Assessing SQL Programming Language Learning Effectiveness with Peer Assessment Annotation Tool

Shin-Hung Pan*
Department of Information Management
Chaoyang University of Technology
Taichung, Taiwan
vincentpan2005@gmail.com

Bing-Sian Yang
Department of M-Commerce and Multimedia Applications
Asia University
Taichung, Taiwan
roy00374@gmail.com

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***Abstract*—In recent years, programming skills such as programming and program traceability have become increasingly important due to the need to develop and maintain many Artificial Intelligence (AI) and Internet and Things (IoT) applications. As a result, many studies have used the traceability of program segments to assess the ability of learners to write, test, and debug programs. Several assessment methods have required testing questions such as selection or filler. However, it is still challenging to identify the root cause of these errors by assessing these questions.**

Structured Query Language (SQL) is a standard computer language used for relational database management and data manipulation; though particularly useful for querying, adding, modifying, and deleting records in databases, it is a fundamental skill and an essential course for students in the information field to learn how to use databases. Therefore, this study proposes using an annotation tool for peer assessment of SQL language learning and analyzing the correlation between this method and learning outcomes to verify that the method helps assess students' SQL language writing and error detection abilities. The results of the study showed that the average score of students who used the annotation tool to learn SQL language was 17.38 points higher than that of students who did not use the annotation tool, thus proving that the annotation tool can improve learning outcomes.

Keywords—Structure Query Language, annotation tool, Moodle, learning outcomes

I. INTRODUCTION

In computer science education, writing and tracing programs is a fundamental skill for novice programmers. Moreover, due to the high cost of system maintenance and testing in modern software development companies, assessing program tracking ability has become increasingly important in recent years. Therefore, many studies have used program tracking assessment of program fragments to assess the test ability of learners [1] and their understanding of programming [2] [3].

So far, many methods of program tracking assessment using learning tools [4-9], game-based learning [6], gamification [7], and the use of multiple-choice questions have been proposed. However, it is still challenging to find out the extent to which learners are tracking the programs through these methods. Therefore, identifying learners' misconceptions about programs from their tracking process is an exciting and challenging problem.

Structured Query Language (SQL), a language commonly used to manage and operate relational databases, is an essential course for students in information-related fields. Peer assessment is an alternative method used in recent years to increase classroom interaction and enhance learning through student comments. In this study, we introduce a peer assessment method to teach Structure Query Language (SQL) by using the annotation tool to increase students' ability to detect errors and write SQL syntax by using the feature of mutual commenting. This chapter will be divided into the background of the study and the results of the study. This chapter will be divided into two subsections to explain the background and motivation of the study and the purpose of the study.

To improve all students' ability to write SQL language, relying only on the traditional classroom model is not enough. In this study, students can comment on each other's mistakes during the classroom exercises by using the SQL annotation tool to mark and comment on the learning platform. Since each student may not understand the same topic to the same extent, the commenting method allows students to observe each other's understanding of the topic in continuous commenting and review.

The annotation tool mentioned in this study can be used in SQL and other programming languages. The reason for using SQL as the subject of this study is that SQL has four core instructions, and most of the sentences can be completed with the four core instructions, which is easier to observe than other programming languages. This study will analyze the relationship between the use of SQL annotation tools for peer-assessed learning of SQL syntax and the learning outcomes, as well as the motivation and perceptions of students using SQL annotation tools through a questionnaire.

II. LITERATURE REVIEW

This section examines the effectiveness of past learning tools developed for structured query languages, peer evaluation for programming courses, and the effectiveness of SQL annotation tools for learning structured query languages.

A. Structured Query Language

Structured Query Language (SQL) is a Domain-Specific Language (DSL) used to manage a Relational Database Management System (RDBMS). The SQL language first appeared in the early 1970s when E. F. Codd of IBM published Codd's Relational Algebra, applying the principle of forming data into tables. In 1974, IBM developed SEQUAL (Structured English Query Language) in System R, a relational database, and released a new version, SEQUAL/2, in 1976, renamed SQL in 1980. In 1979, Oracle was the first to provide a commercial version of SQL, and IBM used SQL in DB2 and SQL/DS database systems. In 1986, the American National Standards Institute (ANSI) adopted SQL as the standard language for relational database management systems, and it was later adopted as an international standard by the International Organization for Standardization (ISO).

