Confidence in Code

Analyzing the Relationship Between Self-Efficacy and Meeting Contributions in Student Software Development Teams

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Abstract

This study investigates the relationship between self-efficacy and participation in software development team meetings among computer science students. Drawing on Bandura's theory of self-efficacy, the study explores whether students who rate themselves higher in confidence also contribute more frequently and in different ways during group meetings. Using a mixed-methods approach, data were collected from three project teams in a second-year Software Project course at TU Delft. A domain-specific self-efficacy survey was filled in by all participants, and their meeting contributions were thematically coded into categories such as planning, technical input, and social interactions. Quantitative analysis revealed a positive correlation between self-efficacy and overall contribution frequency, particularly in technical and planning discussions. Qualitative observations showed that group dynamics—such as dominant speakers and team culture—can moderate this relationship, sometimes overshadowing confident team members.

1 Introduction

Computer Science graduates are expected to demonstrate effective communication, task coordination, and group problem-solving skills [1]. To teach collaboration, many CS curricula (including the TU Delft one) incorporate group projects. The issue with such projects lies in the assumption that students will naturally acquire collaborative skills through participation alone. Research shows that, without proper training, students often struggle to develop productive teamwork strategies and encounter problems such as unequal participation and social loafing [14]. Social loafing is not limited to members who choose not to contribute. It can also emerge as a consequence of dominance, where less assertive team members become disengaged, despite having relevant knowledge. Ocker's work [8, 9] highlights how dominant individuals can reduce team creativity and suppress meaningful contributions from peers, even when everyone's technical capabilities are comparable.

A key psychological factor that affects these dynamics is self-efficacy. Self-efficacy is a person's belief in their ability to succeed in specific tasks. It has been shown to affect motivation, engagement, and participation in group meetings [2]. While its influence in educational and workplace settings has been well-studied, its role in actual software meetings among CS students remains underexplored.

This study aims to answer the question: What is the relation between self-efficacy and meeting contributions in student software development projects?

To support this, the following subquestions are posed:

- How does students' self-efficacy relate to the overall frequency of their contributions in team meetings?
- Does self-efficacy correlate with specific types of contributions (e.g., technical input vs. coordination)?
- How do group dynamics influence the relationship between self-efficacy and participation?

To answer the research question, I analyzed data from three student software project teams. I used self-efficacy survey responses from each student and transcripts of their group meetings. Meeting contributions were categorized for each student and correlated with their survey responses to explore whether students with higher self-efficacy participated more actively, contributed more, and differed in the types of contributions they made.

This paper is structured as follows: Sections 3-4 outline the methodology and analysis protocol. Section 5 presents key results and discusses findings in the context of prior research. Sections 6-7-8 conclude with implications and future directions.

2 Related Work

Prior research has extensively studied self-efficacy in educational settings. Bandura's foundational work [2] defines self-efficacy as one's belief in their capabilities to execute tasks successfully.Studies in the STEM fields have linked self-efficacy with higher task performance, better retention, and more positive attitudes toward learning [6].

In the context of computer science education, self-efficacy has been linked with performance in programming tasks [11]. However, most instruments used in these studies—such as the Generalized Self-Efficacy Scale (GSE) [12] or the Computer Programming Self-Efficacy Scale (CPSES) [14]— either assess broad confidence across domains but are not designed for CS-specific group tasks or focus on technical skills like debugging and code writing, largely omitting communication or teamwork elements.

Other tools such as the Motivated Strategies for Learning Questionnaire (MSLQ)[10] and the Science Motivation Questionnaire (SMQ)[5] incorporate self-efficacy constructs but are oriented toward academic tasks (e.g., studying for exams) rather than collaborative work.

Beyond individual traits, research has also looked at collaboration and group dynamics within CS groups, but the emphasis has largely been on task outcomes or tool use rather than interpersonal dynamics. For instance, Meulen and Aivaloglou [13] have examined how work allocation varies across student teams, finding that coordination challenges often affect performance more than technical ability alone.

A study by Ocker [9] has demonstrated that group dynamics and status effects can strongly influence contribution levels, often overshadowing individual competence.

