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IMPLEMENTING TEAM-BASED LEARNING: FINDINGS FROM A DATABASE CLASS

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ABSTRACT

Aim/Purpose	The complexity of today's organizational databases highlights the importance of hard technical skills as well as soft skills including teamwork, communication, and problem-solving. Therefore, when teaching students about databases it follows that using a team approach would be useful.
Background	Team-based learning (TBL) has been developed and tested as an instructional strategy that leverages learning in small groups in order to achieve increased overall effectiveness. This research studies the impact of utilizing team-based learning strategies in an undergraduate Database Management course in order to determine if the methodology is effective for student learning related to database technology concepts in addition to student preparation for working in database teams.
Methodology	In this study, a team-based learning strategy is implemented in an undergraduate Database Management course over the course of two semesters. Students were assessed both individually and in teams in order to see if students were able to effectively learn and apply course concepts on their own and in collaboration with their team. Quantitative and qualitative data was collected and analyzed in order to determine if the team approach improved learning effectiveness and allowed for soft skills development. The results from this study are compared to previous semesters when team-based learning was not adopted. Additionally, student perceptions and feedback are captured.
Contribution	This research contributes to the literature on database education and team-based learning and presents a team-based learning process for faculty looking to adopt this methodology in their database courses. This research contributes by showing how the collaborative assessment aspect of team-based learning can provide a solution for the conceptual and collaborative needs of database education.

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Findings	Findings related to student learning and perceptions are presented illustrating that team-based learning can lead to improvements in performance and provides a solution for the conceptual and collaborative needs of database education. Specifically, the findings do show that team scores were significantly higher than individual scores when completing class assessments. Student perceptions of both their team members and the team-based learning process were overall positive with a notable difference related to the perception of team preparedness based on gender.
Recommendations for Practitioners	Educational implications highlight the challenges of team-based learning for assessment (e.g., gender differences in perceptions of team preparedness), as well as the benefits (e.g., development of soft skills including teamwork and communication).
Recommendations for Researchers	This study provides research implications supporting the study of team assessment techniques for learning and engagement in the context of database education.
Impact on Society	Faculty looking to develop student skills in relation to database concepts and application as well as in relation to teamwork and communication may find value in this approach, ultimately benefiting students, employers, and society.
Future Research	Future research may examine the methodology from this study in different contexts as well as explore different strategies for group assignments, room layout, and the impact of an online environment.
Keywords	team-based learning, collaborative learning, database technology, database management, information technology education

INTRODUCTION

Organizational databases are seldom designed and used by individuals. In fact, database design and management can be said to benefit from the idea that two heads are better than one as the problems posed by databases are not the types of problems that have clear solutions (Pretz et al., 2003). Furthermore, the challenging topics and concepts taught in a database course are often perceived by students as difficult, which can lead to a lack of student interest and enthusiasm for the class (Govender, 2021; Huang & Leng, 2019; Senapathi, 2004).

At the same time, there have been calls in the information technology (IT) education literature for the development of “soft-skills” as a part of the educational experience so that students can effectively and successfully work in professional teams upon graduation (Beard et al., 2008; Figl, 2010; Osmani et al., 2016; Ragonis et al., 2020). In fact, research has suggested technical skills alone are insufficient and IT students need to work to develop a broad set of soft interpersonal skills including teamwork and communication as the most desired skills for development and growth (Osmani et al., 2016). Therefore, when teaching students about complex organizational databases as a part of their IT education, it seems that using a team approach would be beneficial for developing student mastery of challenging database concepts as well as the interpersonal skills required by the discipline (Nance, 2000; Taipalus & Seppänen, 2020).

Team-based learning (TBL) has developed as an instructional strategy that leverages learning in small groups in order to achieve increased overall effectiveness (Michaelsen et al., 2002). Particularly, a key aspect of the team-based learning methodology is the group assessment where teams work together to collaborate and solve assessment questions. Team-based learning has been used in a number of different disciplines, from organizational psychology (Haberyan, 2007) to programming (Elnagar &

Ali, 2012) to nursing (Alberti et al., 2021). Research has suggested that team-based learning provides student with valuable team experiences and can prepare them with a stronger foundation for their future workplaces (Choi et al., 2021; Gomez et al., 2009). Therefore, this research attempts to explore if the team-based learning methodology can be used for the teaching and learning of organizational database technology concepts and skills.

The goal of this work is to study the impact of utilizing team-based learning strategies in an undergraduate Database Management course in order to determine if the methodology is effective for student learning related to database technology concepts as well as student preparation for working in database teams. Specifically, this research asks:

RQ1: Does the use of team-based learning show an improvement in student assessment and the mastery of database technology concepts?

RQ2: Do students perceive team-based learning to be an effective experience for learning how to collaborate and work with team members?

This research includes four key objectives. First, we set out to understand the field of database technology and the related educational practices. Second, we explore the pedagogy of collaborative learning including the instructional strategy of team-based learning, focusing specifically on the team-based assessment phase of the process as an assessment method for improving student learning. Third, we seek to demonstrate the feasibility of using a team-based assessment for the topic of database management. Fourth, we address our research questions to analyze whether or not team assessments are effective in relation to student learning performance as well as whether or not team assessments are effective from the student perspective in relation to learning how to collaborate and work in teams.

This paper is organized as follows: The next section presents the background for this research related to database technology education and collaborative and team-based learning. The following section presents the research methodology, followed by the results and findings of this work. This research concludes with a discussion and conclusion highlighting implications for both educators and researchers interested in using team-based learning for database management education as well as limitations and future research opportunities.

BACKGROUND

The background for this research begins with a review of database technology education followed by a focus on collaborative learning pedagogy including the practice of team-based learning.

DATABASE TECHNOLOGY EDUCATION

Database technologies have received vast attention since the 1960s and remain one of the fastest growing fields in IT (Huang & Leng, 2019; Mason, 2018). Database management is seen as a foundational element of any IT program (Leidig & Salmela, 2021; Topi et al., 2010) and increasingly included in general business programs as the inclusion of data management and data analytics skills are recommended in the 2018 Association to Advance Collegiate Schools of Business (AACSB) guidelines (AACSB International, 2018; Larson et al., 2021). The teaching of database management often covers important topics such as structured query language (SQL), database modeling and normalization, data administration, security, business intelligence, and big data topics such as NoSQL. Student understanding of database analysis, design, and implementation needs to take into account many factors including organizational requirements and security, historical and future data perspectives, ownership and diversity of user community, among others (Hoxmeier & Monarchi, 1996). The process is often a moving target or cyclical process including philosophies of continuous quality improvement

such as Total Quality Management (TQM) and Business Process Redesign (BPR). Overall, the primary goal of database management education is to teach students to use an application to gather information and solve business problems (Chen, 2010).

