Journal of Engineering Education Transformations,
Volume No 35, January 2022, Special issue, eISSN 2394-1707

WRITE: An Instructional Strategy to Give Hands on Experience of Structured Query Language (SQL) to Students

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Abstract— In current situation, students must have theoretical as well as more practical knowledge about RDBMS (Relational Database Management System) which is one of the core course of Computer Science and Engineering. This course is also of paramount importance in the competitive examination like GATE, Technical Aptitude Test etc. SQL (Structured Query Language) is a domain-specific language used for manipulating data held in a RDBMS. Since SQL is used for softwares design in the industry, students should have in-depth knowledge of this language as well as basics of RDBMS.

In this study, WRITE-instructional strategy is used to teach the course Database Engineering. WRITE consist of five phases which stand for W- Watch, R- Read, I – Implement, T – Test and E – Evaluate. In W-Watch phase, students watch the videos created by the instructor. All videos have the same format containing Learning Outcomes, Topic description, Think & Write containing the quiz on covered topic, content following the Think & Write and Reference. In R-Read phase, students read the instruction given in the handouts related to the assignments to be completed. In I – Implement phase, the students implement the assignments while in T-Test phase, students gives the test on the SQL. Finally E-Evaluate phase is used to evaluate the test as well assignments completed in the lab sessions. This study focuses on improving the critical thinking and problem solving ability of students.

Two group post-test method is considered to check the effectiveness of this method. The participants involved in the activity are 70 undergraduates from engineering stream. The Learning objectives (LOs) are: LO1 – Decide on selecting the appropriate relations from given set of relations required to write the query for given problem statement. LO2 – Write the query for given problem statement using SQL. The research question is – whether WRITE instructional strategy improves the critical thinking and problem solving ability of the students? The result as well statistical analysis using t-Test showed the significant improvement in the students. Also the feedback was conducted to know the perception of students about this activity.

Keywords- SQL, WRITE, Liker's Scale, t-Test.

1. Introduction

In engineering stream particularly Computer Science & Engineering and allied branches, programming language courses such as C, C++, Java, C#.Net, Python, etc. consider to be of paramount importance. SQL is also of paramount importance as it is used as back-end language in designing application based softwares. It consists of two types of basic commands - Data Definition Language (DDL) and Data Manipulation Language (DML). DDL commands are used to create the relations while DML is used to manipulate the data in the database. So it is very important that students must have the theoretical as well as practical knowledge of SQL. To study the SQL thoroughly, the activity WRITE is considered to give hands on experience of this language to the students.

2. Related Work

There are various ways to teach the SQL to the students. The programmed instruction (PI) and meaningful learning (ML) are used in teaching basic structured query language (SQL) in computer lesson (Efendioğlu, A., & Yelken, T. Y., 2010). Online MOODLE is also used to teach the SQL where small course containing videos, quiz based on videos and assignment is considered (Dol, S. M., & Halkude, S. A., 2020). Use of 'Basic SQL-The Online Beginner's Guide' site is used to give Hands on Experience of SQL to Students (Dol, S., & Gandhmal, D., 2018). The research (Njovu, C., 2003) explained how to teach the Database course using lectures, laboratory exercises, practical and theoretical aspects of course work and also small group tutorial exercises. This paper (Nitin Patil, 2011) described how Open Source software like Postgresql is used for teaching Databases course to improve students' understanding while the article (Taipalus, T., & Perälä, P., 2019) explored which kind of errors students struggle with and help teachers choose more appropriate data for running SQL queries for students to use when learning SQL. So the articles (Al-Shuaily, H., 2012) identified the problems in teaching and learning SQL and suggested the new method to teach SQL which resulted in improvement in students' SQL learning. The research (Al-Shuaily, H., & Renaud, K., 2010) proposed a new approach for teaching SQL part by a checklist approach.

In current study, the new approach WRITE is used which consider the use of videos and handouts for improving the performance of students in SQL.

