

Examining Perception Differences in Context Familiarity Between Students and Instructors in Computing Education: a Case Study on Introductory Database Concepts

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Abstract—This full research paper investigates the alignment between instructor and student perceptions of context familiarity and its impact on novice college students’ performance and confidence in database programming. Learning SQL requires mastering both syntax and the logical structure of databases, making context a critical factor in shaping their learning experience. Our study explores the difference between instructor and student perceptions of context familiarity, its impact on student performance and confidence in SQL exercises, and how initial student confidence influences the effect of context familiarity on student performance. We conducted a study in an introductory System and Organizational Security course comprising 101 students across two sessions. Both groups received identical lectures and assessments but practiced SQL through assignments using either a familiar context (library management) or an unfamiliar context (research paper management). We conducted pre- and post-test surveys to evaluate changes in student confidence and performance in SQL. The results suggest that although all students experienced significant improvement ($p < 0.05$) in SQL performance and confidence, a clear misalignment emerged between the instructor-defined and student-perceived context familiarity. Regardless of whether familiarity was defined by the instructor or by students, students in familiar contexts reported higher post-test confidence, reinforcing perceived familiarity’s role in shaping confidence. These results highlight the subjective nature of context familiarity and the importance of considering individual student perspectives when designing instructional materials. Furthermore, learning outcomes can be achieved utilizing both familiar and unfamiliar contexts. However, familiar contexts positively influence student confidence, which is important for motivation and engagement.

Index Terms—Computing Skills, Student Perceptions, Problem Solving

I. INTRODUCTION

Contextualization has been employed in computer science education as an effective method to bridge the gap between abstract concepts and real-world applications. Embedding abstract computing concepts within meaningful, relatable scenarios has shown promise in fostering student engagement [1], [2] and enhancing learning transfer [3]. Educators have experimented with various familiar and novel contexts to

stimulate active learning, with research suggesting that well-chosen scenarios may support not only cognitive processing but also improved problem-solving skills [4], [5].

Previous research has examined the role of contextualized instruction. Familiar contexts can activate prior knowledge [6]. Conversely, unfamiliar contexts can unintentionally increase cognitive load [7]. However, few studies have directly investigated whether instructors and students share the same perceptions of what constitutes a familiar or unfamiliar context or whether differences in these perceptions result in varying learning outcomes. Understanding these divergent views is critical, as it informs educators about potential misalignment between instructional design and student experiences, ultimately guiding the development of more effective, learner-centered educational strategies.

This paper details a mixed-methods quasi-experimental research design guided by the following research questions:

- RQ1: What is the difference between instructor and student perceptions of context familiarity in database exercises?
- RQ2: What is the effect of context familiarity on student performance and confidence in SQL exercises?
- RQ3: How does student initial confidence influence the effect of context familiarity on student performance?

The paper is structured as follows: Section II presents a review of literature pertaining to context familiarity in computing education. Section III provides an outline of the research methodology. Section IV describes the results of the study. This is followed by a discussion of the results, which includes implications and recommendations for instructors in section V. The conclusion of the study, along with its limitations and avenues for future inquiry, are detailed in Section VI.

II. RELATED WORK

A. Contextualization in Computer Science Education

Contextualization has been employed as a pedagogical method in computer science education to improve student

engagement [1], [2] and learning transfer [3]. Researchers and educators have advocated embedding computing concepts within meaningful, concrete contexts to help students deal with the abstract nature of computing concepts. Empirical studies have provided evidence supporting this strategy, suggesting that well-chosen contexts can help students recognize computational thinking patterns and apply them more effectively across different scenarios [4], [5]. However, the efficacy of contextualized learning materials has yielded inconsistent findings in various research settings.

Several studies have highlighted the complexity surrounding the benefits of contextualization. Leinonen et al. [8] reported mixed outcomes, indicating that the effectiveness of contextualized tasks largely depends on the students' perception of the task's relevance and clarity. Similarly, Lovellette et al. [2] conducted a comprehensive three-year study with over 600 novice programmers, finding no significant improvement in student performance due to contextualization or perceived task authenticity, although they acknowledged potential motivational benefits. Craig et al. [9] further explored this nuance by examining the impact of context familiarity explicitly. They concluded that other factors, such as terminology clarity, availability of examples, and overall complexity of the description, often influenced student performance more than familiarity with the context itself.