This study builds on these insights by explicitly connecting students' confidence in contributing to software team meetings with their actual participation patterns, using a tailored survey instrument and thematic coding.

3 Methodology and Data Collection

This research investigates how self-efficacy affects their contributions during group meetings in software development projects. The goal is understanding whether more confident students contribute more actively or in different ways, particularly in terms of planning, technical contribution, and reflection.

3.1 Study Design

The study adopted a mixed-methods qualitative approach, combining a structured survey and observational meeting analysis. Data were collected from three student teams enrolled in the second-year Software Project course (Y2Q4) in the Bachelor of Computer Science and Engineering program at TU Delft.

In the SP course, students work in teams of five. Each team is assigned a real-world software development project (e.g., a client-facing application or internal tool) and is expected to design, implement, and deliver a functioning software system over a period of 10 weeks.

Each team held one self-organized, non-TA weekly meeting lasting approximately one hour. These meetings were typically used for planning, debugging, assigning tasks, and discussing design decisions. In addition to these meetings, students also used asynchronous tools including GitHub (for version control and issue tracking), Slack or WhatsApp (for communication), and Trello or similar platforms (for task management). However, only the in-person meetings were analyzed in this study; contributions via GitHub, Slack, or other digital tools were considered out of scope.

Each team formally has one self-organized, non-TA meeting per week lasting approximately one hour. These meetings are typically used for planning, debugging, assigning tasks, and discussing design decisions. In addition to these meetings, students also use tools for asynchronous communication such as: GitHub (for version control and issue tracking), Slack or WhatsApp (for communication), and Trello or similar tools (for task management).

In this study, only the in-person meetings were analyzed. Contributions via GitHub, Slack, or other platforms were considered out of scope.

The study consisted of two main components:

- A self-efficacy survey, adapted from Bandura's General Self-Efficacy Scale [2], with items tailored to the computer science domain (e.g., confidence in debugging, explaining code, contributing to team meetings).
- Observation and audio-recording of two group meetings per team, during which students collaboratively planned or discussed software tasks. Each meeting was then transcribed, and manually coded using a structured thematic scheme. Participation was measured in terms of verbal contributions during these meetings, as described in Section 3.3.1.

3.1.1 Survey

The decision to use an adapted survey was motivated by the lack of a standard questionnaire that addressed the study's specific variables of interest. Bandura emphasizes that self-efficacy measures should be tailored to the specific domain and behavior under investigation, as domain-specific instruments tend to be more accurate predictors of related outcomes [7]. In this context, the domain is student contributions within software project teams—a setting that combines peer interaction, communication, and collaborative problem-solving.

Although the CPSES [14] focuses on programming-related confidence, it does not address the social and communicative elements of teamwork. Similarly, the GSE [12], MSLQ [10], and SMQ [5] include self-efficacy components but are primarily designed for academic tasks and not tailored to collaborative software project meetings. Therefore, I adapted items from these instruments to better reflect team-interaction aspects, such as confidence in explaining design choices and contributing to group discussions. This approach aligns with Bandura's recommendation to tailor self-efficacy measures to the targeted behaviors [2].

The resulting instrument consists of three types of self-efficacy items:

- **General self-efficacy**: e.g., "I can find solutions to problems even when things are challenging."
- **Programming-specific self-efficacy**: e.g., "I am confident in my ability to debug and fix issues."
- **Verbal/team communication self-efficacy**:
  - "I feel comfortable sharing my ideas during group meetings."
  - "I am confident contributing to technical discussions in a group."

These items were designed to measure students' confidence in contributing to the team's work.

For the full list of survey questions, including all items and response scales, see the Appendix A.

3.2 Data Collection Procedure

Each student in the observed teams completed the self-efficacy survey online prior to their second team meeting.

In total, **seven meetings** were recorded across **three student teams**. These meetings took place during the middle phase of the Software Project course (weeks 3–7), a period when most teams were actively implementing core features and resolving design challenges.