3. WRITE Methodology

This WRITE activity consist of following phases -

- W- Watch,
- R- Read,
- I – Implement,
- T – Test and
- E – Evaluate

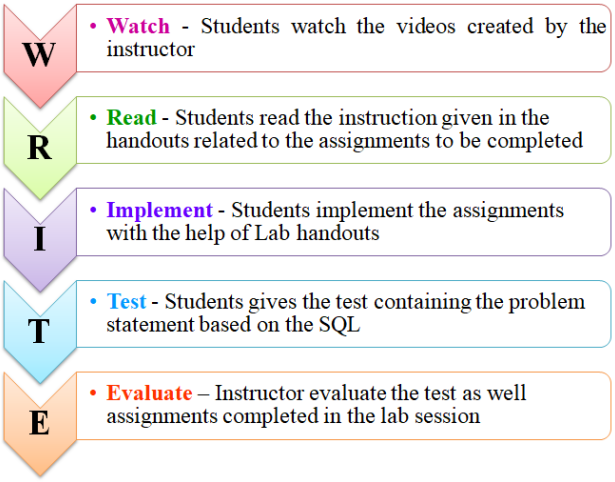

Fig. 1. Phases of WRITE activity

Each of these phases is explained in detailed in following sections.

A. W – Watch

In this phase, students will go through the videos created by the instructor. Each of these videos is of length 10 to 12 minutes. Each video has same format and contains

- Introduction slide
- Learning outcome after watching video
- Content related to the topic
- Reflection spot which contains the multiple choice question or short question or True/False question.
- Explanation about the correct answer of question asked in reflection spot.
- Content following the reflection spot.
- References used while preparing the presentation

Fig. 2: Sample video

Table 2 shows some video topic name and YouTube Link for the topic. These videos are uploaded on institute MOODLE. After every video a short quiz containing 5 multiple choice question is considered. Figure 3 shows the videos and quiz uploaded on institute MOODLE.

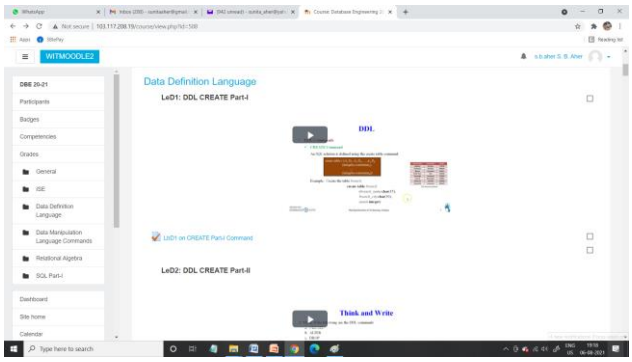

Fig. 3: Videos and quiz uploaded on institute MOODL

Table 1 : Video topic name and YouTube Link

Sr. No.	Name Topic	YouTube Video Link
1	DDL CREATE Command	https://www.youtube.com/watch?v=BGiIZgw9JHY
2	DDL Constraints on CREATE Command	https://www.youtube.com/watch?v=64XfUvdnoHc
3	DDL ALTER and DROP Command	https://www.youtube.com/watch?v=JjUOIURs3u4
4	DML – INSERT command	https://www.youtube.com/watch?time_continue=2&v=xqoW1vJHo5M
5	DML – UPDATE and DELETE command	https://www.youtube.com/watch?time_continue=1&v=eonduiAexk
6	DCL (Data Control Language)	https://www.youtube.com/watch?v=vOooclQ5q_Y
7	TCL (Transaction Control Language)	https://www.youtube.com/watch?v=BttRblah-3s
8	DML – Basic Structure of SQL	https://www.youtube.com/watch?v=aLMcHQKU5ww
9	Basic Structure of SQL	https://youtu.be/DwC_e6ixdn0
10	Set Operations	https://youtu.be/45vjoMnn5EU
11	Aggregate Functions	https://youtu.be/Qqqxn37_96Q

12	Nested Subqueries - Set Membership and Set Comparison	https://youtu.be/JkXnuPBvL6g
13	Nested Subqueries - Test for Empty Relations and Test for Duplicate Tuples	https://youtu.be/lDa041zch6g
14	Complex Queries	https://www.youtube.com/watch?v=iXCBy_6_yss
15	Views Part-I	https://www.youtube.com/watch?v=h93jzx3Kovs
16	Views Part-II	https://www.youtube.com/watch?v=OS6V1O8mM1s
17	Inner Joined Relations	https://www.youtube.com/watch?v=gJ4x9yx5rdk
18	Left Outer Joined Relations	https://www.youtube.com/watch?v=UpQZIjzChJ0

