# A Strategy for Structuring Teams Collaboration in University Course Projects

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Abstract: The increased demand in today's work environment for individuals with diverse skill sets, fast skill acquisition, and ability to collaborate is as a consequence of the rapidly evolving technological environments. Thus, institutes of higher learning have increasingly adopted e-learning platforms, owing that one of the defining aspects of these platforms is the capacity to facilitate collaborative engagement. This adoption has resulted in curriculum changes, and the development of tools and further specialized platforms that are focused on the acquisition and transfer of particular soft, and hard skill sets. One such specialized platform is Teams platform of SQLValidator, a web-based interactive environment for learning, practicing, and acquisition of collaborative problem-solving skills by way of projects centered around the Structured Query Language. In this paper, we give insight into our platform, and the strategy we adopted to ensure the acquisition of SQL, and collaborative skills. To assess its effectiveness, we monitored the activity and performance of our students on an SQL based collaborative project. Our evaluation indicates that our strategy not only gave us practical insight into the student level of SQL skill acquisition, and interaction, which is important for instructors, but is also proved effective in facilitating the acquisition, and transfer of teamwork ethics and collaborative problem-solving skill among students.

## 1 INTRODUCTION

The challenge, structure, and requirements of the 21st-century work environment have made the acquisition of teamwork and collaborative problem-solving skills indispensable (Sundstrom et al., 1990). This is most evident in the information technology sector, where the work is often split into well-defined subtasks to create complex tools. Ergo, it requires a team of individuals with different backgrounds and skill sets. Usually, the basis for this skill acquisition is set during a person's studies. Due to the recent move to online learning in most institutions of higher education, curriculum administrators and developers are resorting to online environments that can stimulate task engagement, team collaboration, task reflection, and the acquisition of teamwork skills. Early implementations of team-based learning showed that collaborative problem-solving within small groups was effective in stimulating active learning (Michaelsen et al., 2004; Gomez et al., 2010). As observed in (Michaelsen et al., 2004), team members assumed specific roles in an effort to efficiently solve the assigned tasks. While most team members were not effectively suited for the assigned roles, team leaders took it upon themselves to ensure their peers' learning. This challenge of fitting team members into defined roles still persists in recent traditional lecture settings (Michaelsen and Sweet, 2011).

Most recent efforts at orchestrating team collaboration involved platforms designed to facilitate team collaboration processes, such as planning, scheduling, information lineage, brainstorming, data creation, gathering, and distribution (Gruba, 2004; Taras et al., 2013; Gruba and Sondergaard, 2001). One

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of such learning platforms is SQLValidator (Obionwu et al., 2021; Obionwu et al., 2022). SQLValidator is an integral part of the database courses held in our faculty, and encompasses exercises, questionnaires, and tests to assess students' SQL programming skills. Up till 2021 academic year, the platform was used mainly as an individual learning platform, where collaboration between students was not possible. Due to the increasing importance of teamwork, we integrated the *Teams component* of the platform. Ergo It's description, and workflow, is an important topic in this paper. Further important is the facilitation of task reflection, and acquisition of collaborative problem-solving skills. Our initial results show that, when students collaborate, their solutions of project tasks are on average better than those without visible collaboration within a team. Furthermore, our investigation of different degrees of instructional designs shows that an explicit indication for team self-organization helps in completing collaborative tasks more efficiently. In summary, we contribute:

- a collaborative task design for SQL teaching courses.
- an evaluation showing that collaboration leads to better results when accomplishing SQL tasks.

This paper is structured as follows: in Section 2, we discuss related work and, in Section 3, we describe the design of our system. A characterization of participating students of our study through a survey is given in Section 4. An overview of the collaborative project is given in Section 5, and team activity results are discussed in Section 6. In Section 7, we summarize and indicate directions for future research.

## 2 RELATED WORK

Traditionally, teams are formed as a strategy for tackling difficult challenges, or hard deadline scenarios. A survey conducted in 2019 by Slack,[1] a highly popular collaboration platform revealed that ease of communication resulted in good collaboration while top collaboration challenges centered around communication difficulties as not being able to convey gestures.

In the subsequent paragraphs, we discuss the essential features of freely available, or open-source collaboration platforms that are used in the educational sector. To select these studies and platforms, we did a literature search and the following platforms have been selected:

Schom (Berjón et al., 2015) is a tool for communication and collaborative learning, which employs mobile instant messaging for the exchange of information between members of an institution. It offers interaction via e-mail, chat, discussion boards, or microblogging and ensures digital anonymity. Thus, users can anonymously interact with other users and groups. Our Teams' platform, unlike Schom, is designed for effective interaction between students of a team and, thus, each user knows its teammates as in traditional scenarios.