As noted above, the topics and concepts taught in a database course are often perceived by students as difficult, which can lead to a lack of student interest and enthusiasm for the class (Govender, 2021; Huang & Leng, 2019; Senapathi, 2004). Hands-on learning has been found to be the preferred method for students learning database management, as it allows for developed interest in the subject, peer communication, and the inspiration to study related topics after student graduation (Ramakrishna, 2000). However, according to a systematic review of SQL and database education, it was recommended that students should learn SQL in teams and focus on how to read SQL before applying it hands-on (Taipalus & Seppänen, 2020). Furthermore, research has argued students of database technologies not only need to understand database concepts and book knowledge, but they need to combine this knowledge with an understanding of how to think through database theory and processes in relation to database implementation and improvement (Huang & Leng, 2019). One approach to accomplish this understanding is through breaking down concepts of database management into appropriate and achievable steps through the use of regular, topic focused quizzes. Combining a conceptual and theoretical foundation with hands-on application work would be an optimal approach for the development of database technology knowledge and skills. Therefore, based on what we know about teaching and learning related to database management, this topic area offers a suitable context for the adoption of a collaborative learning process which would include student preparation and assessment followed by application.

COLLABORATIVE AND TEAM-BASED LEARNING

Collaboration has been identified as a critical skill for students (Bruns, 2007) and a crucial activity in the classroom (Szewkis et al., 2011). Indeed, the use of peer learning groups (in or out of the classroom) in higher education has been shown to increase student success and aid in the development of both personal and social skills (Arendale, 2014). One approach for including the development of team skills in the classroom is related to the instructional pedagogy of collaborative learning. Prior research has suggested that collaborative learning offers an improvement over traditional teaching methodologies as it promotes student engagement and learning as well as supports the development of teamwork skills and communication (Cabrera et al., 2017). Collaborative learning has been defined as “a learning process that emphasizes group or cooperative efforts among faculty and students” (Hiltz, 1997, p. 3). This approach emphasizes learning through interacting while suggesting that different people with different backgrounds can work together to address challenges and solve problems (Kirschner & Van Bruggen, 2004; Shen et al., 2006). In fact, the diverse backgrounds of collaborative learners allows for rich problem analysis and rich solutions (Kirschner & Van Bruggen, 2004). Conditions for collaborative learning in a course include a common goal, positive interdependence, coordination and communication, individual accountability, awareness, and joint rewards (Szewkis et al., 2011). Results in education have found greater student involvement, learner engagement, level of understanding, problem solving, and critical thinking (Alavi, 1994; Cabrera et al., 2017; Leidner & Fuller, 1997; Shen et al., 2006; Sloffer et al., 1999). Furthermore, the National Survey of Student Engagement (NSSE) indicates that one of the most important benchmarks for encouraging student engagement is “active and collaborative learning” which is identified as a precursor for the growth and development of critical thinking, moral reasoning, intercultural effectiveness, and well-being of students (Pascarella et al., 2010). In regard to database education, group-based learning has even been found to positively impact academic performance for students who are less technical or who have struggled in programming courses (Van Der Vyver & Lane, 2003).

Team-based learning is an instructional strategy that leverages collaborative learning in small groups in order to achieve increased overall effectiveness (Michaelsen et al., 2002). Research related to small group learning has suggested small groups can be used to produce higher student achievement and

more positive relationships among students than other types of competitive or individual assessments (Johnson et al., 1991). Research has also suggested that team-based learning provides students with valuable team experiences and can prepare them with a stronger foundation for their future workplaces (Choi et al., 2021; Gomez et al., 2009).

Key factors of team-based learning consists of both 1) individual accountability and 2) motivation related to the learning of others (Gomez & Bieber, 2005; Kluge et al., 1999). Essential elements include 1) properly formed and managed groups, 2) student accountability for quality of both individual and group work, 3) frequent and timely feedback, and 4) assignment design which ensures both learning and team development (Michaelsen & Sweet, 2008).

Team-based learning is a multicomponent methodology (Swanson et al., 2019) bundling three key phases (Michaelsen et al., 2002). The first phase is student preparation, with students having time for individual study of key concepts and knowledge. The second phase is focused on a student readiness assessment process (RAP), in which students complete individual testing (iRAP) as well as team testing (tRAP) and a written appeal if necessary. Key aspects of the readiness assessment process include the individual accountability necessary for the individual assessment and the immediate feedback which takes place during the team assessment (McCord et al., 2015; Silva et al., 2021). The second phase also includes mini lectures to further explain any problem areas identified in the testing results. The final phase of team-based learning includes in-class activities and assignments, which are used to apply course concepts. Figure 1 summarizes the three key phases of team-based learning, highlighting the second phase, including the assessment process, which is of particular interest in this study.

