

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-Shuaili, 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-Shuaili, 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

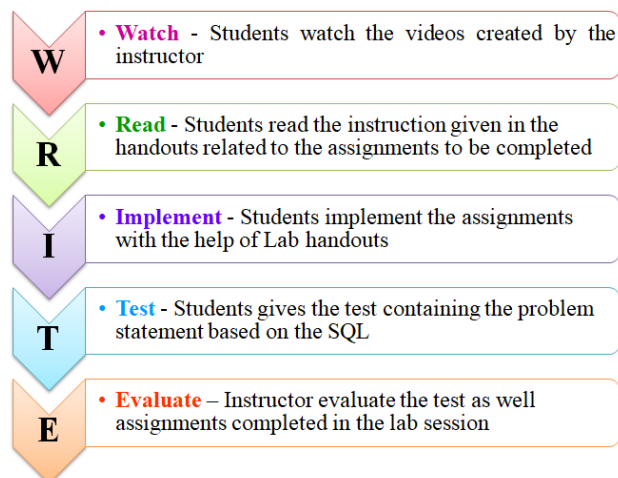


Fig. 1. Phases of WRITE activity

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

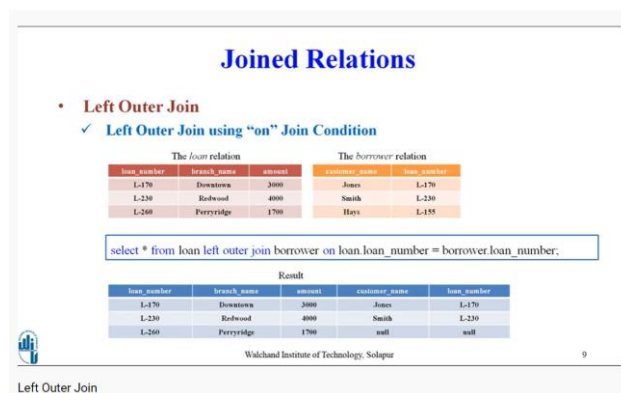


Fig. 2: Sample video

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.

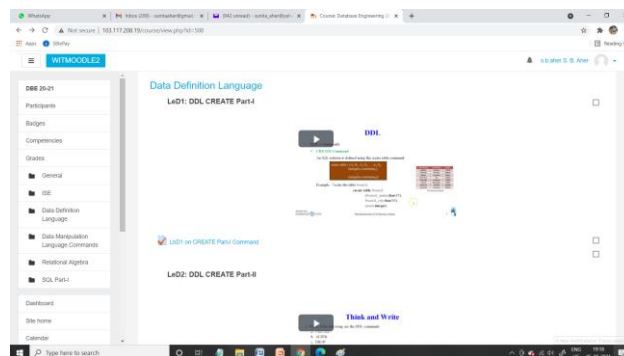


Fig. 3: Videos and quiz uploaded on institute MOODL

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=BGilZgw9JHY
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=vOoocIQ5q_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_vss
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=UpQZljzChJ0

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HANDOUT#01

Aim:
Implementation of SQL DDL commands- CREATE, ALTER, DROP and constraints on relations link Primary Key, Foreign Key and Check

Theory:
The SQL (Structured Query Language) Language has several parts:
1. **Data-definition language (DDL).** The SQL DDL provides commands for defining relation schemas, deleting relations, and modifying relation schemas.
2. **Interactive data-manipulation language (DML).** The SQL DML includes a query language based on both the relational algebra and the tuple relational calculus. It includes also commands to insert tuples into, delete tuples from, and modify tuples in the database.
3. **View definition.** The SQL DDL includes commands for defining views.
4. **Transaction control.** SQL includes commands for specifying the beginning and ending of transactions.
5. **Embedded SQL and dynamic SQL.** Embedded and dynamic SQL define how SQL statements can be embedded within general-purpose programming languages, such as C, C++, Java, PL/1, Cobol, Pascal, and Fortran.
6. **Integrity.** The SQL DDL includes commands for specifying integrity constraints that the data stored in the database must satisfy. Updates that violate integrity constraints are disallowed.
7. **Authorization.** The SQL DDL includes commands for specifying access rights to relations and views.