Flipgrid (Edwards and Lane, 2021) is an online video discussion tool that offers students a platform to discuss ideas, communicate with their peers, and practice their language and presentation skills. Its popularity among educators is driven by the ease by which it is set up and used in classes, and students quickly engage in recorded online video-based conversations with the teacher. It can also be accessed via internet browsers. Our Teams' platform, unlike Flipgrid, emphasizes textual communications as using a text-based medium in computer-mediated communication creates a more equitable and non-threatening forum for discussions, especially those involving women, minorities, and naturally reserved personalities (Warschauer, 1997; Ferris and Hedgcock, 2013; Warschauer, 2004).

In UniConnect, lecturers create private course communities and invite enrolled students. Each community offers dedicated blogs, wikis, forums, libraries, IBM docs, task management tools, and the possibility of viewing group activity streams. Furthermore, students can create workgroups for their assignments and projects. Our Teams' platform does not have this level of customization, which opens up future work for us. While both systems allow students to collaborate within and outside lecture periods, UniConnect unlike Our Teams' platform also features virtual research teams that facilitate research cooperation among two or more universities.

Remote Technical Assistance (RTA) (Blake, 2000), developed at UC Davis, is a collaborative tool that features a chat system that facilitates random textual interactions via a TextPad window. It also allows users to record and forward digitized sound and create shared whiteboards using screen capture. The chat program also lets each user remotely manipulate his or her partner's Web browser, and permits both point-to-point and multipoint/group chat. The collaborative pedagogy of Our Teams' platform is different from that of RTA. Furthermore, Our Teams' platform, as we describe in Section 3, features a chat system, code editor, task management system, and an instructor oversight feature that allows the integration of in-

[1] https://slack.com/blog/collaboration/good-collaboration-bad-collaboration-a-new-report-by-slack last accessed on 25.02.2022

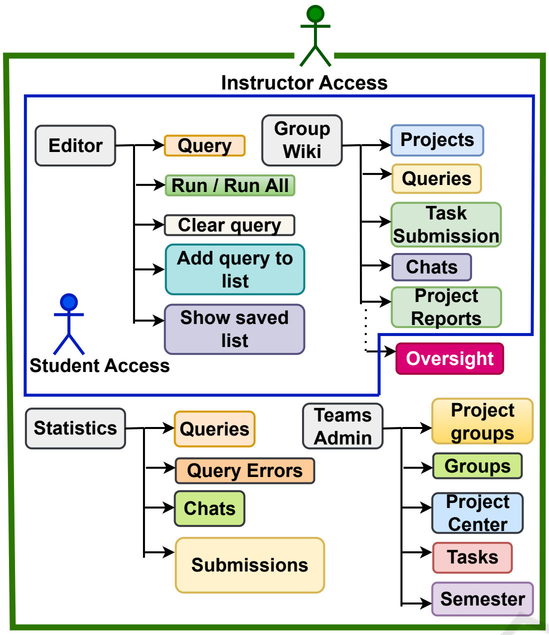


Figure 1: Teams Overview.

structional feedback.

Canvas is an open-source cloud-based learning management platform (Desai et al., 2021; Mulder and Henze, 2014), developed by the US infrastructure company. This platform consists of features, such as page view count visualization, sentiment / message classification and analysis. It has a hierarchical assessment architecture that streamlines the deployment of courses and respective assessment modules. Apart from being free for educators whose university has no subscription, it also serves as a collaboration platform. Our Teams' platform does not have this level of customization, which opens up future work for us. While both systems allow students to collaborate within and outside lecture periods, Canvas unlike Our Teams' platform is a full-fledged learning management system.

# 3 DESIGN AND IMPLEMENTATION

Several systems have been developed to facilitate online instructor / student interactions. One of such web-based tools is SQLValidator (Obionwu et al., 2021). The platform is an integral part of the database courses held and encompasses exercises, questionnaires, and tests to assess students' SQL programming skills. Our Teams' platform is the collaborative environment for the platform. It is designed to facilitate high-level discussions, which are similar in quality to discussions that take place in traditional collaboration settings. Fig. 1 shows an overview of the subsystem, differentiated by access.

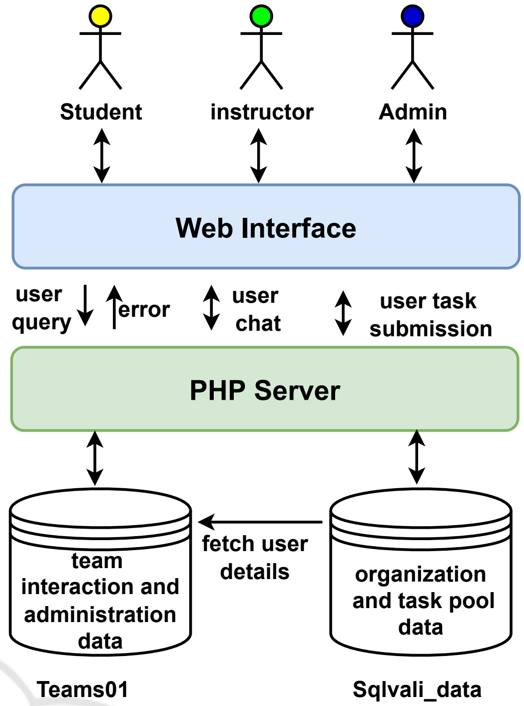


Figure 2: Teams Architecture.