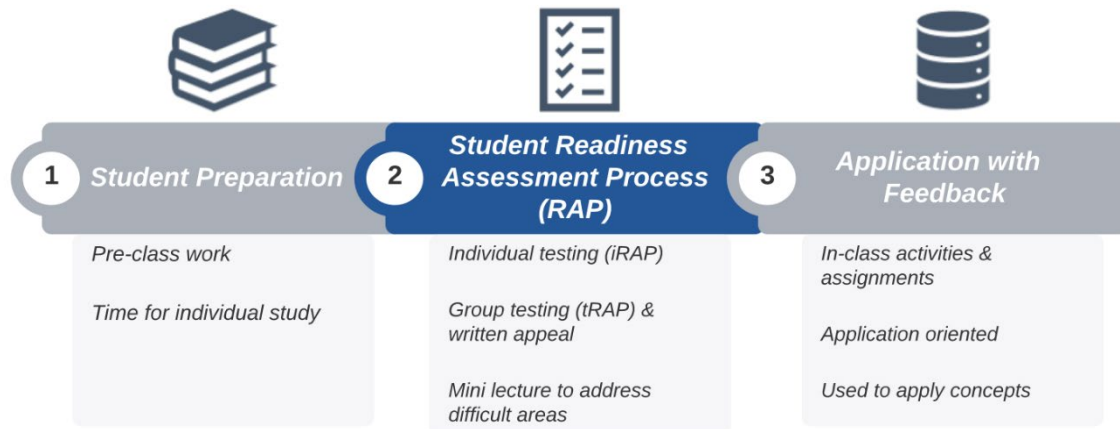


Figure 1: Overview of the team-based learning phases

The instructional strategy of team-based learning, including student preparation, the student readiness assessment process, and concept application with feedback, has been successful in a number of different disciplines (e.g., business, communications, health, management, and sciences) (Choi et al., 2021; Elnagar & Ali, 2012; Haberyan, 2007; River et al., 2016; Thomas, 2012). The use of team-based learning offers many benefits to students as solving problems with peers can lead to the development of expertise and higher level thinking skills (Silva et al., 2021). One study of team-based learning, in an introduction to programming course, found that the adoption of this methodology decreased course drop rates (Lasserre & Szostak, 2011). Furthermore, a meta-analysis of team-based learning found team-based learning to be a “potentially powerful teaching method” (Sisk, 2011, p. 668).

Interestingly, previous studies of team-based learning have adopted modified versions of the methodology, e.g., where lectures are still used in the face-to-face class time (Elnagar & Ali, 2012) or a blended approach utilizing only phase one of team-based learning (Reinig et al., 2011; River et al., 2016). Similar to this previous research, our study primarily focuses on the assessment of team-based learning (i.e., phase 2) as we attempt to adopt the team assessment process in order to understand if

team-based learning can work for the learning of database technology concepts and skills. Notably, assessment through examination is long recognized as the standard way to measure a student's mastery of course concepts as well as an important part of education (Lowell, 1926). However, research has highlighted a challenge for educators to find "objective and creative ways to test students' knowledge that will add to learning rather than seeming like an unpleasant interruption," emphasizing this idea is particularly challenging in courses that rely on collaborative or team-based learning pedagogies (Wu et al., 2008, p. 321). Adopting team-based learning, particularly in relation to student assessment, offers a potential way to aid in the process of student learning.

Previous research has suggested student perceptions of team-based learning are missing from much of the research and that this is an area where more contributions could be made (Jassawalla et al., 2009; Reinig et al., 2011). Therefore, we do make a specific attempt to uncover student perceptions in our work as we explore the use of team-based learning and team assessments in the information systems context of database management by the way of quantitative and qualitative responses.

METHODOLOGY

This research study applies the process of team-based learning in order to teach database management to students. Our aim was to address calls of previous research to explore the use of team approaches for the teaching and learning of database management concepts and skills (Nance, 2000; Taipalus & Seppänen, 2020) as well as to explore student perceptions of team-based learning that is missing from the research (Jassawalla et al., 2009; Reinig et al., 2011). A team-based learning process was designed and piloted over the course of two semesters to determine whether team assessments could be effective in improving student learning performance, while also examining student perceptions of effectiveness and collaboration skills development. The following sections outline the research setting for this study as well as the learning process design and data collection.

RESEARCH SETTING

For this study, team-based learning was introduced in the Spring 2019 and Fall 2019 semesters of an undergraduate course on Database Management. The spring section included 35 students (12 males, 23 females; 1 freshman, 3 sophomores, 18 juniors, 13 seniors) and the fall section included 29 students (17 males, 12 females; 1 freshman, 6 sophomores, 8 juniors, 14 seniors). Table 1 presents a full summary of the student demographics.

Per team-based learning guidelines, the course for this study was divided into modules. The eight modules for this course included: 1) Foundations of Database Management, 2) Structured Query Language, 3) Database Normalization, 4) Data Models, 5) Database Designs, 6) SQL for Database Construction, 7) Database Management, and 8) Big Data and Business Intelligence. Table 2 summarizes each module in more detail. The three phases of team-based learning, including student preparation, student readiness assessment, and application with feedback (see Figure 1), were used for each course module with a focus on the second of the three key phases of team-based learning, i.e., the assessment process. Specifically, this research explores team readiness assessment process (including individual testing, group testing, written appeal, and mini lectures to address difficult topics) portion of the team-based learning methodology.

It should be noted that while team-based learning was used as an important pedagogical methodology in this course for assessing database concept mastery, team-based learning was not the only assessment tool used. Hands-on individual and group assignments, as well as discussions and participation, were included as a part of the overall course assessment and grading. This course structure is consistent with the three key phases of team-based learning (Michaelsen et al., 2002). Additionally, this course structure addresses recommendations from previous work suggesting students learn SQL in teams with a focus on conceptual understanding prior to advanced skills application (Taipalus & Seppänen, 2020).

Table 1: Demographic variables

Variable	Spring	Fall	Total
n	35	29	64
Gender	M (34.3%) F (65.7%)	M (58.6%) F (41.4%)	M (45.3%) F (54.7%)
Year	Freshman (2.9%) Sophomores (8.6%) Juniors (51.4%) Seniors (37.1%)	Freshman (3.4%) Sophomores (20.7%) Juniors (27.6%) Seniors (48.3%)	Freshman (3.1%) Sophomores (14.1%) Juniors (40.6%) Seniors (42.2%)
Major	Accounting (8.6%) Computer Science (34.3%) Data Analytics (11.4%) Finance (5.7%) Information Systems (2.9%) Management (2.9%) Marketing (28.6%) Other (5.7%)	Accounting (6.9%) Computer Science (24.1%) Data Analytics (24.1%) Finance (3.4%) Information Systems (24.1%) Management (6.9%) Marketing (3.4%) Other (6.9%)	Accounting (7.8%) Computer Science (29.7%) Data Analytics (17.2%) Finance (4.7%) Information Systems (12.5%) Management (4.7%) Marketing (17.2%) Other (6.3%)
No. of Teams	10	9	19

Table 2: Course structure and topics

Module	Topic	Key Concepts for Assessment and Application
1	Foundations of Database Management	Database importance, use, and characteristics; database management systems and enterprise options; structured query language (SQL); keys; relational model; NoSQL
2	Structured Query Language	Categories of SQL; query structure, keywords, and operators; functions and calculations; groups, subqueries, and joins
3	Database Normalization	Relational model terminology; database integrity; functional dependencies; anomalies; normal forms and normalization process; updatable versus read-only databases; database design problems
4	Data Models	Entities and relationships for data models; minimum and maximum cardinality; crow's foot notation; process of creating data models
5	Database Designs	Database design; candidate, primary, and foreign keys for relationships; data types; database constraints; association tables; cascade update and delete; triggers; creating database designs
6	SQL for Database Construction	SQL components; data definition language; data manipulation language; views; variables, cursors, and SQL/PSM; functions, triggers, and stored procedures
7	Database Management	Database redesign process and techniques; database administration; database dependencies and structure; database security and control; database recovery; database management
8	Big Data and Business Intelligence	Big data; business intelligence tools; data visualization; database partitioning and replication; CAP theorem; NoSQL

TEAM-BASED LEARNING PROCESS DESIGN

On the first day of class, students were informed of the reasons for adopting a team-based learning approach (e.g., team teaching and learning) and the expectations during this process (e.g., individual preparation, team commitment, and collaboration). Providing this important background is based on prior research of team-based learning (Thomas, 2012).

