges, it also fosters emotional engagement and satisfaction as students navigate these experiences together. The study recommends implementing emotional support mechanisms and personalized guidance to help students manage negative emotions, as well as providing training on effective feedback techniques to enhance communication and collaboration, ultimately improving their learning experience.

Keywords: Project-based learning, control-value theory, emotion, case study

Öz: Bu çalışmanın amacı, Proje Tabanlı Öğrenme (PBL)'ye katılan yedinci sınıf öğrencilerinin duygularını keşfetmek ve kontrol-değer teorisini kullanarak bu duyguların altında yatan nedenleri incelemektir. Betimleyici bir vaka çalışması tasarımı kullanan araştırma, 2022-2023 eğitim öğretim yılında bir ortaokuldan üç yedinci sınıf öğrencisini kapsamıştır. Veriler, takım çalışması, bireysel farklılıklar, takım rollerini anlama, katılım ve motivasyonla ilgili öğrenci duygularına odaklanan yarı yapılandırılmış görüşmeler ve grup tartışmalarının ses kayıtları aracılığıyla toplanmıştır. Bulgular, yedinci sınıf öğrencilerinin PBL süreci boyunca olumlu duygulardan daha fazla olumsuz duygu yaşadığını ve bu olumsuz duyguların karmaşık görevler sırasında yoğunlaştığını göstermiştir. Özellikle, farklı öğrenciler farklı duygusal tepkiler sergilemiş ve planlama, uygulama ve iletişim aşamalarında zorluklara nasıl tepki verdiklerindeki bireysel farklılıkları vurgulamıştır. Olumsuz duyguların yaygınlığına rağmen, öğrenciler işbirliğinden keyif aldıklarını, fikirlerini tanıdıklarını ve öğrenmeleri üzerinde bir kontrol duygusuna sahip olduklarını bildirmişlerdir. Genel olarak, PBL zorluklar sunarken, öğrenciler bu deneyimleri birlikte yaşarken duygusal katılımı ve memnuniyeti de teşvik etmektedir. Çalışmada, öğrencilerin olumsuz duygularıyla başa çıkmalarına yardımcı olmak için duygusal destek mekanizmaları ve kişiselleştirilmiş rehberlik uygulanmasının yanı sıra, iletişim ve iş birliğini artırmak için etkili geri bildirim teknikleri konusunda eğitim verilmesi ve sonuç olarak öğrenme deneyimlerinin iyileştirilmesi önerilmektedir.

Anahtar Kelimeler: Proje tabanlı öğrenme, kontrol-değer teorisi, duygu, durum çalışması

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Introduction

21st-century skills are defined as possessing not only scientific knowledge but also critical thinking, problem-solving, communication, collaboration, creativity, and innovative thinking skills (Chu et al., 2021). These skills highlight inquiry-based, problem-based, and project-based learning environments where students collaborate, consider individual differences, and encourage each other's learning (Zhang et al., 2022a). In traditional teaching methods, students complete tasks assigned by the teacher as quickly as possible and are ranked from 'best to worst' based on their performance, which fosters competition among them (Smith & Chan, 2017). Project-based learning (PBL), on the other hand, is a method that allows students to actively research, produce, and shape their own learning processes. This approach supports the development of individuals who are aware of their learning and skills and actively construct knowledge (Aydın & Göksu, 2018). PBL helps students develop a deeper understanding of scientific concepts by encouraging them to generate diverse ideas and make efforts to persuade each other when there are

differences in these ideas (Miyake & Kirschner, 2014). Moreover, PBL enables students to develop a sense of belonging as students of different achievement levels feel that they have equal status (Cohen & Lotan, 2014), co-construct learning goals with their teachers, and receive peer feedback during both individual and group work (Tanner et al., 2003).

While PBL creates a shared emotional atmosphere among group members, it also empowers individuals to experience positive emotions like curiosity, self-confidence, willingness, enjoyment, and satisfaction (Hernández-Barco et al., 2021). However, it is reported that students may experience conflicts due to unequal contributions (Shpeizer, 2019), lack skills in managing time, resources, and effort, and face difficulties in evaluating the quality of the final product (Lee, 2022). Additionally, students may experience negative emotions when they fail to achieve their personal or group goals or perceive a mismatch between the outcome and their expectations (Mangaroska et al., 2019). Given the interconnectedness of cognitive and emotional processes, research should explore not only the cognitive benefits of PBL,

such as critical thinking and problem-solving, but also emotional experiences that students may encounter during the process (Rogat & Adams-Wiggins, 2015). The control-value theory provides guiding principles for researchers to assess the quality of PBL. These principles focus on the effectiveness, clarity, and motivational quality of teaching processes, as well as the management of emotional experiences and the level of student autonomy (Pekrun, 2009). Previous studies have demonstrated that teaching methods influence students' academic emotions and perceptions of control, leading to changes in emotions such as pleasure, pride, boredom, anger, and anxiety (Bieg et al., 2017; Lazarides & Buchholz, 2019). However, studies analyzing the complex and dynamic emotions that students experience during PBL are limited (Lobczowski et al., 2021; Zhang et al., 2022a). To address this gap, an overarching framework is required to guide the evaluation of emotions within their specific context (Lobczowski et al., 2021). This study aims to fill this gap in the literature by exploring students' emotions during the PBL process through the lens of control-value theory. By applying this theoretical framework, the study aims to provide insights into the emotions experienced by seventh-grade students at each stage of PBL, as well as the underlying reasons for these emotions. This study, which identifies the emotions students experience during the PBL process and the reasons behind these emotions, will contribute to making PBL-based interventions that help students regulate their emotions more effectively.

Project-Based Learning

The roots of PBL can be traced back to the work of John Dewey. Dewey argued that meaningful learning occurs when students work on tasks or problems that relate to real life (Krajcik & Blumenfeld, 2006b; Maida, 2011). Therefore, the goal of PBL is not only to help students understand the scientific content of a concept, phenomenon, or event but also to understand its significance in their daily lives (Virtue & Hinnant-Crawford, 2019).

PBL is widely recognized as a learning approach in which learners, as members of a social community, plan, implement, and evaluate their own research to find solutions to real-world problems they are curious about (Krajcik & Czerniak, 2018). It enables students to research real-world issues using an interdisciplinary approach and produce concrete outcomes through individual or pair work (Turgut & Büyükkasap, 2024). Krajcik and Blumenfeld (2006a) identified five essential features of PBL: a) driving question, b) scientific practices, c) collaboration, d) use of technology, and e) a tangible product. When the driving question is determined by the student, they are motivated to explore information and stayed engaged throughout the learning process as they solve a question of personal curiosity (Miller & Krajcik, 2019). Students engage in inquiry-based learning to answer the question, and apply ideas from relevant disciplines (Pan et al., 2021), and write evidence-based explanations using scientific practices (Alozie et al., 2010). In working settings, students share their ideas and fulfill their responsibilities, and contribute to product development, supporting peer progress through feedback (Kurniawati et al., 2019; Trisdiono et al., 2019). Technological tools such as graphic design tools, computer programming tools, digital images, videos, and email enable students to effectively present their products (Grant, 2011; McGrath, 2004). Blumenfeld et al. (1991) note that in PBL, students are responsible for creating a model, report, video recording, or

other product that answers their driving question. Feedback on shared products allows them to refine both their learning and outcomes.

The effects of PBL on academic achievement in science, mathematics, and technology, as well as on students' understanding of scientific concepts, have been the focus of many studies. For instance, Erdoğan and Acaray (2023) reported that there is no significant difference in students' final test scores between those who participated in PBL—including stages like determining the research topic, planning, implementation, and evaluation—and those in traditional instruction. However, project applications using a four-question strategy—determining materials, predicting outcomes, identifying alternatives, and data collection—positively impact students' scientific process skills (Şahin & Benzer, 2012). PBL-based instruction conducted in out-of-school environments focusing on research, discovery, development, and product creation significantly improves scientific process skills compared to traditional curriculum-aligned instruction (Şimşek & Hamzaoğlu, 2020). Additionally, students in schools where PBL integrates technology and engineering content achieve higher national exam scores than peers in traditional schools (Craig & Marshall, 2019; Han et al., 2015; Schneider et al., 2002). Furthermore, students in PBL-based schools score higher on emotional and social skills inventories (Culclasure et al., 2019).