## 3.1 Teams Architecture

There are three main features when implementing a web-based application, these are centralization, replication, and distribution. The Teams' system uses a centralized client-server architecture. The general architecture of the application has been depicted in Fig: 2. As depicted, users interactions via a web interface by way of posting chats, creating submissions in the group wiki, and executing queries in the editor, etc. is mediated by a PHP server. The relational database management system is tasked with storing and managing all the data resulting from student, and instructor interaction. To achieve this objective, the Teams' platform interacts with two main databases:

- `db2_data` contains all relevant data to maintain the organization of the platform itself, such as user management and task definitions.
- `db1_teams01` contains all standard tables and data used to support project task submissions, chat management, user query evaluations, and admin management.

Thus records of all user interaction is stored for analytical purposes.

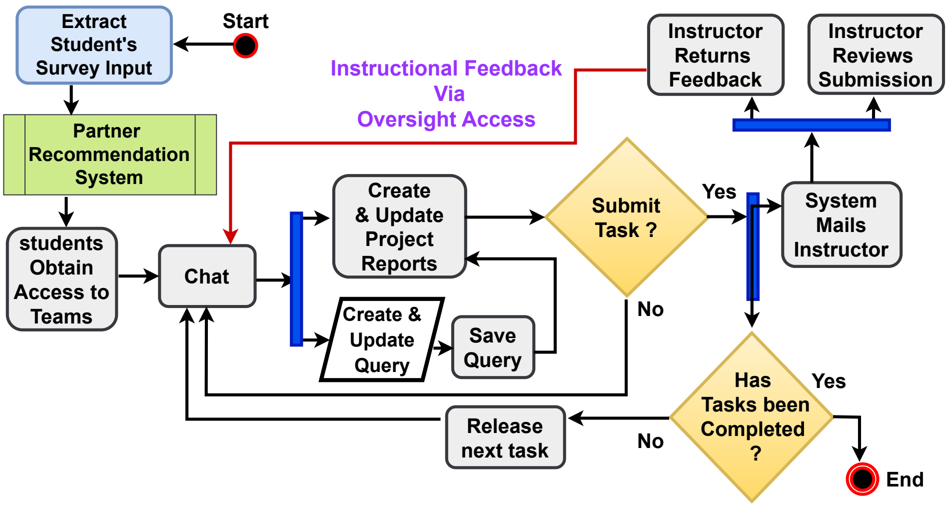


Figure 3: Teams Workflow.

## 3.2 Student Access

As communication is often an integral feature of collaboration tools, we made the chat persistent in the group-wiki, and code editor pages. Students have the option of updating and deleting their chat posts. To keep teams focused on current milestones, we structured the chat in pages. Only the latest 10 chat posts are visible. History buttons are available to provide access to previous chat posts. Our strategy aims to instill a culture of self-assessment and reflection and, thus, we allow teams to improve their solutions, and resubmit again. This feature is accessible in the group wiki/task submissions. Unlike the chat system, where team members can edit and delete their chat posts, team members can only create, read, update, but not delete task submissions. Since many tasks are based on the Structured Query Language SQL, our platform includes a query editor. The editor, apart from executing queries, allows collaborators to store previously used queries. Thus, if in the course of the milestones, it is required to alter the solutions, and hence the queries, the team can access all their previous queries from the group wiki. It also allows selected execution of related queries. The group wiki gives them access to the project tasks, saved queries, and submission pages.

## 3.3 Instructor Access

The instructor, apart from having access to administrative activities, can grant itself membership of any team where his feedback is required. This is facilitated via the oversight access shown in Fig. 3. Thus, the instructor can perform CRUD operations on chats posts, and task submissions. However, all the queries executed in the instructor profile are not transferred to the teams profile. In general, the oversight feature facilitates the integration of instructional feedback, which is typical for traditional team project interactions. The teams overview diagram further (Fig. 1) shows the other activities specific to administrators in Our Teams' platform.