While prior research has extensively explored the potential benefits and limitations of contextualization, it remains unclear how aligned instructor and student perceptions are regarding context familiarity. Potential misalignment in perception may hinder the effectiveness of well-intended instruction designs. This study investigates the differences between instructor-defined and student-perceived familiarity with contexts and how varying levels of perceived familiarity affect student confidence and learning performance.

B. Context Familiarity

Context familiarity has been increasingly recognized as a critical factor influencing learning outcomes across various educational domains [10]–[13]. In our study, we refer to context familiarity as the degree to which a problem's domain or scenario aligns with students' prior experiences and real-world understanding.

Several previous studies have shown that familiar contexts, as scenarios or settings closely related to students' prior knowledge and experiences, facilitate cognitive processes by reducing cognitive load and increasing task relevance [11], [12]. Similarly, Sockalingam and Schmidt [13] reported that familiarity positively impacted student perceptions of learning, promoting more productive discussions and effective problem-solving strategies within collaborative learning environments. Additionally, the role of context familiarity extends beyond cognitive performance to affective and motivational domains. Zhang et al. [12] demonstrated that students experiencing stronger feelings of familiarity were more able to manage their perceptions of difficulty during complex learning tasks,

which in turn positively influenced their learning behaviors and outcomes.

However, other studies caution that familiarity alone does not always guarantee improved learning outcomes. Alant [14] emphasized that familiarity could sometimes lead students to adopt superficial problem-solving strategies rather than engaging deeply with underlying concepts. This aligns with findings by Shaffer et al. [15], who reported that brief exposure to concepts in prior courses (partial familiarity) did not significantly enhance subsequent performance compared to entirely novel content.

Building on these findings, this work explores how different levels of familiarity with contexts affect student learning performance and confidence in programming education.

III. METHOD

A. Context and Participants

The study was situated in a 16-week introductory system and organizational security class at a large Midwestern university during the Fall 2024 semester. The participants in this study were primarily students who were in their first year of undergraduate education and were pursuing a bachelor's degree in Cybersecurity. The course consisted of two sessions, one with 96 students and the other with 105 students. Of these, 159 identified as male (79%) and 42 as female (21%), a gender ratio consistent with the broader college enrollment, which is approximately 75% male and 25% female. Table I summarizes student self-identified racial and ethnic demographics.

Demographic	Count
White	81
Asian	52
International	20
Unknown	20
Two or More Races	10
Black or African American	9
Hispanic	8
Native Hawaiian or Other Pacific Islander	1

TABLE I: Racial and ethnic demographics of students

The course was delivered in an in-person modality with two lecture sessions of fifty-minutes each and one lab session of one hour and fifty-minutes in duration. The course serves as an introduction to the field of information technology as well as Cybersecurity covering topics such as risk management, information security, solution modeling using Unified Modeling Language (UML), and database design [16].

B. Study Design

Both course sessions received identical instruction throughout the semester, with the only difference being the context provided in a take-home assignment designed to investigate the impact of context familiarity on learning outcomes. An overview of the study design is illustrated in Figure 1. One session received SQL-related questions embedded in a *familiar* context, represented by a library management scenario. The rationale is that most college students are likely to have made use of the university library resources. The other session received