SQL language is divided into four types: Data Definition Language (DDL), Data Query Language (DQL), Data

Manipulation Language (DML), and Data Control Language (DCL). DML is mainly used to manipulate the database and perform access work to the objects and data, with SELECT, INSERT, UPDATE, and DELETE as the core commands. DDL is the language responsible for data structure and database object definition, consisting of CREATE, ALTER, and DROP commands. Unlike other programming languages, SQL has the advantage of being non-processing, so you only need to ask "what to do" instead of specifying "how to do" when performing operations. DDL and DML are the most common phrases students encounter when learning SQL, especially at the beginning of their studies. Therefore, a clear understanding of the roles of each of the four types of commands is a good start for students to build a good foundation for learning.

B. Learning Tools for Structured Query Language

There have been many studies on learning tools for SQL language, and some of them evaluate students' learning by prompting [9] or comparing with correct answers [1-3]. This tool [3] helps students to identify and correct their errors by prompting. The results show that this method can significantly reduce the redundant elements of the SQL syntax written by students, but there are two problems with this method. First, there may be more than one answer in an open-ended question and answer, and second, when the complexity of the answer is high, some students may need help to answer the question despite using hints. Another part of the learning tool is to enhance students' motivation through game-based learning [6] or gamification [7], and to get started quickly. The results show that game-based learning and gamification do enhance students' motivation, but this may lead students to focus on finding answers to pass the game levels.

C. Program Design Evaluation

The On-Line Assessment System (OASYS) [12-14] is a web-based programming assessment system that provides multiple-choice and scripted questions to help learners take tests. After answering the questions, the answers to the multiple-choice questions can be automatically marked and peer-reviewed, and the answers to the scripting questions can be marked. During the review process, each learner was required to mark three peer answers, scoring high, medium, and low on the multiple-choice questions. The markers were 5-point Likert scale questionnaires used to rate peers' procedures regarding readability, correctness, and style. The experimental results showed that peer comments were helpful for learners to understand the quality of their program.

The Peer Assessment/Review System (PEARS) [15] provides an online program review and evaluation interface where learners can use either questionnaire or text-based reviews to express their feedback on their peer programmers. The experiment wanted to compare these two types of reviews, and the results showed that learners preferred text-based reviews to questionnaire-based reviews because questionnaires are difficult to cover all of the reviewers' perspectives.

Coursemarker [16] provides a peer assessment environment where learners can view peer-written programs and write textual reviews or select well-defined reviews for their peers from a library of predefined reviews. Each predefined review has an associated weight rating, and the sum of these ratings is the final result.

These studies of programming assessment suggest that applying peer review to programming courses can yield many active learning and critical thinking learning outcomes. However, there are still some drawbacks to such reviews, as questionnaire-based and pre-defined reviews limit reviewers' opinions to these questions and pre-defined reviews. It still needs to be easier to detect misunderstandings in tracing programs.

D. Peer Assessment

In recent years, peer assessment is often used as an alternative assessment method in many classrooms. According to Wen et al. [17], for teachers, peer assessment as a learning aid, whether live or online, can bring many benefits to teaching and learning, increasing classroom interaction and facilitating students' learning. For students, although most people think peer review can help them learn, they are sometimes afraid to comment on their peers and need more confidence to comment on other students.

In a study by Wen and Tsai [18], university students' attitudes and perceptions towards peer assessment and online peer assessment were surveyed through a questionnaire, which contained four dimensions: positive attitudes, online attitudes, understanding and action, and negative attitudes as subscales, and the results showed that the participating students had positive attitudes towards using peer assessment. Still, they viewed online peer assessment as a tool to facilitate the process of peer assessment rather than as a learning aid. They viewed online peer review as a tool to facilitate the process rather than a learning aid. Male students had more positive attitudes toward peer-to-peer assessment than female students, and students with previous experience with peer-to-peer assessment had less negative attitudes toward peer-to-peer assessment. Most students believed peer assessment scores should be calculated as a small part of the total course grade.