Domain Types in SQL:
✓ **CHAR(n).** Fixed length character string, with user-specified length *n*.
✓ **VARCHAR(n).** Variable length character strings, with user-specified maximum length *n*.
✓ **INT.** Integer (a finite subset of the integers that is machine-dependent).
✓ **SMALLINT.** Small integer (a machine-dependent subset of the integer domain type).
✓ **NUMERIC(p,d).** Fixed point number, with user-specified precision of *p* digits, with *n* digits to the right of decimal point.
✓ **REAL, double precision.** Floating point and double-precision floating point numbers, with machine-dependent precision.
✓ **FLOAT(p).** Floating point number, with user-specified precision of at least *n* digits.

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DDL
Data Definition Language (DDL) allows the specification of not only a set of relations but also information about each relation, including:
✓ The schema for each relation.
✓ The domain of values associated with each attribute.
✓ Integrity constraints.
✓ The set of indices to be maintained for each relation.
✓ Security and authorization information for each relation.
✓ The physical storage structure of each relation on disk.

Following are the DDL commands:
✓ CREATE
✓ ALTER
✓ DROP

CREATE Command
An SQL relation is defined using the create table command:
create table <table name> (<table schema>);
(table schema) is:
(integrity-constraint,1)
...
(integrity-constraint,n)
• *r* is the name of the relation.
• each *A_i* is an attribute name in the schema of relation *r*.
• *D_i* is the data type of values in the domain of attribute *A_i*.

Constraints on relations
• **primary key (<A<sub>12n The primary-key specification says that attributes <A<sub>12nnon-null and *unique*.
• **foreign key (<A<sub>12n The foreign key specification says that the values of attributes <A<sub>12nr.
• **not null.** The not null constraint on an attribute specifies that the null value is not allowed for that attribute. In other words, the constraint excludes the null value from the domain of that attribute.
• **check(P).** The check clause specifies a predicate *P* that must be satisfied by every tuple in the relation.</sub></sub>**</sub></sub>**

ALTER Command
The Oracle ALTER TABLE statement is used to add, modify, or drop/delete columns in a table.

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Add column in table
To ADD A COLUMN in a table, the Oracle ALTER TABLE syntax is:
ALTER TABLE table_name
ADD column_name column_definition;

Add multiple columns in table
To ADD MULTIPLE COLUMNS to an existing table, the Oracle ALTER TABLE syntax is:
ALTER TABLE table_name
ADD (column_1 column_definition,
...
column_n column_definition);

Modify column in table
To MODIFY A COLUMN in an existing table, the Oracle ALTER TABLE syntax is:
ALTER TABLE table_name
MODIFY column_name column_type;

Modify Multiple columns in table
To MODIFY MULTIPLE COLUMNS in an existing table, the Oracle ALTER TABLE syntax is:
ALTER TABLE table_name
MODIFY (column_1 column_type,
column_2 column_type,
...
column_n column_type);

Drop column in table
To DROP A COLUMN in an existing table, the Oracle ALTER TABLE syntax is:
ALTER TABLE table_name
DROP COLUMN column_name;

DROP Command
To remove a relation from an SQL database, we use the drop table command. The drop table command deletes all information about the dropped relation from the database. The command
drop table <r>
(a more drastic action than

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Delete from r
The delete statement deletes all tuples in *r*, but does not delete all tuples in *r*. The former deletes not only all tuples in *r*, but also the schema for *r*. After *r* is dropped, no tuples can be inserted into *r* unless it is re-created with the create table command.

Queries and Output:

CREATE Command and Add/Alter Constraints on Relation
SQL> create table branch
2, (branch_name char(15),
3, branch_city char(15),
4, assets numeric(14,2),
5, primary key(branch_name),
6, check(assets>=0));

Table created.

SQL> desc branch;
Name Null? Type
BRANCH_NAME NOT NULL CHAR(15)
BRANCH_CITY CHAR(15)
ASSETS NUMBER(14,2)

SQL> create table account
2, (account_number char(10),
3, branch_name char(15),
4, balance numeric(12,2),
5, primary key(account_number),
6, foreign key(branch_name) reference branch,
7, check(balance>=0));

Table created.