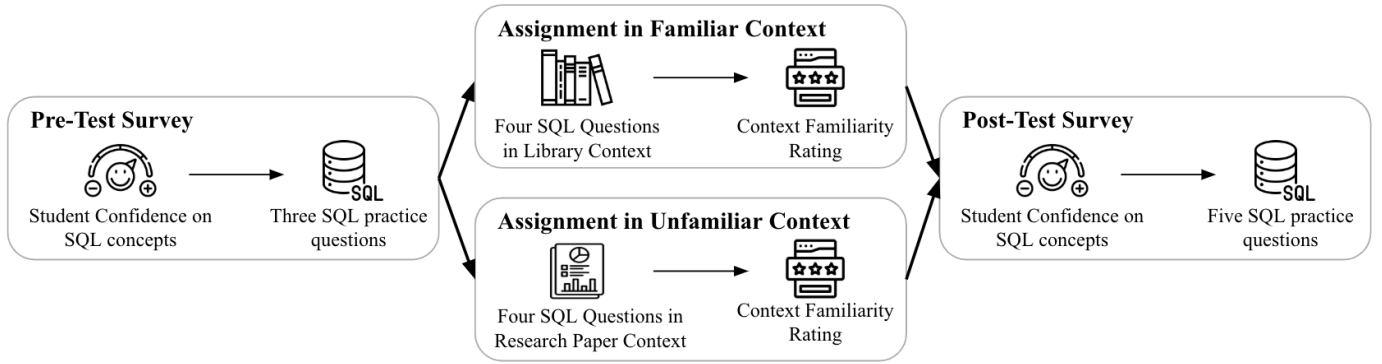


Fig. 1: The flowchart of the research design outlines a pre-test/post-test procedure where students completed a confidence survey and SQL questions, worked on assignments in either a familiar or unfamiliar context, rated context familiarity, and then completed a post-test.

the same set of SQL questions embedded in an *unfamiliar* context, represented by a research paper publishing scenario. This example was selected because participants were primarily first-year undergraduate students, likely with minimal or no prior exposure to academic research and publication processes. Apart from this contextual difference, the assignments given to each session were identical.

C. Procedures

Prior to the intervention, students completed a pre-test survey to establish baseline knowledge and perceptions of SQL. In this survey, students rated their self-reported confidence, which refers to their perceived ability or understanding of SQL concepts using a five-point Likert scale (1 indicating “not confidence at all,” 5 indicating “Extremely Confident”). The survey also included two multiple-choice questions and one open-ended coding question addressing basic SQL concepts, specifically the use of SELECT statements and JOIN operations.

Next, students were given a take-home assignment and had two weeks to complete it. This assignment required them to answer four questions by writing SQL queries to retrieve specific information based on their assigned context (either library management or research paper publishing). At the end of the assignment, students rated their familiarity with the given context using a five-point Likert scale, with 1 representing “very unfamiliar” and 5 representing “very familiar.”

After the assignment deadline, students completed a post-test survey designed to measure changes in their performance and confidence resulting from the contextualized assignment. Similar to the pre-test, students rated their confidence in SQL concepts on the same five-point Likert scale. Additionally, the post-test included two multiple-choice questions and one fill-in-the-blank question requiring students to identify and correct syntax errors in SQL queries. Students also answered two open-ended questions that required writing complete SQL queries involving SELECT, WHERE, and JOIN operations.

D. Data Analysis

To answer RQ 1, which investigates the difference between instructor and student perceptions of context familiarity in database exercises, we first categorized students’ familiarity ratings into two levels: Familiar and Unfamiliar. Students who rated their familiarity as 4 or 5 were placed in the Familiar group, while those who rated between 1 and 3 were placed in the Unfamiliar group. We then counted the number of students in each group to examine how their perceptions aligned with the instructor-defined context categories, library management and research paper. To determine whether there was a statistically significant difference in familiarity ratings across these two instructor-defined contexts, we conducted a Mann-Whitney U test. This non-parametric test was selected due to the unequal sample sizes between the groups [17].

To answer RQ2, which explored the effect of context familiarity on student performance and confidence in SQL exercises, we conducted both between-group and within-group analyses. The analyses were based on: instructor-defined context groups, library management and research paper; and student self-rated familiarity groups, Familiar and Unfamiliar. Student confidence was measured through self-reported ratings on a 5-point Likert scale in both the pre-test and post-test surveys. Student performance was calculated based on how many SQL-related questions they answered correctly in the two surveys. For the between-group analysis, we first performed Mann-Whitney U tests on the pre-test data to ensure that there were no significant differences between the student groups in terms of baseline performance and confidence levels. We then conducted similar between-group comparisons on the post-test data to examine the impact of context familiarity after the intervention. For the within-group analysis, paired t-tests were used to assess changes in student performance and confidence from pre-test to post-test within each context and familiarity group. Additionally, we tracked how individual students moved across different confidence levels from the pre-test to the post-test.

Regarding RQ3, which investigates how student initial

confidence influences the effect of context familiarity on student performance, we conducted a regression analysis using students' pre-test confidence ratings and their gain scores. The gain score was calculated as the difference in accuracy rates of answering SQL-related questions between the pre-test and post-test. This analysis was performed across all four groups, combining both instructor-defined contexts and student self-rated familiarity levels.