While studies have highlighted the impact of PBL (e.g. de Oliveira Biazus & Mahtari, 2022; Elfeky & Elbyaly, 2023; Zhang & Ma, 2023), research also examines how students perceive these effects. Sahin and Top (2015) found that integrating PBL into STEM education improves students' self-confidence, technology proficiency, communication, and collaboration skills. Similarly, students in PBL classes report excitement and enthusiasm, realizing the value of their work when sharing projects with community members (Scogin et al., 2017; Virtue & Hinnant-Crawford, 2019). Students selecting problems related to regional issues feel appreciated, take responsibility, and form meaningful relationships with stakeholders (Turcotte et al., 2022). These findings indicate that PBL not only deepens knowledge but also enhances collaboration and communication skills (Warr & West, 2020). The self-confidence, enthusiasm, and sense of value students experience reveal the link between PBL and their emotions. Understanding emotions in PBL provides opportunities to enhance learning. The next section will discuss "emotion," its diversity per control-value theory, and its relationship with PBL.

The Role of Emotions in Project-Based Learning: A Control-Value Perspective

Emotion is defined as a response to evaluations of success or failure in achieving goals, shaped by both conscious and unconscious mental processes (Schutz et al., 2006). Frijda (2017) suggests that emotions arise from events meaningful to the individual—positive emotions from goal fulfillment and negative emotions from threats. Pekrun's (2006) control-value theory offers a comprehensive framework for understanding achievement emotions, which are tied to outcomes in achievement-related activities. According to this theory, emotions are shaped by the perceived control over these activities and the value assigned to their outcomes (Pekrun et al., 2007; Pekrun & Stephens, 2010).

Pekrun et al. (2023) classify achievement emotions across four dimensions based on valence and activation: positive activating emotions (e.g., enjoyment, hope for success, pride), positive deactivating emotions (e.g., relaxation, satisfaction), negative activating emotions (e.g., anger, anxiety, shame), and negative deactivating emotions (e.g., boredom, hopelessness) (Pekrun et al., 2002). Emotions related to prospective, retrospective outcomes, and activity, with different object focuses and time frames, serve distinct functions (Pekrun, 2006). For outcome emotions, joy and hopelessness are triggered when perceived control is high (joy) or absent (hopelessness) for future-oriented emotions, while hope and anxiety arise when control is uncertain (Pekrun, 2016). Emotions related to past outcomes include pride, joy, gratitude, shame, guilt, and anger. Pride, shame, and guilt involve personal responsibility, while gratitude and anger stem from attributing responsibility to others (Pekrun et al., 2023). Activity emotions arise from ongoing achievement-related activities (Pekrun et al., 2011). For example, enjoyment occurs when a task is perceived as controllable and valuable, while frustration occurs when it is valued but uncontrollable. Boredom arises when physical activity decreases during an unpleasant experience (Pekrun et al., 2010).

Emotions significantly shape students' learning experiences and outcomes (Zhang et al., 2018). Research shows that high achievement emotions before a task boost effort and performance, while negative emotions during a task lower performance (Kiuru et al., 2020). Positive emotions like enjoyment and pride correlate with increased engagement, whereas negative emotions may emerge during challenging phases of PBL. For example, during the preparation phase, students may feel joy, hope, relaxation, or anxiety, and during implementation, they may experience enjoyment, frustration, or boredom (Chue, 2020). Additionally, negative emotions arise when students encounter a problem and perceive that they are unable to solve it (Walters et al., 2016). In PBL, emotions can spread through emotional contagion, affecting group dynamics (Pietarinen et al., 2019). Positive group emotions are linked to efficient, respectful interactions, while negative emotions result from unequal participation or ineffective discussions (Zschocke et al., 2016). These dynamics illustrate the complex role emotions play in PBL experiences.

Substantial research has explored the impact of PBL on student outcomes, particularly regarding academic achievement and attitudes across various disciplines (e.g. Karacalli & Korur, 2014; Keser, 2008; Ülküdür, 2016). While PBL actively engages students in the learning process, the interactions they form during individual, or group tasks can elicit both positive and negative emotions. Research indicates that encouraging emotional awareness helps students improve cognitive development, solve problems more effectively, and perform better in teamwork (Järvenoja et al., 2018; Goagoses et al., 2023). Although there are studies on how students share their emotions, preferences, and perspectives in learning environments (Zhang et al., 2022a; Zhang et al., 2022b), research on how groups navigate social participation, collaboration, and communication during disagreements, conflicts, or competition remains limited (Li et al., 2024). Additionally, it remains unclear whether group members experience both positive and negative emotions simultaneously during the various stages of PBL or if these emotions arise independently.

To better understand how these multi-layered emotional experiences influence learning during PBL, it is crucial to

examine their role (Järvenoja et al., 2018). The control-value framework offers valuable insights into how students regulate complex emotions during learning activities. It emphasizes the role of students' perceptions of control and the value they attribute to tasks in shaping their engagement and performance at various stages. For instance, research has revealed that the interaction between intrinsic value and control plays a critical role in shaping students' emotional experiences and academic achievement (Putwain et al., 2021). On the other hand, students' perceptions of teaching quality—such as teacher support, cognitive activation, and classroom management—enhance positive emotions like joy and pride, while reducing negative emotions such as anxiety, anger, boredom, and shame when they encounter errors or uncertainty in lessons (Chen et al., 2025). However, it is important to consider emotions not as static and one-dimensional, but as dynamic and multi-dimensional constructs that evolve over time. Specifically, in the learning context, addressing the dynamics of negative emotions in this manner can help fill gaps in current research, offering a more nuanced view of how these emotions impact students' experiences (Cloude et al., 2021). This study aims to fill this gap by examining the emotional dynamics of students during PBL activities and their relationship to control evaluations—a perspective that remains underexplored in previous research. In this context, the goal of this research is to investigate the emotions of seventh-grade students during different stages of PBL, such as team name determination, planning, implementation, and communication, and to analyze the reasons for these emotions within the framework of control-value theory. Identifying these emotional dynamics will serve as a foundation for designing instructional activities aimed at helping students regulate their emotions (Zhang et al., 2022a). By doing so, this research aims to contribute to the development of teaching methods that integrate both cognitive and emotional growth, thereby enhancing the effectiveness of PBL for students. Accordingly, this study addresses the following research questions:

- Based on Control-Value Theory, what emotions do seventh-grade students experience during the stages of PBL, including team name determination, planning, implementation, and communication?
- According to Control-Value Theory, what are the underlying causes of the emotions experienced by students during the different stages of PBL?

Method

Research Design

In this research, a descriptive case study approach was used. The purpose of a case study is to provide a detailed explanation of students' experiences in a real learning environment (Yin, 2003). This study aims to explore the emotions students experience in the PBL environment and the reasons behind them. The case in this research involves three students. The emotions and underlying causes that arise during the stages of PBL, such as team name determination, planning, implementation, and communication, were identified. In this way, the study sought to closely examine the types of emotional changes students experience as they transition from one stage to another, and how these changes occur.