SQL> desc account;
Name Null? Type
ACCOUNT_NUMBER NOT NULL CHAR(10)
BRANCH_NAME CHAR(15)
BALANCE NUMBER(12,2)

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SQL> create table studentroll_no char(10), first_name char(30), middle_name char(30), last_name char(30), address char(30), city char(20), pincode numeric(6), state char(20), mobile_number integer);

Table created.

ALTER Command
SQL> desc student;
Name Null? Type
ROLL_NO CHAR(10)
FIRST_NAME CHAR(30)
MIDDLE_NAME CHAR(30)
LAST_NAME CHAR(30)
ADDRESS CHAR(30)
CITY CHAR(20)
PINCODE NUMBER(6)
STATE CHAR(20)
MOBILE_NUMBER NUMBER(10)

SQL> alter table student drop column mobile_number;

Table altered.

SQL> desc student;
Name Null? Type
ROLL_NO CHAR(10)
FIRST_NAME CHAR(30)
MIDDLE_NAME CHAR(30)
LAST_NAME CHAR(30)
ADDRESS CHAR(30)
CITY CHAR(20)
PINCODE NUMBER(6)
STATE CHAR(20)

DROP Command
SQL> desc student;
Name Null? Type

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ROLL_NO CHAR(10)
FIRST_NAME CHAR(30)
MIDDLE_NAME CHAR(30)
LAST_NAME CHAR(30)
ADDRESS CHAR(30)
CITY CHAR(20)
PINCODE NUMBER(6)
STATE CHAR(20)
MOBILE_NUMBER VARCHAR(10)

SQL> drop table student;

Table dropped.

SQL> desc student;
ERROR:
ORA-04043: object student does not exist

Conclusion:
We have studied the various DDL command
a. CREATE Command
b. ALTER Command
c. DROP Command and
d. Constraints like Primary Key, Foreign Key and Check

References:
• Database system concepts by Abraham Silberschatz, Henry F. Korth, S. Sudarshan (McGraw-Hill International Edition) sixth edition.
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• <http://codes.aiaa.edu/aiaa-ib-book/ib-11ide-dir>
• <http://codes.aiaa.edu/aiaa-ib-book/ib-11ide-dir>
• <http://codes.aiaa.edu/aiaa-ib-book/ib-11ide-dir>

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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.