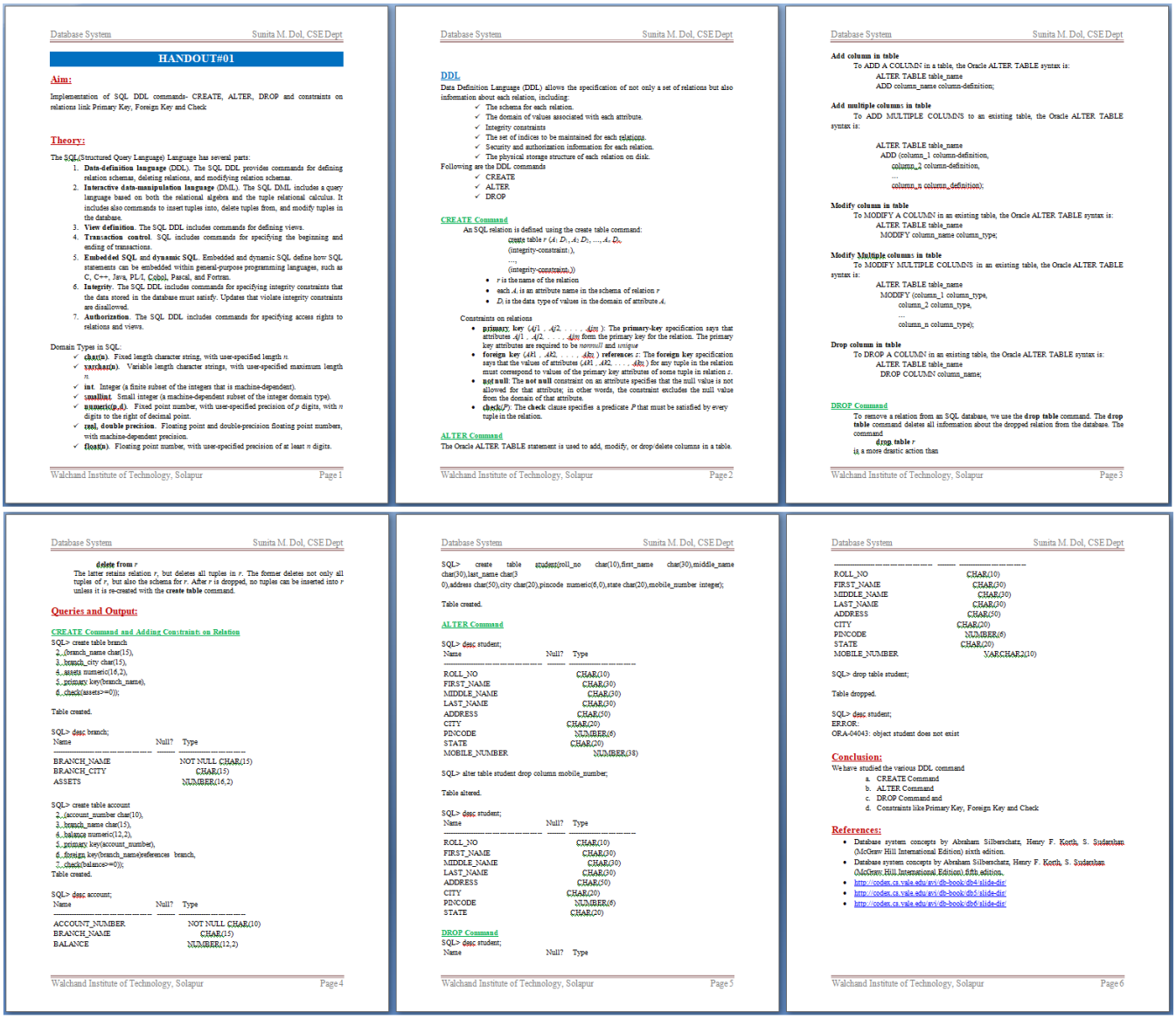

Fig. 4. Sample handout

B. R – Read

Second phase is the Read phase. In this phase, during the online laboratory session students were asked to go through the lab handout provided to them. This lab handout is document which contains the step by step procedure to complete the given problem statement. The lab assignments considered for the SQL are

1. Implementation of Basic SQL DDL commands
2. Implementation of SQL DML commands
3. Draw E-R diagram for any specific database application
4. Write simple queries in SQL on the schema created for a specific application
5. Write SQL queries using aggregate function and nested subqueries,
6. Write SQL queries using Views and Join operation

7. Write SQL queries for different integrity constraints and authorization

For assignment, the lab handouts contains

- Aim
- Theory
- Queries and Output
- Conclusion
- References

The sample handout for the assignment number 1 is shown in Figure 4.