Participants

The participants in this study were seventh-grade students studying at a middle school during the 2022-2023 academic

year. The participants were selected using a purposive sampling method from the only seventh-grade class at the school. Participants were selected from the school where the second researcher was employed and taught. To select the participants, the “Emotion Regulation Scale for Adolescents (ERSA)” developed by Duy and Yıldız (2014) was administered to all students in the class. This scale was used to assess the students' emotions before the PBL process began. The ERSA is designed to measure the emotion regulation abilities of students aged 11 to 18. The items on the scale are scored as follows: “Never (1), Rarely (2), Sometimes (3), Often (4), and Always (5).” Although the scale consists of 18 items and four dimensions, the total score obtained was calculated as 70, with the lowest score being 38, due to the dimensions not being directly related to the PBL process and the researcher's specific use of the scale for participant selection. To group the participants into low, medium, and high levels, the highest score was subtracted from the lowest, and the range was divided into three categories. The ranges were determined as follows: low (38-48.6), medium (48.7-59.3), and high (59.4-70). Students were assigned to groups according to their low, medium, and high scores from ERSA. As a result, 22 students were divided into six groups: two groups of three students each and four groups of four students each.

To analyze students' emotions during the PBL process, the researchers aimed to select participants to ensure diversity. Initially, they sought to create a representative sample of students with varying emotional responses. While the original plan involved 22 students, conducting detailed interviews and analyzing data for such a large sample was anticipated to be challenging. Each student would participate in six interviews: one before the PBL process began, one after each of the four phases, and one at the end of the process. Additionally, the researchers would analyze audio recordings of group conversations to gain a comprehensive understanding of students' emotional experiences. To maintain the study's depth and efficiency, the number of participants was limited to six students (two groups). However, due to irregular attendance in one group, data from only three students in the other group could be used in the analysis. To ensure confidentiality, real names were replaced, and 'R' was used to refer to the researcher. Among the six groups formed based on ERSA scores, Yiğit, Nesil, and Beyza were selected for analysis due to their varied emotional responses, with scores of 40, 52, and 68 respectively. These students were consistently part of the same group throughout the PBL process. During group recordings, letters were used instead of students' real names.

Data Collection Tools

In this research, data was collected through semi-structured interviews and audio recordings of group conversations. Semi-structured interviews with Yiğit, Beyza, and Nesil were conducted after completing the various stages of PBL, including team name determination, planning, implementation, and communication. The interview form consisted of 30 questions, which were developed by reviewing the literature (Lyons et al., 2021; Sevim, 2019; Tüfekçi & Benzer, 2019; Zuniga, 2019) to assess students' emotions in relation to team formation, individual differences, team members' roles, participation, and encouragement. An interview form consisting of 30 questions may appear excessive in terms of interview duration. However, not all of these questions were utilized in a single interview. The form

was designed as a comprehensive framework to gain an in-depth understanding of students' emotions and experiences during group work. During the interviews, specific questions were selected from the form based on the objectives of the research and directed to the students. This flexible approach ensured that the interviews remained both focused and responsive to the students' answers. To ensure the content validity of the questions in the form, feedback was obtained from a faculty member who an expert in PBL is. Based on this feedback, two questions that did not align with individual differences and the roles of team members were removed from the interview form. Additionally, modifications were made to questions that were deemed inappropriate for the students' level in each section. After these revisions, five seventh-grade students were asked to read the questions. The interview questions were then revised again based on the students' feedback to assess their readability, clarity, and suitability for the intended purpose. The purpose of the interview questions is outlined below:

Team Formation: To understand students' levels of cooperation with their group mates, their ability to work together, and their emotional responses. The processes of reaching consensus, freely expressing emotions, and taking responsibility in joint activities are examined. The positive or negative emotions they experience during this process are also considered.

Individual Differences: To explore how students react when encountering different thoughts, ideas, and approaches within the group. It investigates how different ways of thinking affect participants' emotional responses and how they adapt to these differences.

Team Members' Roles: To ask questions about how students perceive their roles and abilities within the group, and how they feel about whether these roles are suitable for them. It focuses on the experiences each individual has during task distribution and whether these roles align with their skills.

Participation: To have students reflect on whether each member of the group has an equal opportunity to participate and the emotional impacts of this. It evaluates whether participation is provided fairly, the sharing of responsibilities, and each individual's contributions during this process.

Encouragement: To investigate how group members encourage, motivate, and provide emotional support to each other. It addresses how the support received during the process of coping with negative emotions is experienced and the impact of emotional dynamics within the group.

Nesil, Yiğit, and Beyza were asked to answer the questions in the interview form after they completed the stages of PBL and to describe in detail the situations they encountered during the project process and how these situations led to emotional reactions. The fact that the participants were in the same group allowed for a comparison by revealing their different emotional reactions to a specific task or situation and determining the similarities and differences between these reactions.

During the interview, to help students clarify the emotions they expressed, the “Emotion Self-Assessment Tool” developed by Järvenoja et al. (2018) was reviewed, and the researchers developed an “Emotion Card”. The emotion card consists of a 4x4 grid. The emotions on the card are achievement emotions explained according to the control-value theory by Pekrun and Stephens (2009). These emotions are identified as joy, hope, hopelessness, relief, anxiety, pride, gratitude, sadness, shame, anger, liking, frustration, boredom,

and enjoyment. The Emotion Card, which shows these 16 emotions both with emojis and written explanations, was shown to the students as they completed the stages of PBL, and they were asked to explain which emotion or emotions they felt from the card. In this way, it was possible to determine the students' interactions with each other, their experiences, and how they reacted to a specific stage of PBL. After completing each stage of PBL, individual interviews lasting approximately 8 to 10 minutes each, and totaling about 90 minutes, were conducted with the three students.

To relate the emotions obtained from individual interviews to group interactions, the group conversations of Nesil, Yiğit, and Beyza were recorded with an audio device. The audio recordings of the group dialogues consist of approximately 20 minutes for each stage of PBL and a total of 60 minutes. Although PBL consists of four stages, the communication stage was conducted as a whole-class activity, so there was no group dialogue at this stage. The researchers started the recording when the group conversations began and ended the recording when the conversations were finished. The setup was maintained consistently across all five weeks.

Data Collection Process

This research was conducted in the Technology and Design course. The Technology and Design course consists of two class hours per week. The aim of this course is for students to create projects with their original ideas and to use technology while doing these projects. In this study, the objectives of "Expressing the difficulties of living for individuals with special needs. Investigating the design features of products developed for the ease of living for individuals with special needs. Designing a product that will provide ease of living for individuals with special needs by drawing it." was addressed. The class size consists of 22 students. The study was conducted in a classroom environment. The implementation was carried out by the second researcher, who is the science teacher of this class. The implementation lasted for 10 class hours. In this research, PBL was applied in four stages (Fuller, 2017; Hasni et al., 2016).

Team Name Determination (2 hours): The team name was determined, and task distribution was done.

Planning (2 hours): The problem was defined with constraints, and the question of the importance of the problem was addressed. The materials needed for the design were identified, and design tasks were determined. The design and construction stages of the product were written. The materials needed for the product, the time required to complete the product, and the feasibility of the proposed solution in terms of capacity, cost, durability, aesthetics, and time factors were assessed.

Implementation (4 hours): At this stage, the prototype of the design was made. Deficiencies in the prototype were identified. The product was tested to determine its level of solving the selected problem. To understand if the designed product meets the needs of an individual with special needs, the product was tested by an individual with special needs. After the test, if there were any deficiencies in the product, changes were made, and it was redesigned.

Communication (2 hours): Various strategies were developed to market the designed product. At this stage, students evaluated their products. A slogan was determined to market the product, a poster was prepared, and pricing was set.

Students were divided into groups of three and four to facilitate group work. The second researcher, who also served

as the Technology and Design teacher for this class, had a background in Science Education and was employed as a paid teacher at this school. Ethical approval was obtained for all protocols from the local Educational Research Ethics Committee. When students became aware that their voices would be recorded, the purpose of the research, its scope, the data to be collected, and the potential risks and benefits were clearly explained to them to minimize the impact of this awareness on their responses. Participants were informed that their voices would be recorded, how the recordings would be used, and that they had the right to withdraw at any time. They were also assured that the recordings would be anonymized, securely stored, and used exclusively for the stated purposes. Additionally, participants were given the opportunity to ask questions and express any concerns about the process (Cychosz et al., 2020).