All meetings were self-organized **non-TA**, typically used for planning, debugging, and assigning tasks. Each meeting lasted between **38–62 minutes** (average: 49 minutes). Meetings were audio-recorded with informed consent and later transcribed using Microsoft Word for analysis.

3.3 Coding and Analysis

3.3.1 Thematic Coding Scheme

The transcripts will be manually coded using a structured scheme. The sceme builds on Curtis & Lawson's work on collaborative learning [3] and is adapted to the software engineering context using insights from Meulen & Aivaloglou [13], Ocker [9], and Driskell et al. [4]. and contains the following coding categories:

- **Planning/Coordination**: Organizing the team's work by defining scope, assigning tasks, scheduling, or setting agendas. For example: "Can you meet tomorrow at 10 am?" or "Let's break this user story into two."
- **Task/Technical Contribution**: Sharing knowledge, solutions, or technical input relevant to the project. For example: "I think you need to refactor that code" or "I've created a pull request for that issue."
- **Seeking Input/Help**: Requests for clarification, technical help, or guidance. For instance: "Can you help me with the SWV7200 driver?" or "How do I get access to the database?"
- **Reflection on Process**: evaluating team performance or suggesting improvements. Example: "I think we need to improve our communication."
- **Social Interaction**: Off-topic (e.g., jokes, casual banter). Example: "Haha, the meme you sent on WhatsApp was great."
- **Emotional Support/Response**: Encouragement, appreciation, or empathy. Example: "Nice work on fixing the bug!" or "Thanks for the help earlier."

3.3.2 Data Analysis

To answer the research questions, a combination of descriptive statistics, correlation analysis, and qualitative interpretation was used:

- **RQ1: How does students' self-efficacy relate to the overall frequency of their contributions in team meetings?**
  I computed the total number of contributions per student across all coded meetings. These values were compared with each student's overall self-efficacy score using Pearson's correlation coefficient. Additionally, I performed a quartile analysis to compare participation between high and low self-efficacy groups.
- **RQ2: Does self-efficacy correlate with specific types of contributions (e.g., technical input vs. coordination)?**
  I broke down contributions into the six coding categories and calculated category-specific contribution totals for each student and then correlated the results with the self-efficacy scores to identify whether particular contribution types were more strongly associated with self-efficacy.

- **RQ3: How do group dynamics influence the relationship between self-efficacy and participation?**
  To investigate this, I compared individual participation patterns within each team and reviewed deviations from the expected correlation. I used qualitative observations (e.g., turn-taking, dominance, silence) to explain contextual factors that may have influenced participation, despite self-efficacy levels.

4 Contributions and Analysis Approach

This research contributes to the understanding of how students' self-efficacy beliefs influence their participation in collaborative software development meetings. The main contributions of the study are:

- A quantitative and qualitative analysis of the relationship between self-efficacy scores and different types of contributions (e.g., technical input, planning/coordination, and social interaction), providing insights into which aspects of participation are most closely linked to students' self-efficacy beliefs.
- An investigation of how group dynamics—such as the presence of dominant speakers and implicit role distributions—moderate the relationship between self-efficacy and participation, showing the correlation between individual confidence and social context.

Key Hypotheses The study was guided by the following hypotheses:

1. Higher self-efficacy would be associated with a higher overall frequency of contributions in meetings.
2. Students with higher self-efficacy would contribute more often to technical discussions (idea generation, design proposals) than those with lower self-efficacy.
3. The relationship between self-efficacy and contribution might be moderated by group dynamics—such as the presence of dominant speakers—leading to variability in individual participation even among students with similar self-efficacy levels.

These hypotheses build on Bandura's theory of domain-specific self-efficacy [2] and findings on group communication dynamics in software development education [9, 13].

5 Results

5.1 Survey Results

The self-efficacy survey was administered to all participants across six SP teams, totaling 23 valid responses.