## 3.4 Teams Workflow

Given that individual students have completed the personality survey, team are generated via the partner recommendation system, which is described in obionwu et al. (Obionwu et al., 2023a). The administrator loads several tasks into each team profile, and initializes the teams. The student members gain access, introduce themselves, and immediately start interacting with the tasks in the group wiki. The interaction will result in chat, and project report commits, and they agree that the answer to a respective question, the project report is updated again, after which a submission is made. Once the first task is solved and submitted, the next task is activated. This process continues until the last task is activated. Once a submission event is registered, the system mails the respective instructor and the review process starts. Once the review is done, the instructor, via the oversight link, gives a response in the teams chat. Depending on the response, the entry in the project report will either be updated or left as the final response to the respective question. This process will continue until the final task. A description of the task is shown in section 5.1

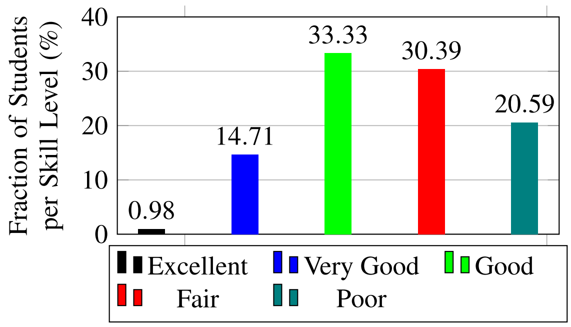


Figure 4: Student's Initial Practical Programming Knowledge.

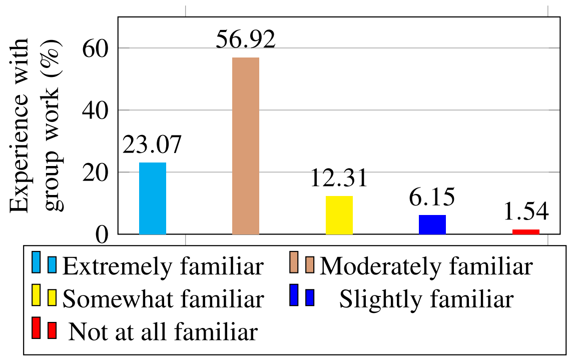


Figure 5: Student's group work experience.

## 4 SURVEY INSIGHTS

Being that the team projects were developed to stimulate the cultivation of collaborative skills (Obionwu et al., 2023b), having systems and structures generate collaborative behaviors alone is insufficient (Erbguth et al., 2022). Collaboration and team engagement as a feature can be utilized to help learners coordinate and communicate effectively to achieve a common goal. Thus, to cultivate community learning and enhance collaboration, we designed tasks to incorporate communication and not force them on the students. We further sought to gain insight into our student's psychological affinity for collaborative engagements, and behavioral dispositions to collaborative learning. To achieve these goals, we partly adapted the "Students' Readiness for CSCL" questionnaire (Xiong et al., 2015). Eight items from this questionnaire were selected from the "Motivation for collaborative learning" evaluation, and ten items were selected from the "Prospective behaviors for collaborative learning" questionnaire. In the 2023 winter semester, we had 140+ enrollments in our teams' platform. Although we decided not to enforce survey participation, 95 students from those enrolled in the semester course participated in the surveys. Furthermore, we allowed the possibility of skipping sections of the questionnaire. In the next subsection, we give a description of the course participants based on the survey results.

### 4.1 Participants

The pilot study was conducted in the context of the 2021 database concept summer semester's course where students were required to form teams consisting of 3 individuals as triads are typically more stable and engaging than other social network structures (Yoon et al., 2013), and well attuned to our task structure as will be discussed in the next subsection. To increase trust among team members, team formation took place at the beginning of the course. But there were lots of teams breakdowns in the pilot study. Thus, we developed a partner recommendation system, which we currently employ to handle team creation. The students completed personality surveys, which allowed us to create the teams. These new teams not only easily became acquaintance, but showed willingness to deal with the team process. As for the collaborative tasks, they are extracted from the concepts described in the lectures, and theoretical exercises; thus, the teams are expected to have acquired all the skills and information needed to engage with the collaborative tasks.

Four exercise instructors oversaw the weekly exercise meetings and helped facilitate teamwork. To estimate the participants perceptions and experiences with respect to teamwork, and collaboration, we conducted surveys. The result of our inquiry into their self-perceived practical programming knowledge is shown in Fig. 4. The results suggest that: about 1% had extensive experience with general programming 15% were proficient, 33% had above-average experience, while 51% had rather limited programming skills. Overall, a considerable number of the students' population were beginners, and hence we taught them the fundamentals of using SQL. Furthermore, Fig. 5 shows their team work experience. The results indicate that: about 80% had worked in team projects or tasks prior to enrolling in our course, while 20% had limited team work experience and thus needed guidance on how to work in team projects.