Data Analysis

During the data analysis process, we applied the deductive approach (Patton, 2015). The Control-Value Theory framework was used to understand the emotional experiences of students in the PBL environment. For the analysis, 16 emotion categories proposed by Pekrun et al. (2011) were considered. Achievement emotions allow for the investigation of emotions specific to the PBL process, as they reveal the variety of emotions students may feel throughout the stages of PBL and relate these emotions to the dimensions of valence, activation, and object focus. Before the analysis, both individual interviews and group dialogues were transcribed, and all interviews were compared with the written records by two researchers. The data obtained from both individual interviews and group dialogues were examined together for the analysis of emotions.

The emotions that emerged in the students' responses were classified according to the dimensions of valence (whether the emotion is positive or negative), activation (whether the emotion motivates the student), and object focus (the target or situation of the emotion). If a student only expressed an emotion from the Emotion Card and was able to explain it according to the specified dimensions, it was included in the analysis. However, if a student only expressed the emotion but could not explain it according to the specified dimensions, it was not included in the analysis. In this process, to ensure reliability in data analysis, two researchers independently analyzed the data. These data were selected from the written transcripts of individual interviews with three students. Although these students were initially identified as participants by the researchers, they were excluded from the study due to the lack of continuity in their participation, as explained in the participants section. Therefore, since the dataset used is derived from the main dataset, the calculation of agreement between the coders is reliable, and the agreement rate was determined to be 85%.

To better understand the reasons behind the emotions identified in individual interviews, the written records of group dialogues were also analyzed. For this analysis, we applied content analysis following Fraenkel et al.'s (2012) approach. To understand the reasons for the emotions that emerged during group interactions and to compare them with individual emotions, excerpts from group conversations were taken. In the analysis of each stage, a general summary of the group's interactions was provided first. Then, the emotions of Beyza, Nesil, and Yiğit at each stage of PBL were presented together. In this way, it was determined how the interactions the students established with each other during group work reflected on their emotions. These emotional insights were accompanied by written excerpts from the group conversations.

Tablo 1. PBL Stage 1 – team name determination

Student	Emotion	Valence	Activation	Object Focus	Data Source	Quote
Yiğit	Boredom	Negative	Deactivating	Group decision-making process	Individual interview+ Group conversation	“There were so many ideas and I was stuck making decisions. They didn't like what I suggested.”
	Enjoyment	Positive	Activating	Diversity of ideas	Group conversation	“Different ideas emerged; I didn't expect so many to come up.”
Nesil	Anger	Negative	Activating	Yiğit's lack of contribution	Individual interview+ Group conversation	“I was already angry because Yiğit didn't care about our ideas and didn't contribute at all.”
	Enjoyment	Positive	Activating	Group idea-sharing process	Group conversation	“I was happy because it was a good thing; everyone was offering ideas, and good ideas were emerging.”
Beyza	Anger	Negative	Activating	Yiğit's lack of support for group ideas	Individual interview+ Group conversation	“At first, I was happy because it was a good thing; everyone was offering ideas, and good ideas were coming up... But when Yiğit didn't like our ideas and didn't support them, we had some anger issues...”
	Enjoyment	Positive	Activating	Group collaboration	Group Conversation	“I was happy... we all found something in common.”

Findings

This section presents the analysis of the emotions of students participating in PBL and the reasons for these emotions according to the control-value framework.

PBL Stage 1: Team Name Determination

Table 1 summarizes the emotions experienced by Yiğit, Nesil, and Beyza during the team name determination stage of PBL. During the team name determination stage, students were tasked with deciding on a team name that aligned with the design they would create for individuals with disabilities. Table 1 categorizes each emotion according to its valence, activation, and object focus, providing a clear overview of how each student interacted with the group dynamics.

After this stage was completed, it was revealed in individual interviews with the students that Yiğit was experiencing boredom and he explained the reason as follows: “There were so many ideas and I was stuck making decisions. They didn't like what I suggested.” Group conversations reveal that these feelings stemmed from the group members struggling to decide on a team name. Yiğit rejected the proposed team names, such as “scholars or knowledge worms, design guardians, technology explorers, and design explorers,” and when his friends asked him to contribute to finding a team name, he responded, “What should I find now?.. I haven't found anything”. Yiğit's dialogue with his group members indicated that he found the idea generation process at this stage to be insufficient.

B: Yiğit, why do you seem bored?

Y: I'm not bored.

N: Exactly. Yiğit, you seem bored.

Y: Too many unnecessary ideas came up, that's why.

B: Which ones are unnecessary?

Y: Like “guardians.

Yiğit's boredom is a negative emotion (negative valence, activity focus). He felt this way because he saw the contributions of his group members as worthless (negative valence) and struggled to come up with a name himself, leading him to give up on the task of finding a team name (deactivating).

Beyza and Nesil stated that they felt angry during the event. For example, Nesil explained her anger as follows: “I was already angry because Yiğit didn't care about our ideas and didn't contribute at all.” Beyza shared similar reasons, saying, “At first, I was happy because it was a good thing; everyone was offering ideas, and good ideas were coming up... But when Yiğit didn't like our ideas and didn't support them, we had some anger issues... When we were expressing our ideas, he wasn't contributing. I mean, we would share an idea, and we couldn't even discuss it because he wouldn't comment at all.” Although anger is a negative emotion that emerged due to group interactions (activity focus), it motivated the students to engage with Yiğit in an attempt to solve the problem they were facing (activating). For example, in the group conversations below, Beyza indicated that they were waiting for Yiğit's contribution, saying, “How about... You tell us then... We need to get inspiration from somewhere.”

B: Design Guardians could work.

Y: What are we guarding to be called guardians?

N: Design Guardians is actually nice. How about Design Explorers?

Y: When you say Design Explorers, it sounds like we're discovering designs!

B: It's a difficult word to say. What do you think, Yiğit, how about a team name?

Y: Are we searching for treasure? I don't think either works.

B: Then you suggest one, Yiğit.

Y: What should I come up with now?

B: We need to get inspiration from somewhere.

Table 2. PBL Stage 2 – planning

Student	Emotion	Valence	Activation	Object Focus	Source of Data	Quote
Yiğit	Boredom	Negative	Deactivating	Group's time management and planning	Semi-structured interview	"I got a little bored while planning...Everyone was saying something different, and our plans were incomplete because we didn't use our time well."
	Frustration	Negative	Deactivating	Disagreement with group members' efforts	Semi-structured interview+ group conversation	"Nesil did not work as much as we did. That was why I was a little disappointed."
	Enjoyment	Positive	Activating	Group collaboration and planning process	Semi-structured interview	"I enjoyed it because we did the planning."
Nesil	Anger	Negative	Activating	Yiğit's lack of focus on the task	Semi-structured interview + group conversation	"I felt anger... (Yiğit) was talking to other groups. I mean, we were making a plan, but he was going to other groups."
Beyza	Frustration	Negative	Deactivating	Unequal contribution from group members	Semi-structured interview	"I was disappointed because Nesil did not work as much as we did; we did more with Yiğit."
	Enjoyment	Positive	Activating	Contribution to design process	Semi-structured interview	"I enjoyed it because we used my drawing talent to create the design."

A similar interaction occurred between Yiğit and Nesil, where Nesil made efforts to engage Yiğit in the discussion, encouraging him to share his ideas.

B: How about Design College?

N: Memorable, sounds nice.

Y: Striking, beautiful.

B: Does anyone else have an idea? Yiğit, what did you come up with? It seems like you have something.

Y: I haven't come up with anything, Beyza.