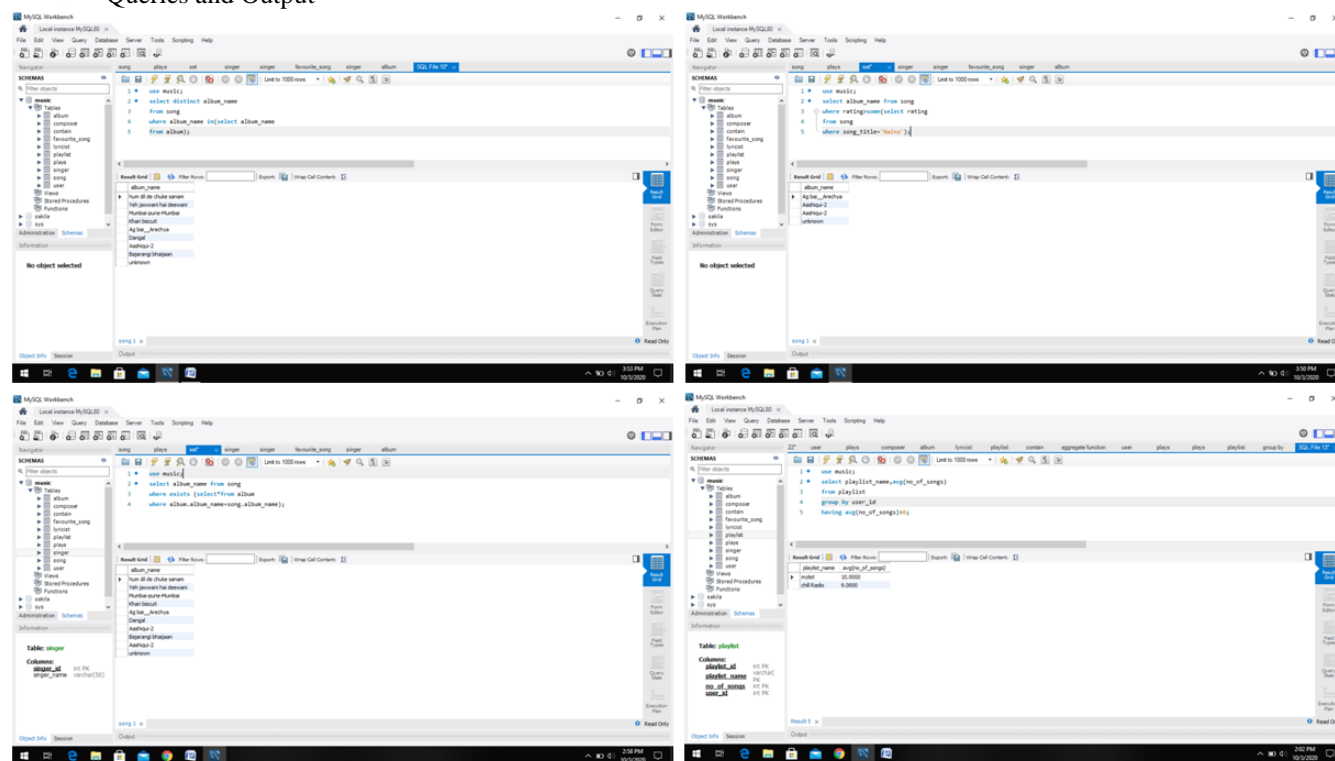


Fig. 5. Sample assignment submitted by student

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 insert the data in those relations.

ID	name	dept_name	salary	course_id	title	dept_name	credits
10101	Srinivasan	Comp. Sci.	65000	BIO-101	Intro. to Biology	Biology	4
12121	Wu	Finance	90000	BIO-301	Genetics	Biology	4
15151	Mozart	Music	40000	BIO-399	Computational Biology	Biology	3
22222	Einstein	Physics	95000	CS-101	Intro. to Computer Science	Comp. Sci.	4
32343	El Said	History	60000	CS-190	Game Design	Comp. Sci.	4
33456	Gold	Physics	87000	CS-315	Robotics	Comp. Sci.	3
45565	Katz	Comp. Sci.	75000	CS-319	Image Processing	Comp. Sci.	3
58583	Califieri	History	62000	CS-347	Database System Concepts	Comp. Sci.	3
76543	Singh	Finance	80000	EE-181	Intro. to Digital Systems	Elec. Eng.	3
76766	Crick	Biology	72000	FIN-201	Investment Banking	Finance	3
83821	Brandt	Comp. Sci.	92000	HIS-351	World History	History	3
98345	Kim	Elec. Eng.	80000	MU-199	Music Video Production	Music	3
				PHY-101	Physical Principles	Physics	4

The instructor 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

The course 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

- Find all the courses taught in the both the Fall 2009 and Spring 2010 semesters using set membership.
- Find all the courses taught in the Fall 2009 semester but not in the Spring 2010 semester using set membership.
- Selects the names of instructors whose names are neither "Mozart" nor "Einstein" using set membership.
- 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.