In both semesters and course sections (Spring and Fall), teams of three to four students were formed by counting off. The intent of this approach was to achieve random team demographics (e.g., gender, year, and major), to ensure students were not forming teams with their friends (i.e., classroom seat neighbors), while also allowing for students to be partnered with others they might not know or might not have worked with before (Choi et al., 2021).

As mentioned above, each of the course modules followed the team-based learning methodology, specifically in relation to the second phase focused on the student readiness assessment process, including individual testing as well as group testing. In accordance with the second phase of team-based learning (Michaelsen et al., 2002), each of the modules in this course included an individual assessment with ten questions and an identical team assessment. The quiz questions included a variety of assessment questions with varying difficulty based on Bloom's taxonomy (Anderson et al., 2001; Bloom et al., 1956). For example, some of the questions would ask students to "remember" or "understand" database concepts while other questions would ask students to "apply" or "analyze" a sequence of SQL code or an example of a database model. Figure 2 shows some example quiz questions.

Given the table: STAFF (StaffNo, Name, Phone, HireDate), which of the following SQL queries would find all staff members whose name begins with the letter "T"?

- a.

```
SELECT *
FROM STAFF
WHERE Name IN ['T'];
```
- b.

```
SELECT StaffNo
FROM STAFF
WHERE Name LIKE 'T';
```
- c.

```
SELECT *
FROM Name
WHERE STAFF LIKE 'T*';
```
- d.

```
SELECT *
FROM STAFF
WHERE Name LIKE 'T%';
```

_____ is when a distributed database is broken into sections and those sections are stored on different servers.

- a. disbursing
- b. replication
- c. distributed two-phase locking
- d. partitioning

Figure 2: Example quiz questions

Following guidance from Michaelsen and Sweet (2008), students completed their individual assessment on their own and turned in their answers. The individual quizzes were not graded immediately, so students did not know if their answers were right or wrong. While students were not treated to

immediate feedback during this initial assessment, this step was nevertheless important for individual preparation and accountability prior to the formally assessed team collaboration.

Once all individual quizzes were completed and submitted, students immediately gathered with their assigned team members to work together and to answer the team assessment questions. During this team collaboration period, student teams read through each question-and-answer choices as a group and worked together to compare and contrast their individual quiz answers in order to work towards agreement on team answers. As previously mentioned, the two assessments were identical. However, unlike the individual assessment, team assessments were in scratch-off form to provide real time feedback, a critical aspect of team-based learning which highlights the importance of the team discussion and negotiation process as student teams would know right away if they had chosen the correct answer or not. The use of these scratch-off forms has previously been studied as a way to adapt classroom assessment emphasizing instant feedback and intrinsic motivation, as scratch-off forms are comparable to lottery scratch-off cards in regards to the immediate feedback or instant gratification from a successful answer (Leung & Pluskwik, 2018; Shipherd & Burt, 2018). Figure 3 shows an image of the scratch-off forms used for this study, which can be customized according to an answer key, quiz length, and the number of answer choices. With these forms, the correct answer notification (i.e., a star mark) is always in a different location within a square so the entire square needs to be scratched off in order to determine if an answer is correct or not.

IMMEDIATE FEEDBACK ASSESSMENT TECHNIQUE (IF AT®)					
Name _____			Test # <u>3</u>		
Subject _____			Total <u>41</u>		
SCRATCH OFF COVERING TO EXPOSE ANSWER					
	A	B	C	D	Score
1.	☆				5
2.				☆	2
3.	☆				5
4.			☆		2
5.	☆				5
6.				☆	5
7.				☆	2
8.			☆		5
9.	☆				5
10.		☆			5

Figure 3: Immediate feedback form from Epstein Education
(Epstein Educational Enterprises, 2022)

With the scratch-off forms, student teams were able to earn a full five out of five points for a question if they answered correctly on the first try; two points for the second try; one point for a correct answer on the third attempt; and zero points if teams had to reveal every option to find the correct answer. This process accommodates the immediate feedback benefit of team-based learning by allowing students to identify and internalize the correct answers instantaneously as opposed to moving on from a test without a clear understanding of the correct answers.

Once teams were done with their quizzes, they calculated their team scores and submitted their cards for instructor review and grade capturing. Team assessments were reviewed in class, directly following submission, and mini lectures were used to address any questions that were missed during the team assessment. Student teams could also submit written appeals via email for questions and answers they disagreed with. A couple of teams did take advantage of this appeal process. Both of these steps are consistent with the second phase of team-based learning (Michaelsen et al., 2002).

Each assessment type (individual and team) made up 10% of a student's total course grade, for a total of 20%. If a student was absent during an assessment, they would receive a 0 for both individual and team assessments. In order to offer flexibility and accommodate student absences, the students were allowed to drop the lowest score for both their individual and team assessments. With eight modules in the course, this means each student would ultimately be graded on seven individual quiz scores and seven team quiz scores as a part of their final course grade. For the purpose of this study, any student with a 0 for a missing score was omitted from our analysis so as to not skew the results.

DATA COLLECTION

As mentioned above, students were informed of the reasons for adopting a team-based learning approach (e.g., team teaching and learning) and the expectations during this process (e.g., individual preparation, team commitment, and collaboration) on the first day of class. Providing this necessary background is based on prior research implementations of team-based learning (Thomas, 2012).

At the end of each semester, peer assessment feedback was gathered through a survey. Students answered Likert scale questions based on previous research (Michaelsen & Sweet, 2011) regarding team member contributions:

1. My team members were prepared for the module quizzes when they came to class.
2. My team members contributed to the discussion of our quiz answers.
3. My team members listened when disagreements occurred.