B: It seems like it's on the tip of your tongue but you can't say it.

In addition to the negative emotions, Yiğit Beyza and Nesil expressed that they enjoyed the team name selection activities (activity focus). Yiğit noted, "Different ideas emerged; I didn't expect so many to come up." Beyza shared, "I was happy... we all found something in common." Similarly, Nesil remarked, "I was happy because it was a good thing; everyone was offering ideas, and good ideas were emerging." These responses suggest that the students found enjoyment in the process, especially when diverse ideas surfaced within the group (activating) and were appreciated by their peers (positive valence). The group conversations provide feedback showing that students appreciate each other's ideas (e.g., "Memorable, sounds nice," and "Striking, beautiful.").

PBL Stage 2: Planning

Table 2 summarizes the emotions experienced by Yiğit, Nesil, and Beyza during the planning stage of PBL. During the planning stage, students are tasked with identifying a need for individuals with special needs, developing a material to address this need, and explaining the reasons for their choice. Table 2 organizes each emotion based on its valence,

activation level, and object focus, offering a summary of how students engaged with the group dynamics.

In the individual interviews conducted after this stage, students reported feeling emotions such as boredom (Yiğit), frustration (Yiğit and Beyza), anger (Nesil), and enjoyment (Yiğit, Beyza, and Nesil). Yiğit mentioned feeling bored during the planning phase, explaining, "I got a little bored while planning...Everyone was saying something different, and our plans were incomplete because we didn't use our time well." His boredom stemmed from the group's time management issues. During group work, Yiğit disengaged from his task for a while and was redirected by Nesil, as he started focusing on unrelated activities.

B: We need to produce something that will be useful for all disabled people. I think it should be something that brings them together.

B: Let's put some effort into it.

N: Right, Yiğit? (Meanwhile, Yiğit is busy with something else.)

He expressed that the group members did not allocate sufficient time to complete the tasks, leading to deficiencies in creating the plan (activity focus, negative valence). Although Yiğit initially contributed by suggesting that clothing could be designed for disabled individuals, he withdrew from further discussions. In this situation, Yiğit initially thought he had control when starting the task and contributed to the group but later decided that his friends had control and stopped contributing (deactivating).

The second negative emotion, frustration, was expressed by both Beyza and Yiğit. Beyza stated, "I was disappointed because Nesil did not work as much as we did; we did more with Yiğit." Yiğit stated, "Nesil did not work as much as we did. That was why I was a little disappointed." The group

conversations show that Beyza and Yiğit offered different suggestions to make the lives of disabled individuals easier. Yiğit suggested tools that would facilitate transportation for visually impaired individuals and make dressing easier for individuals with disabilities. "Buses...Something to make dressing easier for people with walking disabilities, for example, people who have lost their arms or legs." Right after Yiğit's statement, Nesil interjected, saying, "For the hearing impaired," to highlight an error in Yiğit's solution. After Yiğit and Beyza suggested that disabled individuals should be respected, "Y: What can be done, for example, show respect." B: I think people are treated more disrespectfully toward the mentally disabled," Nesil approved their suggestions by saying, "Exactly." Nesil's only contribution after Beyza's statement, "In the simplest terms, the public should be warned about this issue," was to add, "I think a lesson needs to be learned about this, and teachers should teach lessons." Nesil contributed to Yiğit's suggestion for disabled individuals to have easier access to their medications by saying, "For example, some medications are very expensive, but they can be found cheaper... medications that are hard to find can be cheaper." She also added, "The prices can be lowered a bit." As a result, Yiğit and Beyza felt disappointed at this stage because they perceived that their group members were not contributing equally (results-oriented, negative value). Nesil's contributions were primarily in the form of correcting, approving, or building on Yiğit and Beyza's suggestions. In this dynamic, Nesil tended to wait for her group members to present ideas rather than contributing original suggestions of her own. According to Yiğit and Beyza, this limited her role within the group. Although the group members generated ideas for disabled individuals, they couldn't decide on which idea would be most suitable. After the suggestion, "If we only do it for the visually impaired, it would be bad for the others; they should all be able to use it," no further suggestions came from the other group members. In this case, Yiğit, who had initially listed his suggestions, tended to disengage from the task (deactivating).

At this moment, Nesil, on the other hand, felt anger: "I felt anger... (Yiğit) was talking to other groups. I mean, we were making a plan, but he was going to other groups. And it wasn't between us; he was sharing it with them. We didn't want them to steal our ideas." In this case, the reason for Nesil's anger was that Yiğit was leaving the task and focusing on irrelevant issues outside of his duties (activity focus, negative valence). In reviewing the group's dialogues, Beyza noticed Yiğit's declining interest in the task and urged him to refocus. "B: Let's put some effort into it." "N: Right, Yiğit?" (Meanwhile, Yiğit was busy with something else.) (activating). In this situation, Nesil was angry with Yiğit but was trying to activate him by directing his attention back to the task.

The shared positive emotion felt by the students was enjoyment. Yiğit stated, "I enjoyed it because we did the planning." Beyza added, "I enjoyed it because we used my drawing talent to create the design." Nesil expressed, "I enjoyed it because we slowly started to develop the product with our ideas, and it became fun." The following dialogue that emerged within the group indicates that Beyza was influenced by her friends' comments regarding her talent.

N: Beyza is talented in drawing. I think she should do the drawings.

B: It doesn't matter to me, but yes, I have talent.

N: That's why you should do it.

Y: Then Beyza will draw the drafts and so on.

B: Okay, I can improve myself as well.

The joyment indicates that the students assign a positive value to their tasks, emerging specifically during the planning activity (positive valence, activity). In the group conversation below, after discussing the difficulties faced by individuals with special needs, Yiğit, Beyza, and Nesil proceeded to present their suggestions for addressing the needs of individuals with visual, motor, and hearing impairments. These suggestions fostered empathy towards individuals with special needs and allowed them to consider each other's different perspectives. The group conversations demonstrate that a supportive learning environment was established, particularly when Beyza and Yiğit built upon each other's suggestions and further developed these ideas (activating).

Y: A person who loses an arm, they are also considered disabled, right?

N: Yes, for example, those who have low vision, like 50% or 60%, they are also considered visually impaired.

Y: For example, something to make dressing easier for people who have lost an arm or a leg.

B: It could be something that fits their body type. ...

...

B: I think there is more disrespect towards people with mental disabilities.

N: Exactly.

A: For example, there is one in our village. Everyone makes fun of him. That is a very bad thing.

B: They make fun of those who cannot speak and every disabled person. Children are a bit arrogant.

A: Exactly.

N: What do they do?

B: At the very least, the public should be warned about this, but I don't think they will listen.

...

N: For visually impaired people, they wear clothes at night that do not glow in the dark. They can wear glowing clothes to reduce the risk of accidents, like neon colors.

B: Good idea.

Y: For example, there is a disabled person. He doesn't have an arm... That is a very bad thing for him. For example, instead of wearing clothes like ours, they can produce special ones. The price should not be too expensive; it should be affordable. Every disabled person should be able to buy it.

N: For example, if there were wheelchair distributions, it would be better for those without legs.

PBL Stage 3: Implementation

Table 3 summarizes the emotions experienced by Yiğit, Nesil, and Beyza during the implementation stage of PBL. At this stage, the students are expected to create a prototype of the design, identify deficiencies in the prototype, and address them. Table 3 categorizes emotions by valence, activation level, and object focus, presenting an overview of how students interacted within the group dynamics.