Overall Self-Efficacy Scores. The average overall self-efficacy score was relatively high, with the mean score across all items being 4.0 out of 5 (SD = 0.46). This indicates that most students felt generally confident in their abilities to write, debug, and explain code. Specifically:

Survey Item	**Mean**	**SD**
Confidence in solving programming problems	4.3	0.49
Debugging and fixing issues	4.2	0.54
Explaining code or design choices	4.1	0.56

Verbal Self-Efficacy. In terms of verbal participation in meetings (e.g. sharing ideas, technical discussions), the mean scores were slightly lower than technical skills:

Item	**Mean**	**SD**
Sharing ideas during group meetings	4.0	0.65
Contributing to technical discussions in a group	4.0	0.63
Belief that input is valuable	4.1	0.57

Confidence in Course Success. When asked if they felt confident they could achieve a high grade in the course, the mean response was 3.7 (SD = 0.75). This measurement shows that while students generally felt confident in their abilities, they were more uncertain about their overall course performance.

Qualitative Comments. Many students provided feedback about factors that influence their confidence in a team setting. Common ones were:

- Dependence on team dynamics (e.g. trust, respect, and communication quality).
- Prior experience (e.g. lack of Rust knowledge or experience with large-scale projects).
- Individual's perceptions of own skill level compared to peers.

These results show that even very confident students can feel hesitant if team dynamics or unfamiliarity come into play.

Programming Experience. In addition to the self-efficacy questions, students also reported their programming experience:

Item	Mean	SD
Years of programming experience	5.1	2.6
Programming languages known	5.0	2.0
Code-implementing courses taken	11.4	4.3

As a whole, the survey results show that most students are confident in their technical skills. The situation is more nuanced in verbal self-efficacy, and team dynamics and domain-specific experience influence students' comfort and participation in meetings.

5.2 Contribution Analysis

A total of 950 contributions were coded across the meetings, with contributions classified according to the thematic coding scheme described in Section 2.3.1: Planning/Coordination, Technical Contributions, Seeking Input/Help, Reflection on Process, Social Interaction, and Emotional Support.

On average, each student contributed approximately 14–15 times per meeting. Table 1 summarizes the mean contribution frequencies by category:

Contribution Type	Mean	SD	Range
Planning/Coordination	3.8	1.5	0–8
Technical Contributions	4.2	1.9	0–10
Seeking Input/Help	1.4	0.7	0–4
Reflection on Process	1.1	0.6	0–3
Social Interaction	1.6	1.0	0–5
Emotional Support	0.8	0.5	0–3

Table 1: Mean contributions per student per meeting by category.

Notably, Planning/Coordination and Technical Contributions were the most frequent types of contributions, with means of 3.8 and 4.2 respectively. Contributions involving Reflection on Process, Social Interaction, and Emotional Support were generally less frequent.

5.3 Relationship Between Self-Efficacy and Participation

This study aimed to explore the relationship between students' self-efficacy and their participation in team meetings of a software development project. Self-efficacy was measured as a composite score based on participants' agreement with statements related to confidence in their programming skills, problem-solving ability, and perceived value to the team. Participation was measured using the coded meeting contributions across multiple categories (Planning/Coordination, Technical Contributions, Seeking Input/Help, Reflection on Process, Social Interaction, and Emotional Support).

5.3.1 Overall Frequency of Contributions

To address the first subquestion — How does student's self-efficacy relate to the overall frequency of their contributions in team meetings? — we computed each participant's total contribution count by summing all coded contributions across all meetings. Preliminary analysis revealed a positive correlation $r(13)=.45$, $p=.092$ between self-efficacy scores and total contributions. This suggests that students who reported higher confidence in their abilities also tended to participate more actively during team meetings. These students were more willing to engage, share, and contribute, which alignings Bandura's theory that self-efficacy influences task engagement.

5.3.2 Contribution Types

Addressing the second subquestion — Does self-efficacy correlate with specific types of contributions (e.g., technical input vs. coordination)? — we examined the relationships between self-efficacy scores and the frequency of each contribution type. The strongest correlations were observed with Technical Contributions $r(13)=.48$, $p=.075$ and Planning/Coordination $r(13)=.41$, $p=.132$, indicating that confident students were more likely to take leadership roles and share technical insights. These findings suggest that self-efficacy is particularly relevant for contributions that require domain expertise or leadership in coordinating group tasks.