Students were also asked questions from previous research (Gomez & Bieber, 2005) regarding team learning:

4. I learned a great deal from my team.
5. Team-based learning improved my ability to integrate concepts from different parts of the semester's materials.

Finally, in order to gather exploratory data about student perceptions, students were asked open-ended questions about the positive and negative aspects of their team-based learning experience, as well as their overall opinion. Specifically, these questions asked:

6. What were the positive aspects of the team-based learning quizzes? What went well?
7. What were the negative aspects from the team-based learning quizzes? Were there challenges?
8. Overall, what is your opinion of the team-based learning quizzes in this course? Did you benefit from this format of quizzes? Or do you prefer to work individually?

The data captured from the final survey, along with student assessment performance scores, was used in the evaluation of the research findings.

RESULTS AND FINDINGS

This section presents the findings from this study exploring the use of team-based learning for teaching and learning database technology concepts and skills. The following subsections specifically present the research questions and findings related to student learning performance and perceptions.

STUDENT LEARNING PERFORMANCE

The first research question from this study asks: *Does the use of team-based learning show an improvement in student assessment and the mastery of database technology concepts?* One way to determine the success of team-based learning is to look at the scores of the individual and team assessments. In both course sections (Spring and Fall), the overall team assessment scores were higher than the average individual scores (see Figure 4). This increase in average scores suggests that team assessments are useful for students to make better choices when working together to solve problems.

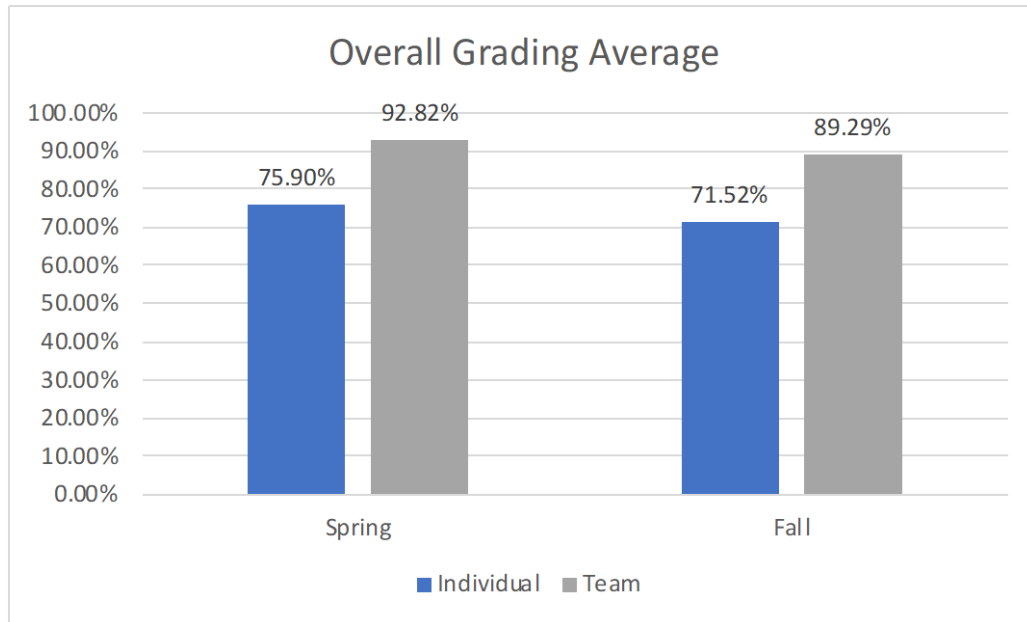


Figure 4: Overall individual and team grading averages compared across course sections

Table 3 further examines the difference between individual and team performance for each of the module assessments using paired t-tests illustrating that for all the module quizzes, team scores were significantly higher than individual scores (with results holding at the .01 significance level or higher).

Table 3: Comparison of individual and team assessment performance

Module	Individual Average	Team Average	Change	t
1	80.0%	93.3%	+13.3%	9.822*
2	71.7%	92.0%	+20.3%	10.201*
3	80.6%	94.3%	+13.7%	7.378*
4	68.3%	89.9%	+21.7%	12.051*
5	80.2%	97.1%	+16.9%	8.507*
6	83.1%	96.0%	+12.8%	8.026*
7	71.4%	91.3%	+19.9%	8.816*
8	72.3%	90.5%	+18.2%	9.010*

Note: * p <.01

It could be argued that team assessments allow for one student in the group to know all the answers and, therefore, allow everyone in the group to get a better grade. However, this is not necessarily true due to the collaboration and negotiation process of team members. For example, there were some instances where a student would perform more poorly on a team assessment than they would on their individual assessment. This is certainly interesting and could suggest either 1) a student was not

confident enough in their original answer or 2) a student was outvoted and not able to persuade their team to follow their lead. However, the overall average scores did always favor the team assessment. Furthermore, it should be noted that the intent of the individual assessment, prior to the team assessment, was to emphasize the importance of individual preparedness prior to team collaboration so that social loafing would be less likely. This was further addressed by the equal weighting of both the individual and team assessments in the overall course grading.

The team-based learning module approach used in this study replaced the previous assessment method used in prior semesters of this course where students were assessed via three individual exams over the course of the semester. Therefore, to further examine the impact of the team-based learning approach and whether the treatment of the modules did lead to increased learning over times when these modules were not a part of the course, scores from the two sections of the class in a year when the modules were used were compared to the preceding year with the two sections of the class which alternatively used three exams and had no modules. With the three exams, $n_1 = 37$ with an average exam performance, $\bar{x}_1 = 83.117$. With the eight team-based learning modules, $n_2 = 72$ with an average module performance, $\bar{x}_2 = 88.316$. Our analysis of this data demonstrates there was a significant change under the new course structure with the team-based learning module assessments ($t = 2.7258$, $df = 54$, $p\text{-value} = 0.0086$) thus providing evidence of an increase in performance evaluating learning database concepts with the new module assessments over the previous exam format.

STUDENT LEARNING PERCEPTIONS

The second research question from this study asks: *Do students perceive team-based learning to be an effective experience for learning how to collaborate and work with team members?* To address this question, we wanted to explore student perceptions and engagement with the team-based learning assessment. One way to evaluate the team collaboration is to look at the student responses regarding team member contributions, team learning, and overall perceptions. With regard to team member contributions, survey results did reveal student perceptions of their team members to be prepared contributors and good listeners during the team member assessments. Similarly, students reported agreement when asked if they were able to learn from their team members and integrate course concepts. Table 4 shows the results across both course sections. For this study, the data was analyzed using SPSS Statistics 27. The Mann-Whitney U test was used to determine whether or not there were any significant differences between the scores by semester using a 0.10 level of significance. According to our analysis there were no significant differences between any of the questions by semester with p-values of 0.485, 0.537, 0.671, 1.0, and 0.518.