IV. RESULTS

Overall, we collected 148 pre-test survey submissions, 151 assignment submissions, and 131 post-test survey submissions from 201 students across the two sections. Only 33 students from the section that received the Library management context and 68 students from the section that received the Research Paper context completed all three components: the pre-test survey, the assignment, and the post-test survey. Data analysis was therefore only conducted on the submissions made by these 101 students.

We performed between-group analysis using Mann-Whitney U tests to identify any potential differences in students' prior backgrounds in database programming that could influence the study results. We found no statistically significant differences ($p > 0.05$) in student performance or confidence in the SQL exercises in the pre-test survey, either between the Library Management and Research Paper contexts or between the self-rated familiar and unfamiliar groups. In other words, students in both contexts had comparable baseline knowledge and confidence before the study intervention, allowing us to attribute observed outcome differences to context familiarity.

A. Student Perceptions of Context Familiarity

Overall, student perception did not align with the instructor-defined familiar and unfamiliar context. In both the Library Management and Research Paper contexts, we observed mismatches between intended and perceived familiarity shown in Table II. Specifically, some students rated the Library context as unfamiliar ($N = 10$), while approximately half of the students in the Research Paper group rated that context as familiar ($N = 34$). The results of the Mann-Whitney U test indicated no significant difference ($p > 0.05$) between the groups in terms of student context familiarity ratings.

B. Effect of Context Familiarity on Student Performance

We measured student performance by their accuracy rate in answering SQL-related questions in both pre-test and post-test surveys. We used t-tests to assess within-group improvements and calculated Cohen's d for effect sizes of context familiarity on student performance. Between-group comparisons were conducted using Mann-Whitney U tests where appropriate. Overall, within-group t-tests showed that students in both the instructor-intended familiarity groups and the self-rated familiarity groups demonstrated statistically significant improvements between the pre-test and post-test in their performance on SQL-related questions ($p < 0.05$).

Instructor-intended familiarity groups. Students in both the Library Management group (Cohen's $d = -1.48$) and the Research Paper group (Cohen's $d = -1.51$) exhibited large effect sizes. Additionally, a between-group comparison revealed no significant difference ($p > 0.05$) in post-test performance between students who used the Library Management context and those who used the Research Paper context.

Student self-rated familiarity groups. Likewise, students in both the self-rated familiar and unfamiliar groups demonstrated large effect sizes (Cohen's $|d| > 0.8$). A between-group analysis using the Mann-Whitney U test showed no significant difference ($p > 0.05$) in post-test performance between students who rated themselves as familiar versus unfamiliar with the context.

C. Effect of Context Familiarity on Confidence in SQL Knowledge

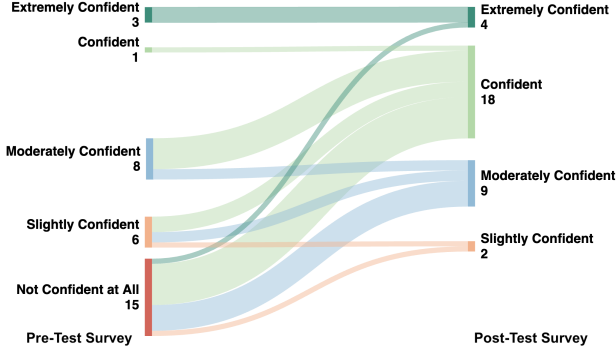
We measured students' confidence in SQL knowledge based on their ratings using a five-point Likert scale in both pre-test and post-test surveys, where 1 indicated "not confidence at all" and 5 indicated "Extremely Confident." Overall, our t-tests revealed that students across both instructor-intended and self-rated familiarity groups reported statistically significant increases ($p < 0.05$) in their confidence in SQL exercises from the pre-test to the post-test survey.

Instructor-intended familiarity groups. Students in both instructor-intended familiarity groups demonstrated large effect sizes, with the Research Paper group (Cohen's $d = -2.45$) showing a higher gain than the Library Management group (Cohen's $d = -1.34$). Additionally, our between-group comparison of post-test confidence levels revealed no significant difference between the two groups. Visualized in the Sankey charts (Figure 2), the Library Management group (Figure 2a) showed a clear upward shift in confidence levels: the majority of students who initially reported being Not Confident at All or Slightly Confident transitioned to being Moderately Confident or Confident by the post-test. Similarly, in the Research Paper group shown in Figure 2b, a larger proportion of students progressed to higher confidence levels, with many moving from Not Confident at All to Confident or even Extremely Confident. This visual trend further supports the quantitative findings of significant confidence improvement in both groups.