In the individual interviews conducted with the students at this stage, they reported feeling emotions sadness (Yiğit and Nesil), and anxiety (Beyza). Yiğit said, "My friends did not pay much attention to my suggestions." Beyza added, "Nesil and Yiğit cannot express their feelings to each other. I feel sad at times like this." Nesil remarked, "Yiğit was a bit more disengaged...we needed to implement our ideas and produce a product. Yiğit did not participate much in the task on this issue either" Their words reflected a sense of sadness. In the following conversation, Beyza and Nesil expressed their desire

for Yiğit to help them choose the materials, but Yiğit rejected this request, stating that “his suggestions were not appreciated”:

Table 3. PBL Stage 3 – implementation

Student	Emotion	Valence	Activation	Object Focus	Source of Data	Quote
Yiğit	Sadness	Negative	Deactivating	Differing evaluations of responsibility	Semi structured interview + group conversation	"My friends did not pay much attention to my suggestions."
	Joy	Positive	Activating	Completion of the task with the group	Semi structured interview	"I felt joyful. They gave me a writing task because my writing was good. I was happy to work with my group mates."
Nesil	Sadness	Negative	Deactivating	Yiğit's disengagement and focusing on other groups	Semi structured interview + group conversation	"Yiğit was a bit more disengaged...we needed to implement our ideas and produce a product."
	Joy	Positive	Activating	Teamwork and contribution of different ideas	Interview	"The reason I felt joyful is that we all worked together as a group, had different ideas, and had fun."
Beyza	Anxiety	Negative	Deactivating	Worrying about completing the project on time	Semi structured interview	"I thought I wouldn't be able to finish the project and that it wouldn't be good. I was worried about negative comments."
	Joy	Positive	Activating	Working with others and sharing common ideas	Semi structured interview + group conversation	"I felt joyful because we had common ideas."

B: Let's determine which materials we will use.
 N: Yiğit, can you come up with some ideas? (Meanwhile, Yiğit is talking to another group member.)
 Y: You don't really like what I produce, do you?
 In the dialogue below about creating the prototype, Yiğit expressed the deficiencies of the product while working on the prototype and was warned that he was not putting in enough effort.
 N: Should it be this size?
 Y: I think the size is good.
 B: I think it's good too.
 N: I think it could be a bit bigger.
 B: It's done, but this part should be fixed a bit more, but never mind.
 N: It's okay.
 Y: I can't do it...
 B: ...okay, we didn't say anything to you.
 N: Well, I can't do it either, but I'm trying. I wish you would try too!

The feelings of sadness stemmed from differing evaluations regarding the fulfillment of individual responsibilities (outcome/retrospective). For example, although Yiğit believed he contributed to the group work, his group mates provided feedback suggesting that he was not engaged with the task (negative). Beyza believes that the times when group members express their feelings to each other are rare, and that Nesil and Yiğit cannot express their feelings to each other and do not understand each other's emotions (deactivating). Nesil, on the other hand, feels sad because Yiğit does not value her ideas (negative valence) and is more interested in conversations with other groups rather than

focusing on his own group (deactivating). The following conversation took place between Beyza and Nesil because Yiğit was engaging with another group instead of focusing on his task.

B: Yiğit, come here.
 Y: I'm coming, just a minute. (Meanwhile, Yiğit is looking at his friend's design in another group.)
 B: Yiğit, focus on our project. Everyone will work with their own group.
 N: Exactly, come on.

On the other hand, Beyza felt anxious. “I thought I wouldn't be able to finish the project and that it wouldn't be good. I was worried there would be negative comments about the product we made.” She also stated, “Sometimes, Nesil didn't help the group, and Yiğit was always busy with other things.” This situation led Beyza to believe they would not be able to complete the product on time (negative valence, outcome/prospective). In this case, Beyza decided that the group was failing in creating the prototype and associated the failure with her group mates not fulfilling their assigned tasks. She felt anxious because she could not cope with a situation beyond her control (deactivating). Nevertheless, she directed Yiğit to contribute to the group work (Yiğit, focus on our project. Everyone will work with their own group).

Students also stated that they felt joyful at this stage. Yiğit said, “I felt joyful. They gave me a writing task because my writing was good. I was happy to work with my group mates and to complete the product.” Beyza said, “I felt joyful because we had common ideas.” Nesil added, “The reason I felt joyful is that we all worked together as a group, had different ideas, and had fun.” They expressed that they felt joyful. The

conversations below show that when students realized that their materials were not sufficient to create a prototype, they cooperated to solve the problem and took into account each other's suggestions for a solution.
 B: We need to find more sticks.

Table 4. PBL Stage 4 – communication

Student	Emotion	Valence	Activation	Object Focus	Source of Data	Quote
Yiğit	Anger	Negative	Activating	Nesil's lack of contribution	Semi structured interview	"Nesil did nothing at this stage. We prepared the poster; she just watched."
	Enjoyment	Positive	Activating	Writing on the poster and group collaboration	Semi structured interview	"They asked me to write because my handwriting is beautiful. I felt happy because my group mates and I worked together to complete the product."
Nesil	Sadness	Negative	Activating	Yiğit's anger and lack of participation	Semi structured interview	"Yiğit told me that I did not help in the group work and that he was angry. He said we do everything... I felt sad. Then I took his warnings into consideration and worked."
Nesil	Enjoyment	Positive	Activating	Group collaboration and completing the Project	Semi structured interview	"I felt happy while making the presentation. Because we finished the project together and presented it."
Beyza	Enjoyment	Positive	Activating	Completing the Project	Semi structured interview	"I felt happy... everyone had different ideas, and we finally decided."

Y: Where would we find them?

N: There is one in the school yard, actually. If the teacher allows it, we can get it from there and come back.

Y: Let's see; if we can't find it, I'll try to find one from our house.

B: How are we going to stick this? It won't stick.

Y: Let's ask for a glue gun. It will stick more easily with that.

In this case, when students realize that their roles are distributed equally and their ideas are valued, they feel happy (activity, positive valence). Even if group members face challenges, they continue their tasks and take action to solve the problem (activating).

PBL Stage 4: Communication

Table 4 summarizes the emotions experienced by Yiğit, Nesil, and Beyza during the communication stage of PBL. At this stage, students were expected to evaluate the product they have prototyped, come up with a slogan to market the product, and prepare a poster. Table 4 classifies emotions based on their valence, activation level, and object focus, providing an insight into how students participated in the group dynamics.

The negative emotions felt by the students are anger (Yiğit) and sadness (Nesil). The reason for Yiğit's anger is that "Nesil did nothing at this stage. We prepared the poster; she just watched. She only gave her ideas when we were finding a name for the project. "There was tension, and I got angry at him." The following conversation illustrates the discussion between the students while they were preparing their posters:

N: I'll paint this, Yiğit

B: I'll paint this too.

Y: Okay, you're not doing anything!

....

Y: Generation, these papers tear. We paint them before they dry. And we paint them fast.

N: Do you have any objections?

In the initial dialogue between Yiğit and Beyza, Yiğit expresses his frustration by saying, "You are not doing anything." The tension between them is further highlighted when Yiğit cautions Nesil that the paper might tear while painting because it is wet. Rather than recognizing Yiğit's concern, Nesil responds defensively. To Yiğit, this reaction reinforces his view that Nesil is not contributing to the group work (activity focus). This negative sentiment further underscores the disconnect between Yiğit and Nesil in the subsequent conversation.

N: What should our product be called?

B: I think it should be "The Ladder of Life."

N: It doesn't look like a ladder, though.

Y: How doesn't it look like one?

N: It's more like something for climbing.

B: How is life like climbing?

N: When you say life, it seems to give hope; it's beautiful, but we're not climbing mountains.

B: These ideas came to my mind, but you can find a better one too.

Y: I think this is beautiful.

N: Then let's choose this one.

These conversations show that Nesil pointed out the flaws in Beyza's suggestion and provided justifications, but didn't offer a suggestion herself. Yiğit responded defensively, asking for justifications for the flaws Nesil mentioned ("How is it not similar?"). This response indicates that Yiğit's anger is ongoing. The conversation between the researcher and Yiğit reveals that Yiğit took steps to address the issue he was experiencing due to his anger toward Nesil (activating).