### 4.2 Collaboration and Team Interaction Questioner Description

In the first survey among the participants of the course, we aimed to elicit our participants' self-evaluation and experiences on team interaction, and

Table 1: Motivation for collaborative learning Questionnaire.

| Item | Motivation for collaborative learning | No. | Mean | SD |
|---|---|---|---|---|
| Mot.1 | I like to work with other students in group activities. | 65 | 2.8 | 1.21 |
| Mot.2 | Comparing with doing individual assignments, it is more effective to learn by doing group work. | 65 | 2.85 | 1.21 |
| Mot.3 | I will need teamwork skills in my future job. | 65 | 3.2 | 0.89 |
| Mot.4 | Working in groups allows me to tackle more complex topics than working individually. | 65 | 3.05 | 1.08 |
| Mot.5 | There are many opportunities for discussion and sharing ideas by working in groups. | 65 | 3.08 | 1.00 |
| Mot.6 | I believe I can do well in the group work. | 65 | 3.15 | 0.87 |
| Mot.7 | I believe I can support group-mates. | 65 | 3.2 | 0.90 |
| Mot.8 | I believe I can play an important role in the accomplishment of the group task. | 65 | 3.02 | 0.89 |

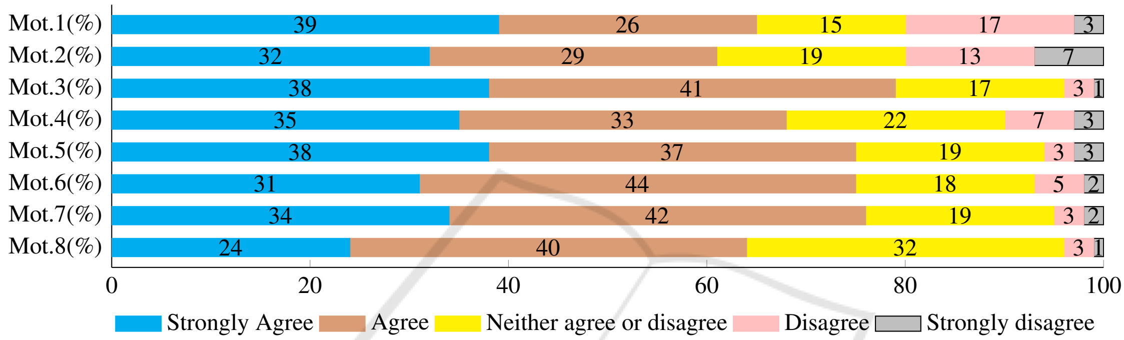


Figure 6: Motivation for collaborative learning feedback.



collaboration. A total of 65 of the participants responded to the optional voluntary survey at the beginning of the course. Most of the users were between the age of 27-31, and have previously not used our collaboration platform.

We show descriptive statistics like the mean, the standard deviation for the quantitative questions rated on a 5-point Likert scale (in numeric representation: 0 = Strongly Disagree to 4 = Strongly Agree) in Table 1, which contains questions and responses about their motivation for teamwork, and in Table 2, we show their self evaluation of their collaboration behavior. The vast majority of quantitative replies were agree (3) and Strongly Agree (4) on the scale. Therefore, the standard deviations are fairly small for a vast majority of the questions. There were no questions that were answered mostly negative, but there are several questions with mixed replies. In general, questions were prepared in such a way that not only perceptions about current team collaboration, and interaction events are elicited, but also their previous collaboration and teamwork experiences, behavior, and opinions.

We observe from Table 1 and the corresponding plot, Fig. 6, that more than 65% of the participants liked working in groups (item Mot.1), and 61% agreed that it was more effective to work in groups (item Mot.2). 79% of participants in item Mot.3 held a notion that teamwork skill was important for their future job, while in item Mot.4, 68% agreed that complex tasks can easily be tackled by sharing the workload with group members. Furthermore, in item Mot.5, 75% agreed that working in groups provided opportunities for discussion and sharing of ideas, and in item Mot.6, 75% can perform well while in group work. 76% believed that they can support their group mates in item Mot.7 and in item Mot.8, 64% believed they can play an important role in the accomplishment of the assigned group task.

Considering Table 2 and corresponding feedback, Fig. 7, 60 students participated in this survey group of question as our survey questions are not obligatory, out of which 77% of the participants indicated that they liked to share ideas (item Beh.1), and in item Beh.2, 87% indicated that they were open to new ideas. In item Beh.3, 84% are tolerant of different ideas. 82% indicated that they can express their thoughts appropriately (item Beh.4) and 75% further indicated in item Beh.5 that they always participated appropriately during group work. In item Beh.6, 73% of the participants indicated that they were able to provide feedback on individual team member's performance, while 70% in item Beh.7 indicated that they were able to provide feedback on in-

Table 2: Prospective behaviors for collaborative learning questionnaire.