In contrast, the correlations were weaker for Seeking Input/Help $r(13)=.25$, $p=.366$ and Social Interaction $r(13)=.20$, $p=.468$. This may indicate that seeking help is more context-dependent, influenced by task complexity or team climate rather than purely self-confidence.

5.3.3 Moderating Role of Group Dynamics

To answer the third subquestion — How do group dynamics influence the relationship between self-efficacy and participation? — qualitative observations from transcripts and coded data were analyzed alongside the survey results. Groups with balanced task allocation and clear leadership structures showed stronger alignment between self-efficacy and contribution levels. For example, in Group A, participants with high self-efficacy consistently contributed more and took on more technical and planning roles, while in Group B, students with similar self-efficacy results contributed less when the group lacked clear coordination(such as conflicting/overlapping tasks).

Additionally individual reflections from surveys show that some students felt less confident sharing ideas in groups with more experienced or vocal members, regardless of their own self-efficacy scores. This suggests that team environment and interpersonal dynamics can amplify or inhibit the participation in group meetings.

5.4 Qualitative Observations

The qualitative data provided important context for interpreting the correlation between self-efficacy and meeting participation. While the overall trend supported a positive relationship, several notable deviations suggest that team dynamics can significantly moderate how self-efficacy translates into actual behavior.

In one team, a high degree of conversational dominance was observed. One student accounted for nearly 50% of the technical contributions across two meetings. Despite scoring highly on the self-efficacy survey, other team members in the same group spoke far less. Transcript analysis showed that these students attempted to interject or propose solutions but were frequently interrupted or ignored. This behavioral pattern resembles what Ocker [9] describes as "status silencing", where dominant individuals unintentionally suppress the input of peers. The result was a misalignment between confidence and contribution—a form of social loafing caused by perceived futility in contributing.

Additionally, qualitative responses from the post-survey open question reinforce these patterns. Several students noted feeling less confident in teams with "strong personalities" or when they perceived themselves to have less experience. Others reported being more vocal when they felt their input was valued or when team communication was described as "open and respectful." These findings reflect the broader literature on psychological safety in teams, where inclusive climates can facilitate participation from members across the confidence spectrum.

Overall, these observations highlight that self-efficacy does not operate in isolation. It interacts with peer behavior, role expectations, and group norms.

6 Responsible Research

This study adhered to ethical research practices throughout all stages of data collection, analysis, and reporting. Participation in the study was entirely voluntary, and informed consent was obtained from all participants prior to data collection. Students were informed about the purpose of the research, the use of their data, and their right to withdraw from the study at any time without consequence.

Audio recordings of meetings were only made with explicit consent, and all transcripts were anonymized to protect participant privacy. Data were stored securely and accessible only to the research team. Additionally, no personal identifiers are included in the final analysis or presentation of results.

Regarding reproducibility, all steps of data collection, survey design, and coding procedures have been described in detail in the methodology sections. Although the exact survey items and coding categories are summarized in the text, a full appendix with the complete survey questions and coding template will be included in the final version of the thesis to support replication. This ensures that other researchers could reproduce the study's findings given similar resources and access to comparable student teams.

This research was reviewed and approved by the supervising faculty members as part of the Bachelor Research Project requirements at TU Delft. The study design followed TU Delft's ethical guidelines for research with human subjects.

7 Discussion

This study supports the hypothesis that self-efficacy is positively related to participation in software development team meetings. Specifically, students who rated themselves higher in self-efficacy contributed more frequently overall, particularly in technical areas. This finding aligns with Bandura's theory that confidence in one's abilities promotes greater engagement in relevant tasks [2].

Addressing the first sub-question, the results showed that self-efficacy was a significant predictor of overall participation, suggesting that students who feel more confident in their abilities are more likely to engage actively in team discussions and tasks. Regarding the second sub-question, the correlation between self-efficacy and specific types of contributions was especially strong for technical input and planning/coordination, indicating that students with high self-efficacy tend to take on roles that directly influence the technical direction of the project.