R: Were your group mates capable of doing the given task? How did this make you feel?

Y: Nesil did not do anything at this stage..

R: How did she not do anything?

Y: R: How did you feel in this situation?

Y: Angry.

R: Did you tell Nesil how you felt?

Y: Yes, I told her that she did nothing.

Yiğit expressing his anger toward Nesil caused her to feel sad (negative valence). However, Nesil took Yiğit's warnings into consideration and moved on with her work (activating). The following interview was conducted to determine the feelings that emerged in Nesil's dialogue with Yiğit and their reasons.

R: Were your group mates able to express their feelings and thoughts?

N: Yes, they did.

R: For example, how did this happen? Who expressed it? Can you give an example?

N: Yiğit told me that I did not help in the group work and that he was angry. He said we do everything.

R: So how did you feel?

N: I felt sad. Then I took his warnings into consideration and worked.

The fact that Yiğit's anger made Nesil feel sad led to a change in her contribution to the group work. Rather than criticizing her friends' suggestions, Nesil began to participate by helping develop these ideas. In the conversation below, Beyza's initial suggestion—starting with a drawing of a bed—was furthered by Nesil, who accepted the idea (as possible) and expanded on it: “There are hospital beds; let's draw them like that and then draw the product.”

B: I think we should draw a bed on the poster.

N: Maybe.

Y: Let's add a pillow and a headboard.

N: There are hospital beds; let's draw it like one of those and put the product on top.

B: Now we'll draw a picture of a disabled person, and then we'll paint it.

In another similar conversation, Nesil suggests that Beyza enhances the work to complete the missing parts of her assignment. This shows that Nesil has shifted from merely pointing out deficiencies through criticism to actively working on completing them.

Y: Beyza, have you finished drawing the poster?

B: I drew that one. Are the others finished?

Y: There's only one left; I'll draw that one.

N: We can thicken the sides like a frame.

B: Exactly, with colored pencils.

All three group members stated that they felt enjoyment during the communication phase (activity focus). Yiğit said that he felt happy because he wrote the text on the poster. (They asked me to write because my handwriting is beautiful. I felt happy because my group mates and I worked together to complete the product.) Beyza stated that she felt happy because the product was finished (I felt happy... everyone had different ideas and we finally decided.) Nesil also stated that she felt happy because the project was completed on time and the group worked as a whole. (I felt happy while making the presentation. Because we finished the project together and presented it.)

At this stage where students feel a sense of joy, the conversations they have about creating the poster show that they are working together on the poster, making suggestions to each other to make it better, and sharing information with each other about the progress of the task (positive, activating).

Discussion

This study explored the emotions of seventh-grade students in a PBL environment and the reasons for these emotions. It contributes to the literature by analyzing the emotions felt by students during the stages of PBL and the reasons for these emotions through the control-value theory. Additionally, the findings highlight how these emotions relate to task demands and group dynamics, contributing to a deeper understanding of emotional processes in PBL.

The findings were organized according to the stages of PBL: determining a team name, planning, implementation, and communication. In general, the number of negative emotions experienced by students was higher than positive emotions at all stages of PBL. Notably, negative emotions increased as the process progressed, indicating that students felt more stress and pressure when faced with more complex tasks, such as planning, implementation, and communication. Similarly, Pešlak (2005) observed that while students began PBL with confidence and positive emotions, these feelings were soon accompanied by negative emotions like anger, discomfort, and disappointment as the project advanced. This study highlights the dynamic nature of students' emotional responses during PBL processes, showing that students' perceptions of the tasks and their cognitive evaluations can elicit both positive and negative emotions (Mischenko et al., 2022). This suggests that the cognitive challenges students encountered might have led to emotional difficulties as well (Näykki et al., 2021). This aligns with evidence suggesting that complex tasks are linked to higher perceptions of mental, physical, and temporal workload, leading to increased stress and negative emotional experiences (Alessa et al., 2023). Our findings support this perspective, demonstrating that negative emotions such as boredom, frustration, sadness, anger, and anxiety are integral parts of the learning process, particularly when students engage with complex cognitive tasks. However, since the positive emotion "pleasure" persisted throughout all stages in this study, it can be argued that PBL generally motivates students and provides an enjoyable experience, despite the challenges encountered (Pekrun, 2006). PBL helps students maintain a sense of enjoyment while achieving their learning goals by encouraging effective interaction with team members and supporting the understanding and completion of tasks (Näykki et al., 2021). Furthermore, PBL fosters enjoyment by recognizing individual efforts and creating a flexible, creative environment for self-expression (Näykki et al., 2021). Additionally, PBL fosters a sense of enjoyment by recognizing students' individual efforts and providing a freer, more creative environment for self-expression (Grant, 2011; Zhou & Ee, 2012).

Another finding from the study is that Yiğit and Beyza exhibited different negative emotional reactions compared to Nesil. During the planning phase, Yiğit experienced boredom, both Yiğit and Beyza felt disappointment, while Nesil expressed anger. This may suggest that Yiğit and Beyza were more emotionally affected by unmet expectations or challenges encountered during the planning phase. In the implementation phase, all three students experienced sadness; however, Beyza also felt anxiety, which may indicate she was more concerned about the uncertainties surrounding the outcomes. In the communication phase, Yiğit expressed anger, Beyza felt disappointment, and Nesil experienced sadness. Although the three students shared common emotions during the planning and implementation phases, they each experienced a distinct emotion in the communication phase. This situation shows that students may face disagreement,

conflict, and competition at all stages of PBL (Li et al., 2024). Furthermore, it highlights that negative emotions are interconnected and often co-occur. In other words, when a student experiences a negative emotion during the PBL process, it usually triggers other negative emotions, leading to a "chain of negative emotions" (Ketonen et al., 2018). Additionally, individual differences among students, such as conflicting learning goals, varying priorities, or diverse study styles, can add new links to this chain (Huang et al., 2024). Therefore, instead of assuming that students will exhibit certain emotions at specific stages of PBL, it can be inferred that those who experience negative emotions need more personalized emotional support (Zheng et al., 2023).

The boredom experienced during the team name determination and planning phase was unique to Yiğit. He felt this emotion because he perceived the ideas as worthless, which led him to disengage from his task. Penuel et al. (2016) found that students in PBL-based learning environments often experienced boredom when facing difficulties during lessons. Additionally, reluctant students in hands-on learning environments reported feeling more challenged (Gerstner & Bogner, 2017). PBL requires students to solve more complex problems than typical problem-solving activities (Bartholomew & Strimel, 2018). Yiğit may have perceived his cognitive abilities as insufficient for tackling the problem, leading him to feel that the learning activity was uncontrollable, which ultimately resulted in boredom.

Both in the team name determination and planning stages, Beyza and Nesil reported feeling anger due to Yiğit's decreased interest in the group task, while Beyza and Nesil's efforts to direct him back to the task reflected a desire to restore a sense of control within the group and increase cooperation. In the study by Hutton et al. (2019), anger surfaced in situations where students made less effort to complete academic tasks or engaged less in class. However, anger motivated students to try to reintegrate the group member who triggered this emotion back into the task. This finding suggests that PBL helps students recognize their anger and seek solutions to manage this emotion more effectively (González-Gómez et al., 2021).

In addition to boredom and frustration emerged during the planning phase. The reasons for frustration in this study were attributed to inequalities in group members' roles and contributions. These discrepancies reduced their sense of control and created a context in which students struggled to achieve their goals, as their efforts were not rewarded, negatively impacting their emotional engagement (Linn & Jacobs, 2015). Furthermore, since they did not provide feedback to each other while completing their tasks, they may have experienced disappointment upon realizing their tasks were incomplete, despite believing they had finished them (Bellocchi & Ritchie, 2015). Regarding the second reason, frustration may have been triggered by feedback that focused on unrelated aspects of the tasks rather than the expected topics (Yu et al., 2021; Zhu et al., 2023).