E. SQL Annotation Tool

The PDF annotation tool [19] is an add-on to the Moodle Learning Platform [20] and has the ability to mark patterns, highlight markers, and markers for Converse, as shown in Figure 5. The purpose of the annotation tool is to allow teachers to upload PDF textbooks to the Moodle Learning Platform that can be directly marked and commented on by students, which may include commenting on key points or asking questions of respondents.

TeamTat [21] is also a PDF annotation tool that has the ability to mark up multiple people at the same time. The tool is also capable of associating multiple tags and tagging images, and after tagging, multiple users can comment and respond to comments on the tags.

Taking advantage of the PDF annotation tool's ability to comment directly on the textbook, this study attempts to combine the annotation tool with the peer review method mentioned in the previous section to apply the tool to learning the four core commands of the SQL language and call it the "SQL Annotation Tool".

In this study, all students are expected to use the SQL Annotation Tool to answer the questions during the class exercise. After the answers are uploaded, the class can see the student's answers on the Moodle learning platform, review

them using the marker function, and give text comments for incorrect answers.

The text commenting makes it easier to detect possible misunderstandings of students when tracing the program than pre-defined comments based on the questionnaire, and it is also more efficient to determine each student's understanding of the SQL language so that teachers can adjust the difficulty level of the course and achieve more efficient classroom teaching.

III. Research Methodology

This section focuses on the effectiveness of peer assessment of SQL learning using SQL annotation tool and the motivation survey of SQL learning using SQL annotation tool. Based on the evaluation method proposed in this study, a research framework is developed, and a questionnaire is combined to understand the evaluation of the effectiveness and motivation of learning SQL through peer assessment using the SQL annotation tool.

A. Experimental design and participants

The experimental design and the participants of this study are described as follows.

- Independent variables: whether SQL markers were used for SQL learning in the "Introduction to Databases" course (3 credits/required).
- Dependent variable: Students' learning effectiveness and motivation.
- Participants: 193 second-year students from four different classes at a university in central Taiwan, all with equal basic database preparation knowledge; each class will be assigned to an experimental group and a control group according to their "willingness" to use SQL annotation tool.
- Duration: 8 weeks, 2 weekly classes, 50 minutes each.

After the experimental course, the final exam and the SQL Annotation Tool Feedback Form questionnaire, which consisted of a four-point Likert scale and an open-ended questionnaire, were administered. The final test results and the questionnaire will be analyzed based on the collected final test results.

B. Student activities and final exam design

The experimental and control groups were given two modules, "Basic SQL Syntax" and "Advanced SQL Syntax", during which both groups practiced SQL syntax questions. The practice questions were open-ended, and the answers were uploaded to the Moodle learning platform for one session (50 minutes).

After the instructor compiles all the students' answers into a PDF file, the experimental group will use the SQL annotation tool for peer assessment. Students in the control group worked on the same questions as the experimental group during the lesson but "did not" participate in the marking activity using the SQL marker tool.

Fig. 1 shows the interface of the SQL annotation tool, and you can see various marker tools placed on the screen, including icon marker, fluorescent marker, Quantum marker, etc. The PDF document display field is in the middle of the screen, and on the right side is the number of marker previews. You can view all the marker positions of students on the PDF document. By clicking on the number of pages marked (Fig. 2), you can see the content of the page markers. Students, as reviewers, mark the wrong answers on the PDF file and suggest how to fix them by commenting on them.