| Item | Prospective behaviors for collaborative learning | No. | Mean | SD |
|---|---|---|---|---|
| Beh.1 | I like to share my ideas with others. | 60 | 3.02 | 0.98 |
| Beh.2 | I am open to new ideas. | 60 | 3.27 | 0.84 |
| Beh.3 | I am tolerant of different ideas. | 60 | 3.25 | 0.88 |
| Beh.4 | I am able to express what I think in an appropriate way, not harming other group members. | 60 | 3.18 | 0.81 |
| Beh.5 | I always participate in an appropriate way. | 60 | 3.13 | 0.83 |
| Beh.6 | I am able to provide feedback on overall team's performance. | 60 | 2.9 | 1.00 |
| Beh.7 | I am able to provide feedback on individual team member's performance. | 60 | 2.8 | 0.95 |
| Beh.8 | I am able to monitor my group's progress. | 60 | 2.87 | 0.98 |
| Beh.9 | I am able to implement an appropriate conflict resolution strategy. | 60 | 2.77 | 0.95 |
| Beh.10 | I am able to recognize the source of conflict confronting my group. | 60 | 2.87 | 1.02 |

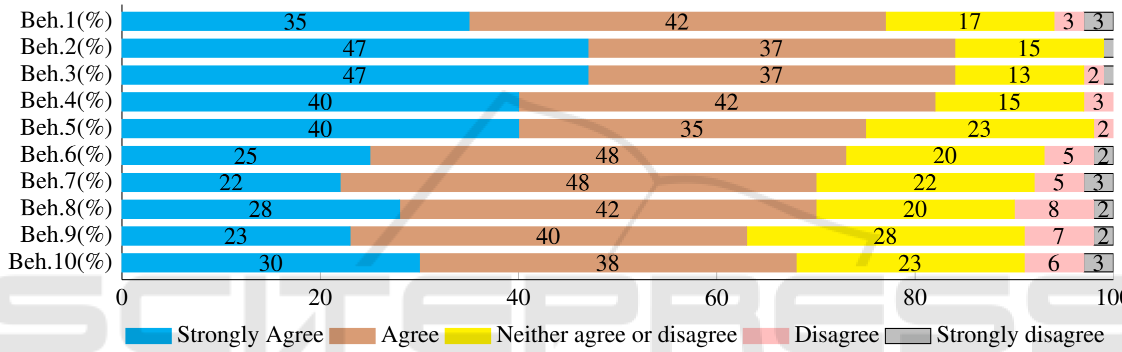


Figure 7: Prospective behaviors for collaborative learning feedback.



dividual team member's performance as well as monitor their group's progress in item 8. Furthermore, in item 9, 63% indicated that they were able to implement an appropriate conflict resolution strategy and in item 10, 68% indicated that they were able to recognize the source of conflict confronting their group.

In general, the standard deviations from the mean were modest, as most of the participants indicated that they either agreed or strongly agreed with the perceptions on collaboration and teamwork that were queried about in the survey. So, in general, all participants have a positive attitude and motivation towards the expected teamwork. This is reinforced by Fig. 5 which showed that about 80% of the participants already experienced group work. Thus, around 20% of our participants have not experienced working in teams. Ergo, our project was a guide for this group of participants on the basics of teamwork, and collaboration.

# 5 COLLABORATIVE PROJECT STRUCTURE AND PARTICIPANTS

## 5.1 Team Tasks

Our collaborative tasks are based on the Structured Query Language SQL, a standard for performing CRUD operations on a database. Thus, to create a collaborative SQL project with reasonable level of complexity, we employed the concept of roles. These roles are known to affect how team members collaborate (Ruch et al., 2018), (Lyons, 1971), (Oke et al., 2016), (Senior, 1997). Furthermore, regulating group learning is important for learning processes and outcomes.

Teams have to plan, monitor and evaluate, respectively, reflect on their teamwork - a challenging task, especially for novices in teamwork. A Collaboration Script that guide the planning, monitoring, and reflection activities can support teams (Näykki et al., 2017). Based on this, we created two conditions,

Table 3: Summary of our task description.

| Collaborative Task Sections | |
|---|---|
| **Introduction and Objective** | **Motivates and stresses the importance of teamwork. Describes the expectancy of each milestone.** |
| **Specification of Roles** | **Explain the different roles to be assumed by participants of the team.** |
| **Teams, Role Formation, & Selection** | **Students form triad social units and choose either a stakeholder, an administrator, or a developer role.** |
| **Planning and Task Sequence** | **Explain the steps that teams should go through to achieve the objective.** |
| **Description of Tasks without reflection script** | **A total of six tasks from database modeling to data definition and querying.** |
| **Description of tasks with reflection script** | **In addition to the tasks with reflection script, it contains another first task, which addresses project planning and an additional last task that inquires team reflection.** |
| **Reflection and Extension** | **Encourage teams with reflection script-based tasks to think about what has been learned and how to apply that learning to different contexts.** |

Table 4: Sample tasks without reflection script.

| Sample tasks without reflection script | |
|---|---|
| **Task** | **Description** |
| **Task 1**<br>**ER modeling** | **The stakeholder(s) designs a use case for which the data management should be done. This use case is described in a natural language formulation and an ER model is designed for it.**<br>**The created and described ER-diagram should contain at least 3 entities and two relations.**<br>**Please upload both in the project submission and discuss whether the solution needs adjustment.** |

structured, and unstructured projects, as we discuss in Section 5.1.1. The general task description is described in the next section.