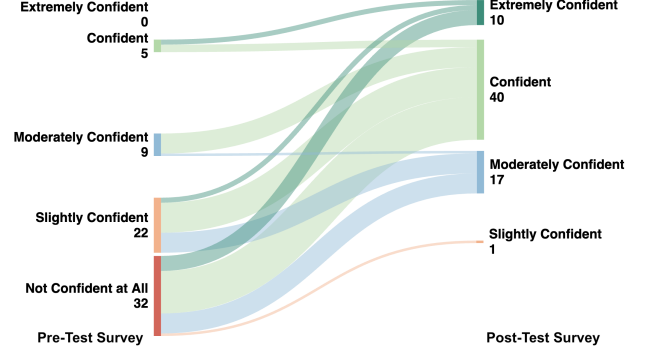
Student self-rated familiarity groups. Students who self-rated the context as either familiar or unfamiliar reported similar large effect sizes on the increases in confidence from pre-test to post-test. However, unlike the instructor-intended groups, a between-group comparison revealed a significant difference in post-test confidence ($p < 0.05$), with a moderate to large effect size ($r = 0.618$). Further analysis indicated that students who rated the context as familiar experienced greater increases in confidence by the end of the study. This trend is illustrated in the Sankey charts (Figure 3), where a notable proportion of students in the familiar group (Figure 3a) progressed to higher confidence levels, particularly to Confident and Extremely Confident. In contrast, while students

	Library Management (Familiar)	Research Paper (Unfamiliar)	Total
Unfamiliar by Students (1 to 3)	10	30	40
Familiar by Students(4 and 5)	21	34	55
No Familiarity Rating	2	4	6
Total	33	68	101

TABLE II: Student self-reported familiarity ratings for two instructor-defined contexts: Library Management (Familiar) and Research Paper (Unfamiliar)



(a) Student confidence change in the Library Management group.



(b) Student confidence change in the Research Paper group.

Fig. 2: Sankey charts illustrating changes in students' self-reported confidence from pre-test to post-test in the instructor-intended familiarity groups: (a) Library Management and (b) Research Paper.

in the unfamiliar group (Figure 3b) also improved, a larger group of students remained at the Moderately Confident level.

D. Influence of Context Familiarity and Initial Confidence on Learning Gains

Overall, the impact of context familiarity on student gain scores showed distinct patterns based on instructor-intended familiarity groups and student self-rated familiarity groups. Figure 4a visualizes the regression lines for each context condition. In the instructor-intended familiarity groups, the relationship between pre-test confidence and gain score remained relatively stable, particularly in the Library context (blue line), where gain scores were consistent regardless of students' initial confidence. In contrast, among the student self-rated familiarity groups, we observed a general negative relationship between pre-test confidence and performance change. This trend was especially pronounced in the Unfamiliar context (yellow line), where students with high initial confidence showed notably smaller gains or even declines in performance, compared to their lower-confidence peers.

Figure 4b illustrates the distribution of gain scores across confidence levels within each group. The variability in performance change was highest among students with low pre-test confidence (ratings of 1 to 3), particularly in the Research Paper (red) and Unfamiliar contexts (yellow). In contrast, for students with higher confidence levels (ratings of 4 and 5), gain scores tended to be lower and less variable. This pattern may be explained by the way gain scores were calculated, as the difference in accuracy between the pre-test and post-test. Students who were already confident may have performed well

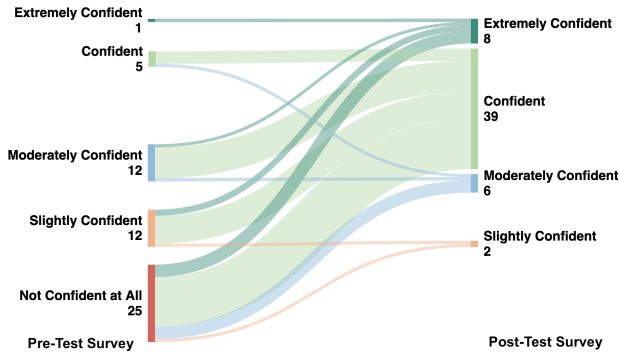
on both assessments, resulting in smaller gains simply due to a lack of room for improvement.