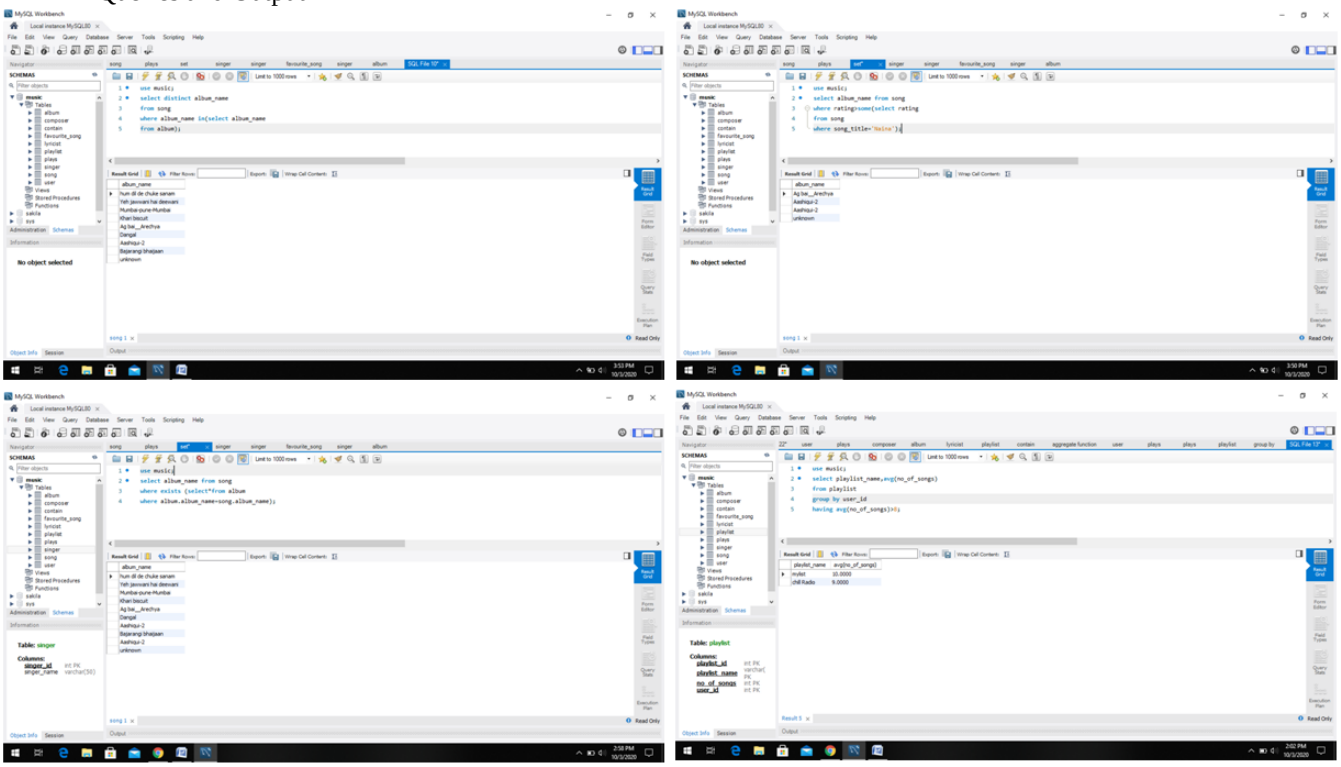

Fig. 5. Sample assignment submitted by student

C. I – Implement

With the help of the lab handouts, students implement the assignments and submit it on the Google Classroom. In this phase, every student will

- Go through the lab handout,
- Study the theory as well as the problem statement in details,
- Follow the steps given in the handout to complete the problem statement,
- Enter the program, input and output in the word document
- Submit the assignment on the Google classroom before given deadline.

Instructor will

- Check the assignment submitted by the students
- If submitted assignment is not upto the mark, then instructor will ask the student to resubmit the assignment.
- Recheck the submitted assignment by student after doing correction.

The sample assignment submitted by one of the student is shown in Figure 5.