Collaborative problem-solving facilitates not only peer knowledge transfer but also several beneficial skills, such as communication skills, teamwork, and respect for others. It also stimulates independent responsibility for learning and sharing information with teammates (Hung et al., 2008; Parker, 2006). Table 3 shows a summary of our task description. In general, it is team-centered, and instructors do not dictate or enforce any collaboration pattern. The overall scene that we present in the part ”Introduction and Objective” is that students should follow the whole design cycle within a data management project – from use case modeling over schema design to schema definition and data analysis. To facilitate collaboration within this scenario, we define the three roles: (1) stakeholder, who is responsible for defining a complex use case and interesting analyses, (2) administrator, who should create the schema and execute the ETL process, and (3) the developer who implements the analyses. To this end, students individually and collaboratively assume responsibility for solving different aspects of the project milestones. The tasks also encourage team strategy reflection. Thus, teams have the option of re-evaluating, and resubmitting a previously submitted solution. The goal here is to induce learning strategies adjustment considerations and stimulation of self-reflection skills.

### 5.1.1 Project Type

We created two project types, groups working on tasks with reflection script and teams working on tasks without reflection script groups, in order to assess the impact of instructional guidance on the extent of collaboration. The tasks with reflection script, shown in Table 4, had a general description of the task, which was assigned to one of the roles (responsibilities change from task to task). Furthermore, the last instruction always asked for a critical discussion inside the group.

In contrast to teams with reflection scripted tasks, teams with tasks that require reflection, Table 5, were required to plan their team work before the first task submission. We further described the planning process and possible discussion points. In the preceding tasks, we also described steps to take and last steps within their tasks required the teams to reflection on what they have done. With these explicit instructions, we aimed at encouraging students to collaborate and especially to regulate their teamwork more systematically.

## 6 ANALYSIS OF THE COLLABORATIVE PROJECT

Having described the platform, task groups, and their respective tasks, we now provide a preliminary anal-

Table 5: Sample tasks with reflection script.

| Sample tasks with reflection script | |
|---|---|
| **Task** | **Description** |
| **Task 0**<br>**Project Planning** | **1. Meet online in the Teams Chat. Briefly discuss the task.<br>Are there any problems of understanding?<br>Clarify any questions about the task.**<br>**2. Then discuss the concrete implementation: make a time plan and distribute the roles (Consideration: Do you already have experience with a certain role or do you want to strengthen your skills in a certain role?) Please also store the role distribution.**<br>**3. Also, briefly discuss what you find important about teamwork.<br>What do you expect from your team members?<br>As a team, write down three key points that the team members want to adhere to.** |
| **Task 1**<br>**ER modeling** | **1. The stakeholder designs a use case for which the data management should be done. This use case is described in a natural language formulation and an ER model is designed for it. The created and described ER-diagram should contain at least 3 elements and two relations. Please upload both in the project reports.**<br>**2. The two team members provide feedback on the stakeholderś solution (assessment and suggestions for improvement). Through this review process, all team members intensively deal with each task.**<br>**3. Discuss (stakeholders) the feedback with the team members and discuss how to proceed.<br>Revise the original solution and upload the final result to project reports.** |

ysis of the collaborative activity. For this analysis, we selected 28 teams from the 2023 winter semester. We further used two indicators, the first of which is based on the number of individuals that submitted respective tasks. Consequent on the user activity view feature in the teams' environment, tutors can know who solved the tasks. Thus, we differentiate between the number of students submitting within the project team as an indication for collaboration. Thus, the label "3 submitters" (13 teams) implies that each of the team members submitted at least one task, while "2 submitters" (8 teams) and "1 submitter" (7 teams) implies that only one or two team members did all the submissions. Hence, many teams distributed the tasks among themselves, which is a positive sign for the overall collaborative setup. Still, when taking a more in-depth look into the data, only 6 teams strictly followed the role distribution. This is a common problem that also (Näykki et al., 2017) identified, as their instructions were also often disobeyed. As a result, we need to implement extra score credit incentives to motivate collaboration among team members.

The second indicator is the project type (cf. Section 5.1.1) as it should have an impact on the teams' team work. In the charts, "Str." stands for groups with tasks that require reflection, (13 groups) and explicit collaboration instructions, while "Unst." designates teams with tasks that required no reflection, (15 groups) with only recommendations for collaborative practices. Notably, teams were shuffled in random

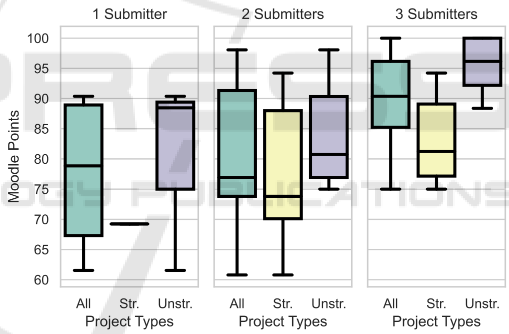


Figure 8: Scores in the Theoretical Exercise Submitted to Moodle (thus, Moodle Points).

into one of both project types without them knowing what task description they got.