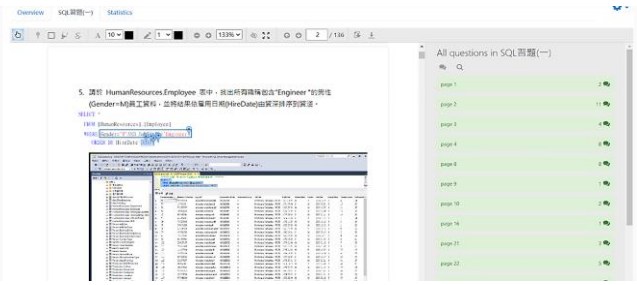

Fig. 1. User interface of SQL annotation tool

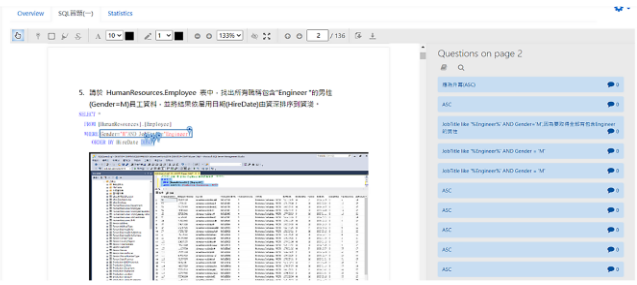

Fig. 2. Detailed marker content in the SQL annotation tool

When the experimental course is completed, a final exam will be administered on two modules of the experimental course. This study will verify whether peer assessment using the SQL annotation tool is associated with learning outcomes by analyzing the final grades and will also analyze the independent sample t-check using SPSS analysis software.

C. Survey questionnaire design

The questionnaire was proposed by Chen et al [22] and adapted in this study as the "SQL Annotation Feedback Form". The questionnaire has two response formats: a four-point Likert scale and open-ended questions.

According to Wu [23], when measuring emotional states, the odd-point scale has higher trait variance and lower method variance; when measuring attitudes, the even-point scale has higher trait variance and is better than the odd-point scale. Both the odd and even point scales have their advantages. In this study, the questionnaire focused more on attitude, so the four-point scale was chosen as the indicator.

The four-point Likert scale includes the impact of markup tools on learning motivation, satisfaction with the operation of markup tools, and opinions on markup tools, with strongly disagree (1 point), disagree (2 points), agree (3 points), and strongly agree (4 points) as the scales. In addition, the open-ended questions include "1. Your opinion on the use of PDF Annotation tool." and "2. Students were asked to answer the questions in a free-response manner.

1. Using the SQL annotation tool is helpful for my learning.
2. Using the SQL annotation tool can save my learning time.
3. The functions of the SQL annotation tool meet my needs.

4. It is easy to learn the functions of the SQL annotation tool.
5. The functions of the SQL annotation tool are easy to use.
6. The interface of the SQL annotation tool is friendly.
7. I recommend the SQL annotation tool to other students or friends.
8. I am satisfied with the results of teaching with the SQL annotation tool and would like to use the SQL annotation tool again.
9. I have negative comments or suggestions about using the SQL annotation tool (open question)
10. My positive opinion or suggestion about using SQL annotation tool (open question)

68 questionnaires will be distributed to all students in the experimental group at the end of the experiment. After the questionnaires were collected, it was expected that a reliability analysis would be conducted using SPSS statistical software to confirm the adequacy of the questionnaire. The open-ended questions in the questionnaire will be used to identify areas of improvement in the current system for subsequent studies.

IV. Research Results

There were 193 participants in the teaching experiment of this study, of which 68 participants used the SQL annotation tool for peer evaluation as the experimental group, and 125 participants did not use the SQL annotation tool as the control group.

This section describes the results of the analysis of the data collected in the teaching experiment and the results of the post-experimental questionnaire analysis, as well as the study of the results of the study in section 3.

A. Analysis of the results of the questionnaire

The target population of this questionnaire was students aged 19 to 20 who took the elective course "Introduction to Database", and all students had basic database knowledge and basic programming skills. The results showed that Cronbach's alpha coefficient of the SQL marker feedback form was 0.97, which indicated that the questionnaire had a good reliability coefficient. In the questionnaire analysis result (Table 1), it was found that the sum of "agree" and "strongly agree" for each question was more than 80%, which means that students generally think that the SQL annotation tool is easy to use and can enhance learning motivation.