D. T – Test

Test was conducted after Implement phase. Three hours were given to the students for completing the SQL problem statement. The sample problem statement is given in Figure 6. In every problem statement considered in Test phase, students needs to

- Go through the relations and problem statement
- Select the appropriate relations to write the query for the given problem statement.
- Create those relations using DDL commands with appropriate integrity constraints
- Write the DML commands to problem statements on these relations.
- Copy the SQL query along with output in word document and
- Submit this test on Google Classroom.

1. Use the following relations to write the query. First decide which relations are required to write the query for the given problem statements, then create those relations and inert the data in those relations.

ID	*name*	*dept_name*	*salary*
10101	Srinivasan	Comp. Sci.	65000
12121	Wu	Finance	90000
15151	Mozart	Music	40000
22222	Einstein	Physics	95000
32343	El Said	History	60000
33456	Gold	Physics	87000
45565	Katz	Comp. Sci.	75000
58583	Califieri	History	62000
76543	Singh	Finance	80000
76766	Crick	Biology	72000
83821	Brandt	Comp. Sci.	92000
98345	Kim	Elec. Eng.	80000

The *instructor* relation

course_id	*title*	*dept_name*	*credits*
BIO-101	Intro. to Biology	Biology	4
BIO-301	Genetics	Biology	4
BIO-399	Computational Biology	Biology	3
CS-101	Intro. to Computer Science	Comp. Sci.	4
CS-190	Game Design	Comp. Sci.	4
CS-315	Robotics	Comp. Sci.	3
CS-319	Image Processing	Comp. Sci.	3
CS-347	Database System Concepts	Comp. Sci.	3
EE-181	Intro. to Digital Systems	Elec. Eng.	3
FIN-201	Investment Banking	Finance	3
HIS-351	World History	History	3
MU-199	Music Video Production	Music	3
PHY-101	Physical Principles	Physics	4

The *course* relation

ID	*course_id*	*sec_id*	*semester*	*year*
10101	CS-101	1	Fall	2009
10101	CS-315	1	Spring	2010
10101	CS-347	1	Fall	2009
12121	FIN-201	1	Spring	2010
15151	MU-199	1	Spring	2010
22222	PHY-101	1	Fall	2009
32343	HIS-351	1	Spring	2010
45565	CS-101	1	Spring	2010
45565	CS-319	1	Spring	2010
76766	BIO-101	1	Summer	2009
76766	BIO-301	1	Summer	2010
83821	CS-190	1	Spring	2009
83821	CS-190	2	Spring	2009
83821	CS-319	2	Spring	2010
98345	EE-181	1	Spring	2009

The *teaches* relation

course_id	*sec_id*	*semester*	*year*	*building*	*room_number*	*time_slot_id*
BIO-101	1	Summer	2009	Painter	514	B
BIO-301	1	Summer	2010	Painter	514	A
CS-101	1	Fall	2009	Packard	101	H
CS-101	1	Spring	2010	Packard	101	F
CS-190	1	Spring	2009	Taylor	3128	E
CS-190	2	Spring	2009	Taylor	3128	A
CS-315	1	Spring	2010	Watson	120	D
CS-319	1	Spring	2010	Watson	100	B
CS-319	2	Spring	2010	Taylor	3128	C
CS-347	1	Fall	2009	Taylor	3128	A
EE-181	1	Spring	2009	Taylor	3128	C
FIN-201	1	Spring	2010	Packard	101	B
HIS-351	1	Spring	2010	Painter	514	C
MU-199	1	Spring	2010	Packard	101	D
PHY-101	1	Fall	2009	Watson	100	A

The *section* relation

1. Find all the courses taught in the both the Fall 2009 and Spring 2010 semesters using set membership.
2. Find all the courses taught in the Fall 2009 semester but not in the Spring 2010 semester using set membership.
3. Selects the names of instructors whose names are neither "Mozart" nor "Einstein" using set membership.
4. Find the total number of (distinct) students who have taken course sections taught by the instructor with *ID* 110011 using set membership.

Fig. 6. Sample assignment submitted by student

E. E – Evaluate

In evaluate phase, instructor evaluate the SQL assignment and test submitted on Google Classroom. The rubric used to evaluate the assignment is given in the Table 3.

Table 3 – Rubric used for assignment and test evaluation

Sr. No.		Correct	Partially correct	Incorrect
1	Selection of relation/s for given problem statement			
2	DDL commands			
3	DML commands			
4	Output of query			

4. Experimental Details

This experiment was carried out for third year Computer Science and Engineering students. The research design steps to carry out this activity are shown in Figure 7.