In the implementation phase, students experienced feelings of "sadness" and "anxiety." They felt sad due to the lack of emotional expression within the group and the absence of appreciation for their individual contributions. Despite making effort, Yiğit lost his sense of control due to negative feedback, which led to a decline in his motivation. Similarly, Beyza and Nesil struggled to express their feelings because of poor communication within the group, causing them to also lose their sense of control. This sadness prompted students to

devalue each other, which negatively affected group relationships and diminished the perceived value of working together. Research suggests that negative feedback in group work can intensify sadness and adversely impact students' subsequent performance (Motro et al., 2021). Since feedback can make a student feel inadequate in completing the task, the sadness that stems from such criticism may lead the student to disengage from the task altogether (Rowe, 2017).

During the implementation phase, Beyza was upset, and she also felt anxious because her groupmates were not contributing enough. This led to a loss of control and her negative evaluation of the group's progress. Similarly, teacher candidates participating in the study by Hernández-Barco et al. (2021) reported experiencing increased anxiety during the project due to the limited time available for completion. Students, who are accustomed to structured project work, where tasks are predefined and monitored with short-term deadlines, may struggle in PBL environments. They may have difficulty assessing whether they are progressing according to their plans or whether they have enough time to complete their projects, and this uncertainty may lead to anxiety (Hsu, 2020). However, Beyza's efforts to direct Yiğit to work caused him to try to regain control, indicating that he developed his own emotional regulation strategies to restore his sense of control.

In the course of the communication phase, negative emotions diversified: "anger," and "sadness" came to the fore. The students' negative emotions resulted in an increase in the sense of control and a reshaping of the value attribution within the group when Nesil participated in the study with this feedback, following Yiğit's anger towards Nesil's lack of contribution. Yiğit's expression of anger towards Nesil affected the group dynamics and caused Nesil to feel sad, but as a result of this communication, Nesil made an effort to move forward with her work by taking Yiğit's warnings into consideration. In the final phase, the students increased their sense of control to avoid the negative emotional burden they would experience when they encountered a product that did not comply with their expectations, but they did not express positive emotions in place of negative emotions (Lobczowski et al. 2021). This situation may be related to the fact that PBL offers students a context that requires multi-layered processes such as open-endedness, decision-making, and problem-solving. Due to uncertainty and ambiguity, students may have developed negative emotions by thinking that they will not be able to carry out their project work and that failure is imminent. In this case, expressing negative emotions is of great importance for the group to develop constructive and effective communication with each other (Stephens & Carmeli, 2015). However, it is also clear that students who do not know how to complete PBL tasks on their own need organizational tools that allow them to manage these negative emotions effectively (Hsu, 2020).

The findings of the study revealed that students enjoyed every stage of PBL. According to control-value theory, if the value a student places on their work is positive and they believe they have control, they enjoy the activity (Pekrun, 2016). Students stated that they enjoyed it when different ideas emerged and their own ideas were valued. Enjoyment in group work is related to being recognized, having their ideas valued, and thus forming satisfying close relationships through group work (Akan & Barışkın, 2018; Hussein, 2021). Although designing and implementing a project is challenging for students, they learn to overcome these challenges through discussions and interactions among themselves, which helps

them advance their personal knowledge and skills. This is why students enjoy participating in PBL (Wu & Wu, 2020). Additionally, in this study, students felt enjoyment when they completed the given task and worked collaboratively. Since PBL allows students to take responsibility, they gain control over their learning (Amorati & Hajek, 2021; English & Kitsantas, 2013). While completing individual tasks allows students to develop a sense of enjoyment, the collaboration required by projects supports both their own learning and that of their peers, contributing to the spread of this feeling among group members (Ayish & Deveci, 2019).

Students also reported feeling enjoyment when group members supported each other. Peer support provided by group members enables them to identify and solve problems when faced with challenges (Ching & Hsu, 2013). Additionally, as group members offer supportive contributions to each other, each member evaluates their own progress and increases their contribution to the group work (Lin, 2018; Paul et al., 2023). Working on projects that align with students' interests was also mentioned as a reason for their enjoyment. According to Chu (2009), since PBL allows students the freedom to choose topics that interest them, this enables them to enjoy PBL more. PBL becomes meaningful and engaging for students by allowing them to recognize a problem as a need and see it in a context that relates it to the real world (Penuel et al., 2022).

Although students reported facing difficulties while trying to complete their projects, they also mentioned enjoying the struggle to overcome these challenges. Students struggle during PBL due to insufficient task-specific cognitive skills, not knowing how to start the project without instructions, and deficiencies in communication skills when dealing with open-ended activities (Hussein, 2021; Park & Scanlon, 2024). These challenges become solvable as students' skills in group decision-making, time management, and responsibility formation progress, so even though they face difficulties, they enjoy participating in the work because they know that the challenges can be overcome (Rees Lewis et al., 2019).

Conclusion Recommendations and Limitations

When students experience negative emotions during PBL processes, these emotions often form an interconnected chain. Therefore, emotional support mechanisms that help students manage their negative emotions should be provided. Being knowledgeable about emotion regulation strategies is crucial for managing the emotions that arise when students work in small groups (Lobczowski et al., 2021; Peslak, 2005). In this context, the effects of instructional materials that help students recognize and regulate emotions emerging during the PBL process could be identified in future studies. Moreover, during stages where emotions such as anxiety and frustration are intense, students can be provided with personalized support through guidance tailored to their individual needs.

The disagreements between students during the planning, implementation, and communication stages led to an increase in negative emotions. In group work, dialogues that promote cooperation can help students communicate with each other in a more constructive and supportive manner. Similarly, throughout the study, it was shown that negative feedback given by group members to each other contributed to negative emotions. Providing guidance to students on how to give effective feedback during group work can help address this issue. In this way, students can learn to present negative

feedback in a more constructive and positive manner, elevating their contributions to group work to higher levels.

The study's findings indicate that students derive significant enjoyment from various stages of PBL, primarily due to the sense of control and value they attribute to their work. This enjoyment stems from collaborative interactions, recognition of individual ideas, and the establishment of supportive relationships within their group. As students navigate challenges together, they not only enhance their own learning experiences but also contribute to a positive collective atmosphere. Therefore, educators should emphasize the importance of collaboration in PBL settings. Encouraging students to support each other can enhance problem-solving capabilities and increase overall engagement. Additionally, teachers should create opportunities for all students to share their ideas and receive recognition. This acknowledgment can motivate students and contribute to a more enjoyable learning experience.

However, this study has certain limitations. Since it is based on identifying the emotions and their causes from only three students, future studies should involve a larger sample size to uncover a wider range of emotions and their underlying causes. Although Yiğit and Beyza exhibited different emotional reactions compared to Nesil, this study does not include data on individual differences among students, such as prior knowledge, academic achievement, gender, goal orientation, or group dynamics like cultural differences and friendships. Additionally, the specific subject studied in this research might have influenced the intensity of the negative emotions experienced by the students. Therefore, researchers recommend conducting further studies that explore these factors to better explain the variations in students' emotions and provide more comprehensive data. To address this limitation, future research should include a larger and more diverse sample to explore the consistency of emotional responses across a broader population and to better understand the role of subject matter and individual differences in emotional reactions. Finally, by considering the connection between the feedback students provide and their emotions, the impact of learning environments that promote interaction through feedback on students' emotions can be further explored.

Author Contributions

All authors have equally contributed to all stages of the article. All authors have read and approved the final version of the work.

Ethical Declaration

This study was conducted with the approval decision obtained from Aydın Adnan Menderes University Ethics Committee for Educational Research (Protocol No. 2023/9-VI) during the 2023/9 meeting dated 12.10.2023.

Conflict of Interest

The authors declare that there is no conflict of interest with any institution or individual regarding the scope of this study.

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