Table 4: Survey questions and results

Survey Question	Spring (n=35)	Fall (n=29)
My team members were prepared for the module quizzes when they came to class.	4.43	4.21
My team members contributed to the discussion of our quiz answers.	4.74	4.66
My team members listened when disagreements occurred.	4.77	4.69
I learned a great deal from my team.	4.40	4.41
Team-based learning improved my ability to integrate concepts from different parts of the semester's materials.	4.43	4.59

^a Note: (1=Strongly Disagree, 2=Disagree, 3=Neither Agree or Disagree, 4=Agree, 5=Strongly Agree)

Next, we looked at the differences among the Likert scale questions based on gender. When reviewing the differences in perceptions of team preparedness based on gender in question one, there were differences of opinion. Specifically, we did find a significant difference present with a $p\text{-value} = 0.060$ which is less than the 0.10 level of significance. In our study, the student ratings showed that females

were less likely to perceive their team members as prepared when they came to class than the males. (See Table 5.) This finding is particularly interesting, as prior research has suggested that team-based learning may be more effective for some students than others (Lasserre & Szostak, 2011) and that gender can play a role in student satisfaction and team perceptions in team-based collaborative learning projects (Fowler & Su, 2018).

Table 5: Survey questions and results comparison by gender

Survey Question	p-value	Mean Likert Scores Female, Male (n=35, n=29)	Mann-Whitney U Mean Ranks Female, Male (n=35, n=29)
My team members were prepared for the module quizzes when they came to class.	0.060	4.17, 4.52	28.84, 36.91
My team members contributed to the discussion of our quiz answers.	0.537	4.74, 4.66	33.67, 31.09
My team members listened when disagreements occurred.	0.501	4.69, 4.79	31.27, 33.98
I learned a great deal from my team.	0.583	4.37, 4.45	31.34, 33.90
Team-based learning improved my ability to integrate concepts from different parts of the semester's materials.	0.450	4.57, 4.41	33.86, 30.86

^a Note: (1=Strongly Disagree, 2=Disagree, 3=Neither Agree or Disagree, 4=Agree, 5=Strongly Agree)

The quantitative data from this study, related to student learning effectiveness and perception, is helpful in showing success with the team-based learning process. However, previous research has called for more exploration of student perceptions of team-based learning as an area where more contributions could be made (Jassawalla et al., 2009; Reinig et al., 2011). Therefore, along with the quantitative survey results, qualitative comments from this study were reviewed. The qualitative feedback from students was gathered through the open-ended questions outlined above. The data was reviewed and coded using Strauss and Corbin's (1998) open coding method looking for similarities, differences, patterns, and themes in the comments. The remainder of this section outlines some of these findings.

Similar to the quantitative data, the qualitative comments from this study suggested students were indeed able to learn through collaboration and discussion with their team members. In fact, a number of student comments cited the benefits of "discussing the questions after taking [the quiz] individually really helped me realize where my thought process went wrong" and emphasized the value in team discussion for strengthening concept comprehension. Student comments also acknowledge team preparation and trust. For example:

I liked hearing other people's thought processes on how they chose the right answer for a question that was tricky for all of us, it gave me some ideas as to how I could apply that logic for future quizzes. When people felt really confident about their answers, they were eager to share that, and we all had that trust that they knew it was right because they explained why.

Overall, students seemed to be respectful of their team members and able to navigate through any disagreements in a collegial manner. For example, one student stated:

We got along well and respected each other's inputs during quizzes. If there was uncertainty, we would work out the kinks and knots and discuss why options seemed right. We did very well overall, I would say.

Multiple comments suggested students appreciated seeing immediate feedback on the team assessments due to the real-time feedback of the team-based learning method, as well as having the opportunity to try out second and third attempts and learn from mistakes. This finding strongly supports the collaborative learning aspect of this study, suggesting that there was a recognized student benefit from using the scratch-off quiz tool. As one such student stated:

I think the team-based quizzes help to understand concepts. It allows us to try the quiz out by ourselves first and then answers we were unsure of can be thought through collectively and talked about to allow a better choice for an answer to help understand the concept and why.

Relatedly, there were even student comments about the quizzes being “fun.” For example, one student commented:

I also really liked the style of the team quiz, scratching to reveal the answer added fun to the mix!

According to the findings, students recognized the team quizzes were a useful tool for understanding database concepts in preparation for the hands-on work that followed each module assessment. For example, one student commented:

I like the team-based learning along with the format of the quizzes. They were very conceptual which is good because the homework is mainly application, so it is nice that my grade reflects both conceptual pieces and application of the content learned.

Finally, research has suggested team learning approaches could be beneficial when teaching students about databases (Taipalus & Seppänen, 2020). This finding seemed to be consistent in this study as teams were able to create learning connections and hold one another accountable. For example:

I prefer the team-based learning because it gives you a chance to collaborate with others. Also, I find it helpful because you can learn from your team members in a way that the professor may not reach you.

Table 6 highlights some specific student comments related to the positive aspects of the team-based learning approach used in this study.

Table 6: Positive student perceptions

	Student Comments (Excerpts)
1	“We were able to discuss the answers we disagreed on. This forced us to reason out our answers, which cemented those concepts in our minds.”
2	“Hearing other people's thought processes on how they chose the right answer for a question that was tricky for all of us, it gave me some ideas as to how I could apply that logic for future quizzes.”
3	“When one group member felt confident in an answer there was never any backlash or arguments on why it should be another answer. We trusted one another.”
4	“I was still motivated to prepare for the quizzes, but I also felt comfortable making mistakes and learning from them.”
5	“We usually did better on the team quiz than the individual.”
6	“Liked knowing the answers I got wrong right away.”
7	“I really liked being with new people and meeting a new group of people.”
8	“My team was really nice to each other and I never felt any anger or hostility when we picked the wrong answer.”

Of course, in addition to the positive comments, there were some challenges highlighted in the student feedback. One student mentioned moving forward with a wrong answer because a team member was passionate or convincing. For example:

Sometimes when we would discuss we would then go to the wrong answer because one person was really passionate about it or thought they knew it, but they didn't, that was frustrating but that happens in teamwork and the rest of us should have been more outspoken or confident in our answers.