TABLE I. Analysis of the Results of the Questionnaire

Question Item	*strongly agree*	*agree*	*disagree*	*strongly disagree*
1. Using the SQL annotation tool is helpful for my learning.	28%	65%	2%	5%
2. Using the SQL annotation tool can save my learning time.	29%	59%	7%	5%
3. The functions of the SQL annotation tool meet my needs.	21%	65%	9%	5%
4. It is easy to learn the functions of the SQL annotation tool.	23%	63%	7%	7%
5. The functions of the SQL annotation tool are easy to use.	26%	60%	7%	7%
6. The interface of the SQL annotation tool is friendly.	26%	58%	7%	9%
7. I recommend the SQL annotation tool to other students or friends.	16%	67%	5%	12%
8. I am satisfied with the results of teaching with the SQL annotation tool and would like to use the SQL annotation tool again.	23%	65%	5%	7%

B. Analysis of final exam results

After the teaching experiment, the final exam was conducted, and the distribution of test scores between the two groups was compared.

Fig. 3 shows the distribution of the final exam scores for all students, where the range of 61-70 is the most popular, and the skewness coefficient is 0.0548, showing a right skew. Fig. 4 shows that the average score of all students was 57.75, and the standard deviation was 26.21, with maximum and minimum values of 100 and 0, respectively.

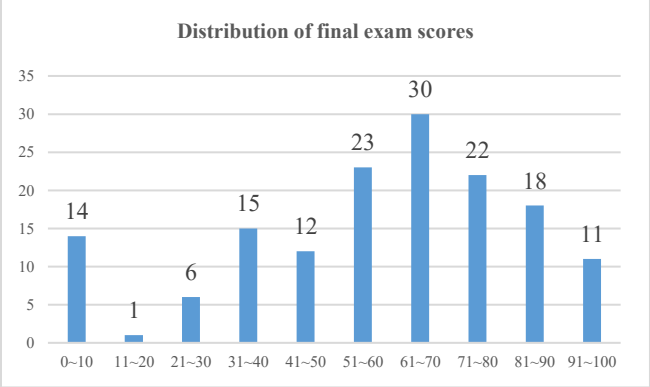

Fig. 3. Distribution of final exam scores

	all final exam results
N Valid	193
Missing	0
Mean	57.75
Std Dev	26.21
Minimum	.00
Maximum	100.00

Fig. 4. Analysis of all final exam results

Fig. 5 shows the distribution of the final exam scores in the experimental group. 91~100 scores are the most numerous ranges, and the skewness is -0.0399, showing a left skew. As shown in Fig. 6, the mean test score of the experimental group was 69.09 with a standard deviation of 21.87, and the maximum and minimum scores were 100 and 3, respectively.

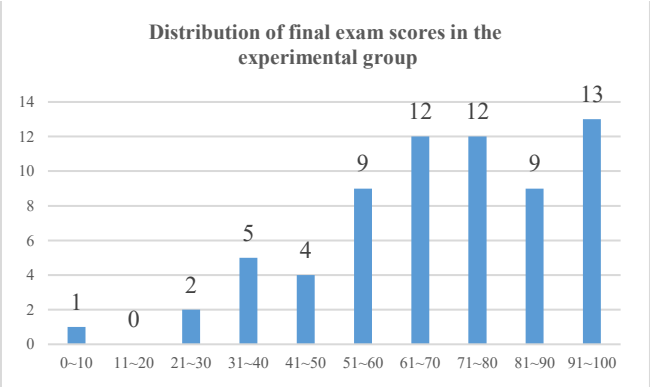

Fig. 5. Distribution of final exam scores in the experimental group

		experimental group
N	Valid	67
	Missing	0
Mean		69.09
Std Dev		21.87
Minimum		3.00
Maximum		100.00

Fig. 6. Analysis of the final exam results of the experimental group

Fig. 7 shows the distribution of the final exam scores of the control group, where 61-70 is the most frequent range, with a skewness of -0.2265, showing a left skew. As shown in Fig. 8, the mean test score of the control group was 51.71, with a standard deviation of 26.39, and the maximum and minimum scores were 90 and 0, respectively.