In the following, we first analyze the skills and motivation of the teams in forms of the Moodle submission, their messaging behavior, as well as their final project grading.

## 6.1 Analysis of Team Skill and Motivation

Fig. 8 shows the group scores obtained from the theoretical part of the exercises which preceded the team's project. These scores range from 61 (minimum criterion for exam qualification) to 100 and usually represent the motivation of the students and their understanding of the exercises because these points come

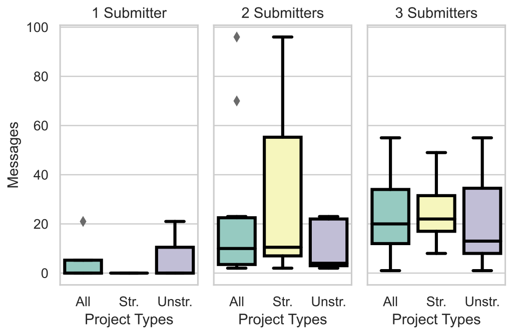


Figure 9: Team Messages.

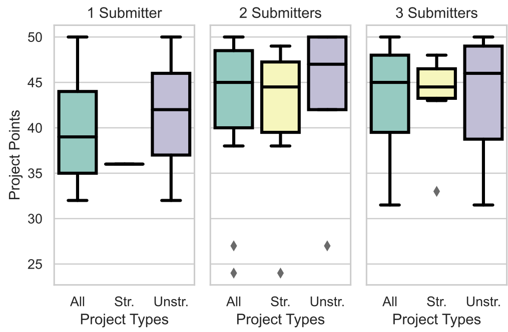


Figure 10: Teams Project Scores.

from graded team submission of theoretical exercise tasks.

This analysis yields two insights. First, we can see that student teams with a higher Moodle score (i.e., motivation) also tend to follow the rules of collaboration more strictly, as we can see from the higher medians of Moodle points for the teams with two or three submitters. Second, overall our random shuffling created a small bias towards team tasks that required reflection where teams with tasks that required no reflection have, on average, better teams, which can influence the final points in the collaborative project.

## 6.2 Analysis of Chat Behavior

In Fig. 9, we show the messages sent through the integrated chat system. A positive result of this analysis is that when collaboration happens (i.e., two or three people submitted tasks), teams working on tasks with reflection requirement made more use of the integrated chats than teams working on tasks with no reflection requirement. This is a positive sign that our extra instructions for collaboration is fruitful. However, this result may also be as a consequence of the extra score credit incentive they receive when instructors observe conversation in the team's chat system. Also, we observed that they used other social media apps for communication, thus some of their real communication may be hidden to us, and may follow a different pattern.

## 6.3 Analysis of Project Results

At the end of the collaborative project, we graded the submitted tasks of the teams. The maximum amount of possible points is 50, with some teams having achieved this, as visible in Fig. 10.

The score distribution leads to two insights. First, comparing the median scores of all groups, teams with more submitters also got better scores. Hence, collaboration really helped students to reach better results in database-related tasks. Our second insight, however, is that teams working on tasks with reflection requirement did not score as good as teams working on tasks with no reflection requirement, which is against our initial goal. However, this could be explained by the results from Fig. 8, where teams working on tasks with no reflection requirement had more Moodle points. This draws the conclusion that they have better skill and motivation for the course, and will, thus, lead to better results in the collaborative project, and thus the acquisition and transfer of teamwork skills among team members.

# 7 SUMMARY AND FUTURE DIRECTIONS

In this paper, we introduced Our Teams' platform, a web-based interactive collaborative learning platform for learning and practicing SQL. We evaluated students' exercise engagements and presented their activities and scores. In general, we observed that placing a collaborative task at the core of a class lecture leads to students achieving better project results and thus, an effective strategy that induces learning, knowledge evaluation, and respective skill acquisition. Furthermore, our students were inclined to use other social media apps for communication compared to the internal chat system, and incentives as extra score credit increased the likelihood that students will comply to the rules of collaborative team engagement. Our Teams' platform is pedagogically structured to stimulate reflection, a sense of community, and collaboration. In the future, we plan to explore how student's activity patterns can best be used to provide instructors and researchers with a clearer picture of which course aspects students find most challenging. We also plan to extend the Teams system further with collaboration stimulation, retrospective evaluation, and graph learning features for better partner selection recommendation and study engagement improvement.

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