V. DISCUSSION

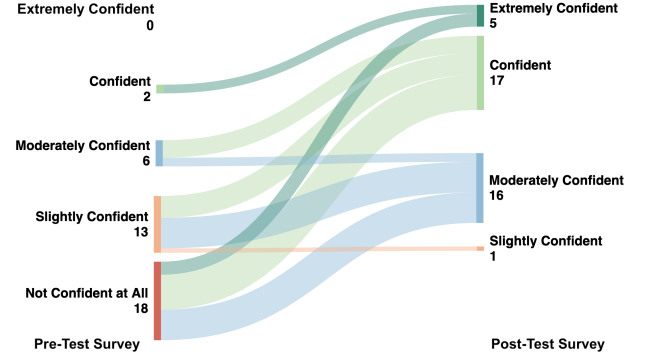
In this work, we implemented a quasi-experimental design within a 16-week introductory system and organizational security course to explore the alignment between instructor and student perceptions of context familiarity and to examine the impact of these perceptions on student learning outcomes in SQL (Structured Query Language) exercises. The results revealed that there is a clear misalignment between instructor-assumed familiarity and students' self-rated familiarity, with some students rating a designed "familiar" context as unfamiliar and vice versa. Moreover, regardless of context, students exhibited statistically significant improvement in both performance and confidence in SQL concepts. Additionally, the impact of context familiarity was moderated by initial confidence levels. Below we reflect on the results from the perspectives of each research question.

A. RQ1: Diverging Perceptions of Context Familiarity: Instructor vs. Student

Our findings indicate a notable misalignment between instructor-assigned context familiarity and students' self-perceived familiarity. While the Library Management scenario was intended to be more relatable, and the Research Paper context less so, students' ratings did not align with these assumptions. This highlights the subjectivity of familiarity. It is possible that instructors may misjudge what students find relatable due to expert blind spot [18] or lack of exposure to diverse student backgrounds [19]. To better align instructional

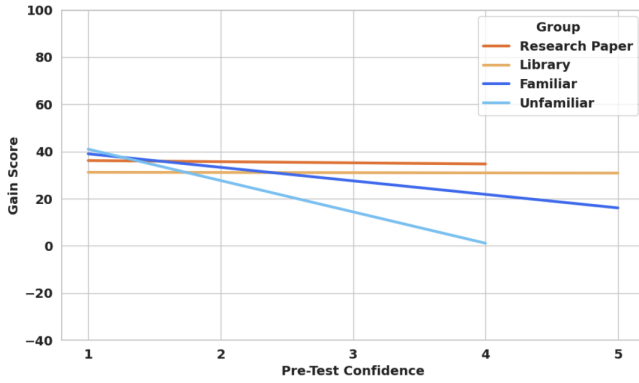


(a) Student confidence change in the self-rated familiar group.

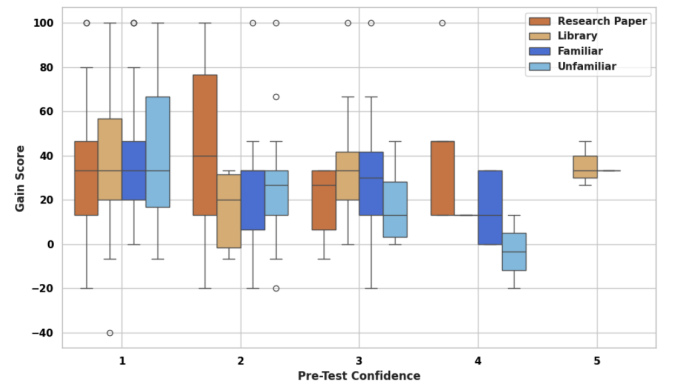


(b) Student confidence change in the self-rated unfamiliar group.

Fig. 3: Sankey charts illustrating changes in students' self-reported confidence from pre-test to post-test in the self-rated familiarity groups: (a) Familiar and (b) Unfamiliar.



(a) Regression lines showing the relationship between students' pre-test confidence and their gain scores across different groups.