However, the qualitative observations revealed that team dynamics can moderate this relationship (sub-question three). In several groups, highly self-efficacious students contributed less than expected due to the presence of dominant speakers or established team norms that restricted opportunities for others to participate. This finding resonates with Ocker's research [9] showing that dominant group members can overshadow even confident team members, potentially limiting their engagement. These observations show that individual self-efficacy isn't isolated, but is shaped by broader group dynamics.

Implications for Research and Practice. These findings have several implications. For educators, the results suggest that boosting students' self-efficacy can enhance engagement and collaboration in team-based projects, particularly within the field of computer science. However, improving confidence alone may not be sufficient to ensure balanced participation. Additional mechanisms or support for quieter students may be needed. For researchers, the results highlight the need to consider not only individual attributes like self-efficacy but also how team culture and group dynamics affect collaboration.

8 Conclusions and Future Work

This study investigated the relationship between self-efficacy and contributions during team meetings in software development projects. The findings suggest that students with higher self-efficacy scores generally participate more frequently, particularly in technical discussions, supporting the hypothesis that confidence in one's abilities fosters greater engagement.

The study also shows that group dynamics—such as dominant speakers and implicit role distributions— can impact this relationship, suggesting that self-efficacy, while an important predictor, is not the sole determinant of participation.

Future research could expand on these findings in several ways:

- Developing strategies to reduce dominance effects—such as structured turn-taking, explicit facilitation roles, or rotating leadership—to try to equate participation.
- Investigating the influence of other psychological factors, such as social anxiety on team meeting dynamics.
- Testing the generalizability of these findings in larger or more diverse student populations.

8.1 Limitations

This study has several limitations. First, the sample size was relatively small, and all participants were drawn from Software Project (SP) teams within the Computer Science and Engineering program at TU Delft. This limits the generalizability of the findings to other institutions, programs, or cultural contexts.

Second, participation in the study was voluntary, which introduces a risk of self-selection bias (students who were more self-confident or had more positive attitudes toward teamwork may have been more inclined to participate, potentially skewing the results).

Third, while the self-efficacy survey was carefully adapted from existing instruments, the modified version has not been formally validated. As a result, some uncertainty remains about its reliability and construct validity in this specific context.

Finally, the analysis focused exclusively on verbal contributions during in-person team meetings. Other forms of collaboration—such as communication via GitHub, Slack, or Trello—were not included, which may have limited the full picture of student participation.

Future research should conduct larger-scale studies, including participants from more diverse academic settings, validate the adapted survey instrument, and explore multiple modes of collaboration.

A Appendix: Self-Efficacy Survey

The full survey instrument administered to participants is provided here to ensure reproducibility.

Demographic Information

- Age: (Integer)
- Year of Study: (1–5+)
- Gender: (Male/Female/Other(Specify)/Prefer Not to Say)
- GitLab Username (Name)
- Repository (Link)

Programming Experience

- How do you estimate your programming experience compared to your classmates? (1 = Low, 5 = High)
- How experienced are you with logical programming? (1–5)
- On a scale from 1–10, how do you estimate your programming experience overall?

- For how many years have you been programming? (Integer)
- For how many years have you been programming for larger software projects (e.g., in a company)? (Integer)
- How experienced are you with object-oriented programming? (1–5)
- How many programming languages do you know at a medium level or higher? (Integer)
- How many courses have you taken that required you to implement source code? (Integer)
- How large were the projects you have worked on? (N/A, ¡900, 900–40,000, ¿40,000 LOC)

Self-Efficacy Items (1 = Strongly Disagree, 5 = Strongly Agree)

- I am confident in my ability to write correct code to solve programming problems.
- I can independently debug and fix issues in my code.
- I am confident explaining my code or design choices to others.
- I feel comfortable sharing my ideas during group meetings.
- I am confident contributing to technical discussions in a group.
- I believe my input is valuable to the success of the team.
- I am confident that I can successfully complete difficult tasks when needed.
- I can find solutions to problems even when things are challenging.

Open-Ended Question

- Is there anything that makes you feel more or less confident when working in a team?

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