This type of situation was even observed by the course faculty when overhearing team member discussions and witnessing a team member convince the rest of their team their answer was the way to go despite another team member knowing the correct answer (as seen on the other team member's individual assessment). One student expressed this very concern:

Although this did not happen often, it could be frustrating when I had the right answer on my individual quiz, but we did not put that answer on the team quiz because I was outvoted. Not a super frequent occurrence, but probably the biggest challenge was reaching a consensus on a question.

Of course, this situation is not entirely negative if the team members are able to learn, in the safety of a classroom environment, how to navigate these types of situations and team member traits.

In some cases, teams were challenged with finding consensus. In fact, with teams of four, the negotiation process could become complicated with split opinions and votes. For example:

I don't think too many challenges occurred, the most pressing thing that ever happened was that we were split between two answers so one group of 2 people had to let the others answer it before trying their answer.

Other negative aspects of the team-based learning adoption were related to social loafing, e.g., "If my team members were unprepared, missing a question had a larger impact on my grade. I spent time studying for each quiz and some of my team members did not, yet they still were able to benefit from my knowledge, I would have appreciated more contribution on their part" or absent team members, e.g., "I personally didn't experience this but know a few people who did, but some negatives could be group members not showing up to class or being prepared for the quizzes."

Table 7 includes specific student comments related to the downsides. Interestingly, there were 18 student comments along the lines of: "there were no negative aspects to the team-based learning quizzes." In fact, one student commented:

I didn't feel like there were any negative aspects to the team quizzes learning wise...the only negative thing I can say is I hate the metallic flecks that stick to my pencil, clothes, fingers, etc. after doing the scratchers (hahaha).

In relation to the overall experience, students were overwhelmingly positive about their ability to "learn." Student comments recognized the importance of the individual assessment with regard to establishing a solid foundation and holding everyone accountable for the team assessment. For example, one student commented:

I think the team-based quizzes perfectly complimented the individual quizzes. It reinforced what we had learned and corrected any errors in our knowledge.

Another suggested:

Overall, very positive and would recommend continuing them in the future. I enjoyed the aspect of trying it by yourself the first time then regroup with others to try it once again while also learning the quiz's correct answers.

Table 7: Negative student perceptions

	Student Comments (Excerpts)
1	“The risk of team-based quizzes is that most times, majority rules. And if the majority of team-members think a particular question is right, when it is wrong, then the team will more than likely plug in the wrong answer.”
2	“If none of us were sure of our answer, then we would have trouble deciding which answer to choose.”
3	“Often times, one or more individual would carry the team if others weren't prepared.”
4	“Logistically it makes more sense to have groups be where people are already seated as few people have changed seats throughout the semester, so we don't waste class time walking around.”
5	“For the past two quizzes, a group member was not present.”
6	“The scratch card method failed whenever I forgot to bring a quarter in with me.”

There were also comments about team structure being useful preparation for the workplace. Specifically, one student commented:

I preferred the group quizzes because it resembles more of the problems you face in the work force.

Table 8 includes some specific comments regarding the overall process.

Table 8: Overall student perceptions

	Student Comments (Excerpts)
1	“It solidifies the topics in your head after taking it twice.”
2	“I learned from my quiz mistakes instead of just turning them in and moving on.”
3	“I like the team-based learning quizzes as an addition to individual quizzes. It holds you accountable for the learning the material not just for yourself, but also for your team-mates.”
4	“I definitely like working with teams after because it clears up questions we have from when we took the quiz and then we can go over stuff we got wrong.”
5	“Helped me figure out why I was incorrect on the questions I and our team worked well together.”
6	“I really liked team-based learning quizzes because I felt like I learned more from my team.”
7	“I like to work alone and work as a team, so it was a good mix for me.”
8	“I loved it! I wish more of my professors used this quiz format.”

Overall, the findings from this study suggest that students were able to collaborate in teams and learn about database technology through the use of team-based learning. Not only did students learn about textbook material, but they were also able to learn about sharing their knowledge, collaboration, negotiation, and compromise, all of which are important workplace and team skills. Students were able to work in teams to share their knowledge and make team decisions about their next steps. Therefore, this research study does support the use of the team-based learning methodology for teaching students about database technology.

DISCUSSION

The results of this study address two key research questions: 1) Does the use of team-based learning show an improvement in student assessment and the mastery of database technology concepts? and 2) Do students perceive team-based learning to be an effective experience for learning how to collaborate and work with team members? To begin, the findings from this study do show that student

teams were able to increase their knowledge and database management concept understanding with higher team assessment scores than individual scores. This finding suggests that students were able to work together to perform better together than they performed individually. Most importantly, the real time feedback from the team assessment, in combination with the post-assessment mini lecture, ensured that students did not leave an assessment with the assumption that all of their answers were correct. In regard to the second research question, it is not often the case that educators receive feedback from students suggesting they enjoyed course assessments. However, the results from this study demonstrate that students enjoyed the team assessments process, and they perceived the experience to be useful for their learning in relation to team collaboration and negotiation processes.

IMPLICATIONS FOR EDUCATION

The implications from this study are important for educators in a couple of ways. First, the data analysis revealed an important difference related to team assessment perceptions by gender. Specifically, this research highlights a significant difference in the perceptions of female students compared to male students in relation to team preparedness. This is certainly an important lesson related to collaborative learning processes in the classroom. Indeed, prior research has highlighted findings that suggest there are differences in team-based learning perceptions by gender (Fowler & Su, 2018) and that a better understanding of how gender impacts the acceptance of team-based learning is necessary (Silva et al., 2021). This difference in our data is particularly important as gender inequality in the field of IT is well cited with regard to an underrepresentation of women in the field (Serenko & Turel, 2021). Notably, IT skills (based on formal or informal education) have been found to contribute to female students' intentions to major in IT, suggesting that technical education targeted towards women is critical and barriers to female skills development need to be limited (Serenko & Turel, 2021). This may suggest team composition with intentional diversity (i.e., gender) be particularly important for team-based learning in the classroom (Brickell et al., 1994; Figl, 2010).