(b) Distribution of gain scores across different levels of pre-test confidence across different groups, showing that no significant differences were found.

Fig. 4: Relationship between pre-test confidence and gain scores across different groups.

design with student needs, it may be beneficial to collect data on students' interests and backgrounds at the start of the course. This would allow instructors to better tailor practice materials or offer choices that account for students' varying life experiences.

Beyond this practical implication, the divergence in familiarity ratings also suggests that context design in education cannot rely on the presumed universality of certain contexts. Even contexts traditionally considered "everyday" or "common" may not resonate equally across a student cohort, especially in courses with larger enrollments. The finding that nearly half of the students rated the Research Paper context as familiar also points to emerging familiarity with research and publishing, perhaps through a combination of academic exposure, extracurricular activities, or personal interests.

B. RQ2: Context Familiarity and Learning Outcomes

Despite the divergence in familiarity perceptions, both familiar and unfamiliar contexts led to statistically significant improvements in students' SQL performance and confidence. This was true regardless of whether familiarity was defined by

instructors or self-reported by students. These results highlight that familiar and unfamiliar contexts can both be effective in supporting SQL learning. This flexibility is encouraging for educators, as it allows for a broader range of context choices when designing assessments and practice activities.

Notably, students who perceived the context as familiar reported higher post-test confidence. This suggests that, while unfamiliar contexts still facilitate learning, familiar contexts may enhance student confidence. This effect may be explained through the lens of Cognitive Load Theory [20], which posits that learners have limited working memory capacity. When students engage with familiar contexts, they experience a reduced extraneous cognitive load, which allows them to allocate more resources to germane cognitive load. This supports schema construction and skill acquisition. By minimizing the mental effort required to understand the context itself, familiar scenarios free up cognitive capacity for focusing on SQL syntax, query logic, and debugging.

These insights reinforce the pedagogical value of strategically mixing familiar and novel contexts throughout instruction. Introducing familiar contexts early can build student

confidence, lower entry barriers, and foster early engagement. As learners grow more proficient, gradually incorporating less familiar contexts can encourage the transfer of skills to diverse real-world scenarios.

C. RQ3: Initial Confidence and Gain Scores

Our analysis revealed that students who began with lower self-rated confidence in SQL demonstrated greater performance gains over the course of the study, regardless of the context assigned in their exercises. In contrast, students who entered the study with higher initial confidence showed smaller learning gains across both familiar and unfamiliar contexts. This may be because these students were already proficient in SQL topics, resulting in limited measurable improvement.

These results underscore the importance of designing instructional materials that are responsive to both students' initial confidence and perceived context familiarity. Rather than applying the same materials uniformly, educators might consider offering differentiated levels of complexity or providing contextual choice. This adaptive approach could better support learning for both novice and advanced students.

D. Limitations and Future Work

We acknowledge several limitations in our study. The intervention was conducted within a single course. Future studies should replicate this work across multiple institutions and disciplines to enhance generalizability. Context familiarity was assessed solely based on self-reported measures from students. Incorporating objective measures in future studies could offer a more accurate understanding of students' prior knowledge and contextual exposure. The pre/post design and take-home assignment format could have introduced variables such as external assistance. Future inquiry might benefit from conducting the study in more controlled settings. The unequal group sample sizes due to incomplete submissions may have affected statistical power. Furthermore, since the analysis focused on short-term learning gains, future work could explore long-term retention, knowledge transfer, and the impact of context familiarity in more complex or collaborative learning settings. Future research should continue to explore these dynamics across different domains, with an emphasis on longitudinal effects and scalable pedagogical models that adapt to students' evolving needs.

VI. CONCLUSION

The primary contribution of this work is the identification of a crucial misalignment between instructor-defined and student-perceived context familiarity and its implications for instructional design. The observed divergence between instructor assumptions and student perceptions of familiarity highlights the need for more learner-centered approaches in instructional design. The findings offer insights into how perceived familiarity influences student confidence and learning outcomes, emphasizing the importance of aligning instructional contexts with students' actual experiences and perceptions. While both familiar and unfamiliar contexts can support

student learning, our results show that familiar contexts better support student confidence. Furthermore, the interaction between context familiarity and initial confidence levels offers valuable insights for tailoring instructional strategies to support diverse learners.

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