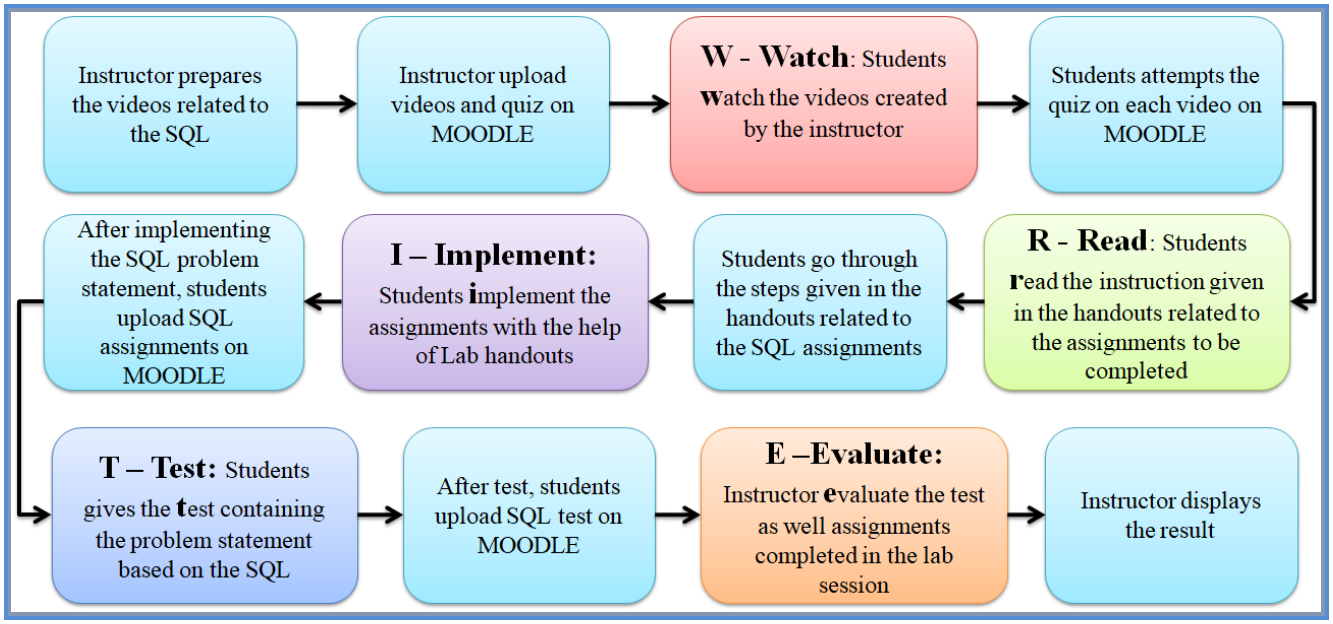

Fig. 7. Research Design

5. Result Analysis

A test mark obtained by the students is shown in the Figure 8 while Figure 7 shows the marks obtained by students after evaluating the assignments as per the rubric given in the Table 3.