A second practical implication from this work is related to the development of teamwork and communication skills in an IT course. The qualitative feedback from the student participants clearly emphasized value from team-based learning assessments as it can help with the development of valuable soft skills in a database management course. Relatedly, recent research has identified an increasing interest for the development of social competence and other “soft skills” for IT professionals so they can effectively and successfully work in professional teams upon graduation (Beard et al., 2008; Figl, 2010; Osmani et al., 2016; Ragonis et al., 2020). In fact, research has suggested technical skills alone are insufficient and students need to work to develop a broad set of soft interpersonal skills, including teamwork and communication, as the most desired skills as well as problem solving, working under pressure, conflict management, and negotiation (Osmani et al., 2016). Interestingly, the team assessment process from this work addresses the development of many of these soft skills needed. In fact, the qualitative feedback from the students outlined in this study suggest students were able to work with a team over the course of a semester and gain practice in communication and negotiation while solving problems under pressure. Interestingly, teams of four with split opinions and votes were especially able to develop their negotiation skills. Similar to previous research, this study does highlight the use of teams in this process does provide students with a team experience that can prepare them for their future workplaces (Gomez et al., 2009).

From the faculty point of view, implementing team-based learning in the classroom does change the role of the instructor to more of a facilitator and guide as student teams become more reliant on one another for teaching and learning of course concepts (Silva et al., 2021). Faculty who are interested in piloting a similar process in their classroom can find a wealth of books (e.g., Michaelsen et al., 2002), faculty training opportunities, or other resources (Epstein Educational Enterprises, 2022) to get started. Because team-based learning has been adopted in many disciplines (e.g., business, communications, health, management, and sciences) discipline specific examples are also available (Choi et al.,

2021; Elnagar & Ali, 2012; Haberyan, 2007; River et al., 2016; Thomas, 2012). From the faculty perspective, the actual development and grading of the individual and team quizzes was not much different in terms of class preparation workload than preparing any other type of student assessment. The mini lectures to follow up on difficult topics are also similar to more traditional faculty lectures, but the timing of these lectures is more helpful as they are directly following student application of concepts and can really be tailored to student misunderstandings. It should be noted that additional work is necessary to form the student teams, match up the quizzes to the scratch-off cards, and record the team scores. However, the reported student enjoyment in this case, which is quite different from general perceptions of assessment, makes any extra work worthwhile.

IMPLICATIONS FOR RESEARCH

The research findings presented in this work contribute to the literature on both database management education and team-based learning, specifically addressing calls for more studies of database concept education (Taipalus & Seppänen, 2020) as well as more studies in the areas of team-based training (Kwak et al., 2019) and soft skills development (Beard et al., 2008; Figl, 2010; Osmani et al., 2016). This study provides an attempt to explore team-based learning in the context of database management teaching and learning. Furthermore, this research not only captured student assessment performance data, but also captured student perceptions of this process, an area identified as missing from the research (Jassawalla et al., 2009; Reinig et al., 2011). Understanding the student viewpoints regarding this process is not only helpful for future implementations of this team-based learning process, but also guides areas for future studies. For example, future research may specifically test gender differences in the team-based learning assessment process (e.g., based on team composition and diversity) or the development of soft skills in students (e.g., perhaps through a discourse or sentiment analysis of the team communication and negotiation process). Studies comparing team-based learning and other teamwork approaches in comparison with classes that do not use the same techniques would also be worthwhile.

CONCLUSION

The primary goal of this study was to explore the instructional techniques of team-based learning in relation to teaching database management concepts to determine if using a team assessment process would be useful for teaching the concepts and skills for database technology professionals. Based on data of student learning performance and student learning perceptions, it does seem that there is value in using team-based learning for the teaching and learning of database concepts.

The contributions of the paper are several. First, the overview of research on database education and team-based learning, along with our research findings, shows how the collaborative assessment aspect of team-based learning can provide a solution for the conceptual and collaborative needs of database education. Specifically, our findings did show success with student learning performance and perceptions as the students both learned both database concepts and skills (including collaboration and negotiation) and enjoyed the assessment process overall. The insight into student perspectives in this study (both quantitative and qualitative) is an important contribution. Second, a team-based learning process is outlined for faculty looking to adopt this methodology in their own database technology courses. Third, this research identifies implications for educators highlighting the challenges of team-based learning for assessment (e.g., gender differences in perceptions of team preparedness), as well as the benefits (e.g., development of soft skills including teamwork and communication) and insights from the faculty perspective. Finally, this research provides implications for research with additional support of the study of team assessment techniques for learning and engagement in the context of information systems education.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This research is not without limitations. Specifically, this study did not compare large student classes or students from very diverse disciplines or different universities. Furthermore, the application of team-based learning in this study was only in the context of a database technology course. Nevertheless, the findings from this work advance the understanding of team-based assessment as well as highlights several considerations for future work. For example, future research might explore optimal team assignment. In this study, random team assignment was used, but would teams be more successful with previously established relationships? Or should teams be assigned with more intentional diversity (e.g., males and females, extroverts and introverts, majors and knowledge areas, cultural, etc.) as has been done in other studies (Brickell et al., 1994; Figl, 2010)? Future research might also explore the differences between formal classroom teams compared to more informal study groups outside of class. For example, a peer assisted learning model (Arendale, 2014) might be another way to benefit from student teams for both learning classroom concepts as well as teamwork and other soft skills.

The impact of classroom layout on team-based learning is another area of interest. For example, in this study, there was a student who commented: “Logistically it makes more sense to have groups be where people are already seated as few people have changed seats throughout the semester, so we don’t waste class time walking around.” While prior research has explored an approach for team-based learning in a fixed classroom (German, 2013), future research might need to address the room layout and classroom space arrangement for the use of team-based learning in the classroom. For example, do team assessments work better if teams are sitting together throughout the course with round, movable tables? Or can taking a moment to move around in the classroom, and including transition time during class, be perceived as a welcome break and motivator in the classroom?

Finally, there has been some research of team-based learning in an online environment (e.g., Choi et al., 2021; Goh et al., 2020; Gomez et al., 2009; Gomez & Bieber, 2005; Parrish et al., 2021; Silva et al., 2021). This exploration would be particularly interesting in relation to online education and the use of team-based learning for assessment. However, more investigation in this area is necessary to see how the team assessment process might work while accounting for dispersed students working through the use of collaboration technologies and learning management systems.

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Team-Based Learning for Database Education

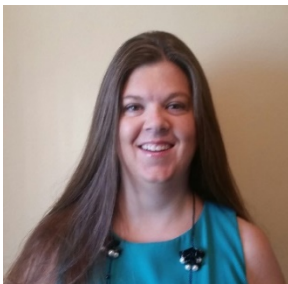
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