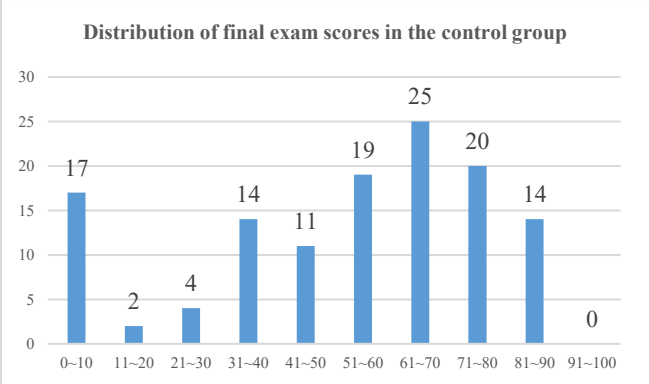

Fig. 7. Distribution of final exam scores in the control group

Statistics

		control group
N	Valid	126
	Missing	0
Mean		51.71
Std Dev		26.39
Minimum		.00
Maximum		90.00

Fig. 8. Analysis of the final exam scores of the control group

Table 2 shows the independent sample t-check of all the final grades; the p-value is 0.013, since the p-value is 0.013 since the p-value is <0.05, so it can be assumed that the number of variances is not equal, and the receiver looks at the significance of the t-value (significance=0.000<0.05) and rejects the null hypothesis (H_0), so it is determined that there is a significant difference between the experimental group and the control group.

TABLE II. INDEPENDENT SAMPLES OF FINAL EXAM RESULTS

	Levene's Test for Equality of Variances			
	F	***Sig.***		
Score Equal variances assumed	6.28	0.013		
Score Equal variances not assumed				
	T-Test for Equality of Means			
	t	***df***	***Sig. (2-tailed)***	***Mean Difference***
Score Equal variances assumed	5.11	191.00	0.000	18.82
Score Equal variances not assumed	5.56	168.91	0.000	18.82
	T-Test for Equality of Means			
	Std. Error Difference	***95% Confidence Interval of the Difference***		
		Lower	***Upper***	
Score Equal variances assumed	3.68	11.56	26.09	
Score Equal variances not assumed	3.39	12.14	25.51	

V. CONCLUSION AND FUTURE RESEARCH

This study evaluated the effect of peer assessment on learning and motivation when using the SQL annotation tool for learning structured query language. Using the SQL annotation tool to identify the errors in the exercises and mark the correct answers for each other in the course, the students increased their understanding of SQL syntax by identifying their peers' errors independently, unlike the usual classroom approach. In this study, a questionnaire survey was conducted to investigate the effectiveness of using SQL annotation tool for peer assessment in learning structured query language, and the student's satisfaction with using SQL annotation tool in learning structured query language was used as an indicator.

The study data showed that the average final exam score of the experimental group using the SQL annotation tool was 69.09, the final exam score of the control group without the SQL annotation tool was 51.71, and the average score of the whole class was 57.75. The average score of students who used the SQL annotation tool to learn structured query language was 17.38 points higher than those who did not use the SQL annotation tool. The p-value was 0.013 (p-value < 0.05), and the t-value was 0.000 (t-value < 0.05) after independent sample t-check analysis. It can be represented that the tool is useful for learning structured query language.

In the questionnaire analysis, we found that the students were generally satisfied with the use of the SQL annotation tool for peer assessment in learning structured query language and had a good increase in motivation to learn. In the open-ended questionnaire, we found that some students felt that

they could not find other students' mistakes when using the SQL annotation tool with insufficient basic knowledge and that the interface needed to be more intuitive and guided enough. Future research efforts will be directed towards increasing the ease of use of the tool interface and providing students with hints to correct directions.

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