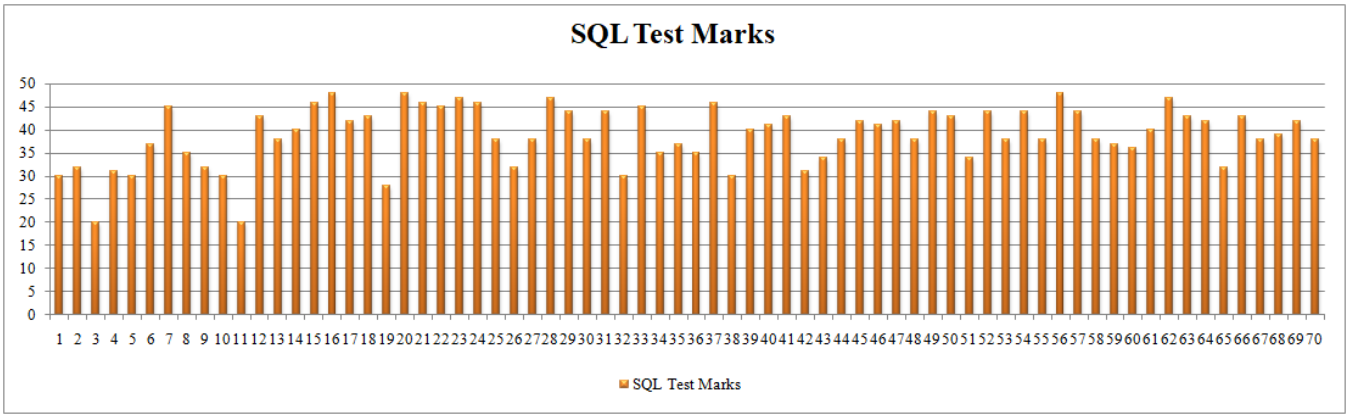

Fig. 8. SQL Test marks

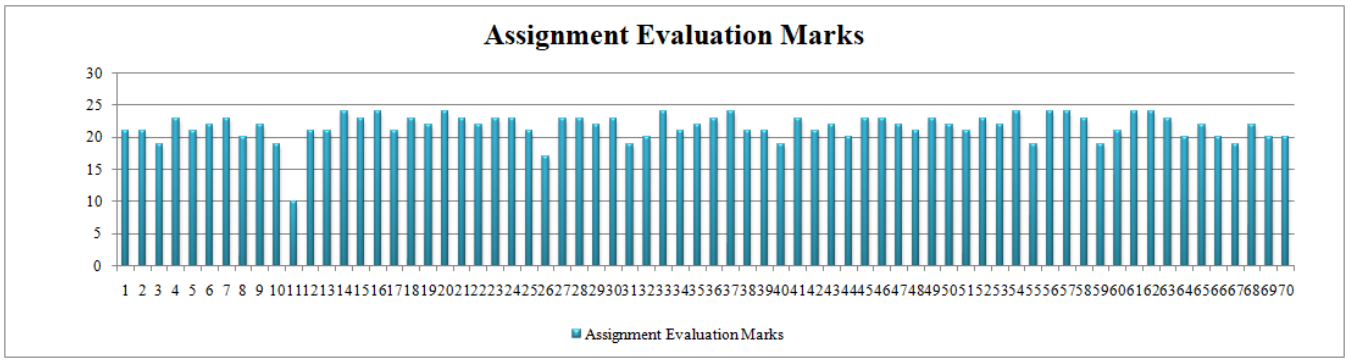

Fig.9. Assignment evaluation marks

Table 4: Statistical Analysis

	Population mean	t-value	p-value
Assignment Evaluation Marks	21	2.328132	0.011421
SQL Test Marks	37.5	1.857993	.033718

A t-test is used to determine whether two sets of data differ significantly. A single sample t-test is used to compare the mean of a single sample of scores to a known population mean. The t-value is a ratio of the difference between the mean of the two sample sets and the variation that exists within the sample sets. Higher values of the t-value indicate that there is statistically significant difference between the two sample sets and if p-value is less than 0.05, it is concluded that there's a statistically significant difference two groups. From the Table 4, it is observed that p-value is less than 0.05 for assignment evaluation marks as well as for SQL test marks.

A. Feedback

To understand student's perception about these activities, the feedback for control group as well as for experimental group was conducted at the end of activity. The questions in feedback form and feedback analysis for control group and experimental group is shown in table 5.

6. Conclusion

In the current study, the activity WRITE is considered for the Structures Query Language which consist of five phases W-Watch the videos, R - Read the instruction given in the lab handouts, I - Implement the problem statement given in the lab assignment with the help of handouts, T – Test on SQL, and E - Evaluate the test and assignments. The result shows that the students learning is improved which is proved with the help of statistical analysis. This activity can be considered for any engineering course having the practical sessions.

Table 5: Feedback about WRITE activity

Sr. No.		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	The content covered in each video clears the SQL doubts	65%	35%	-	-	-
2	The videos were found to be clear and understandable	55%	45%	-		
3	Guidelines provided in Lab- handouts helped you to complete the assignment.	45%	53%	-	-	-
4	Theory part given in the handout was useful to clear the concept about problem statement.	50%	46%	2%	-	-
5	Lab handouts boost our interest in implementation of SQL problem statements.	53%	23%	-	-	-
6	I will be able to immediately apply what I learned by going through the videos and lab handouts.	57%	43%	-		
7	The problem statement considered in the test was challenging.	45%	55%	-	-	-
8	Did you like WRITE activity?	100%				

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