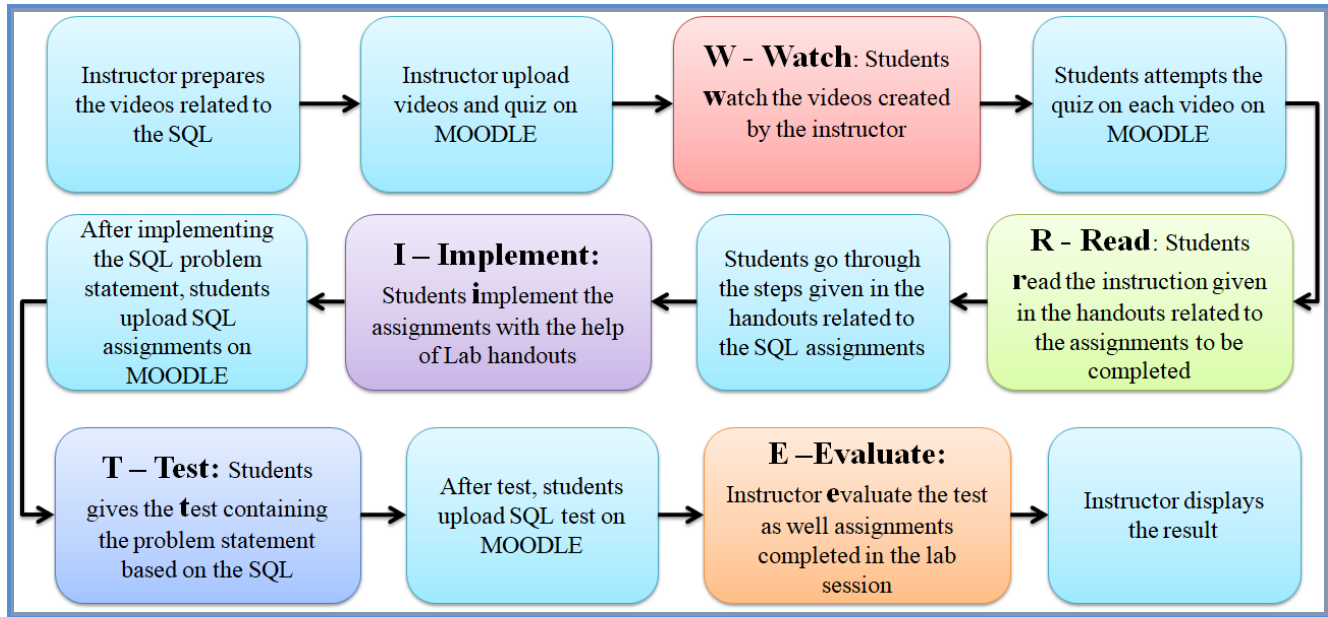


Fig. 7. Research Design

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.

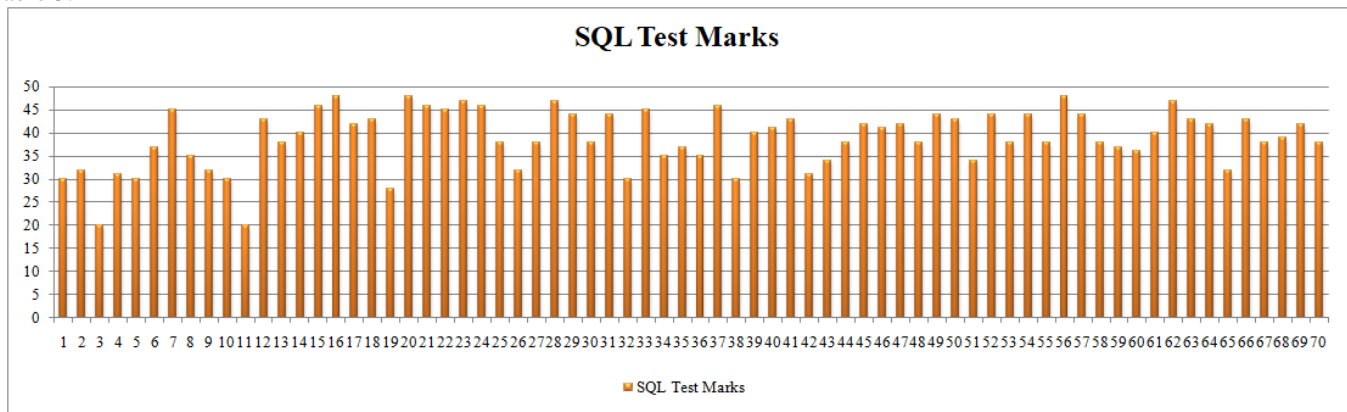


Fig. 8. SQL Test marks

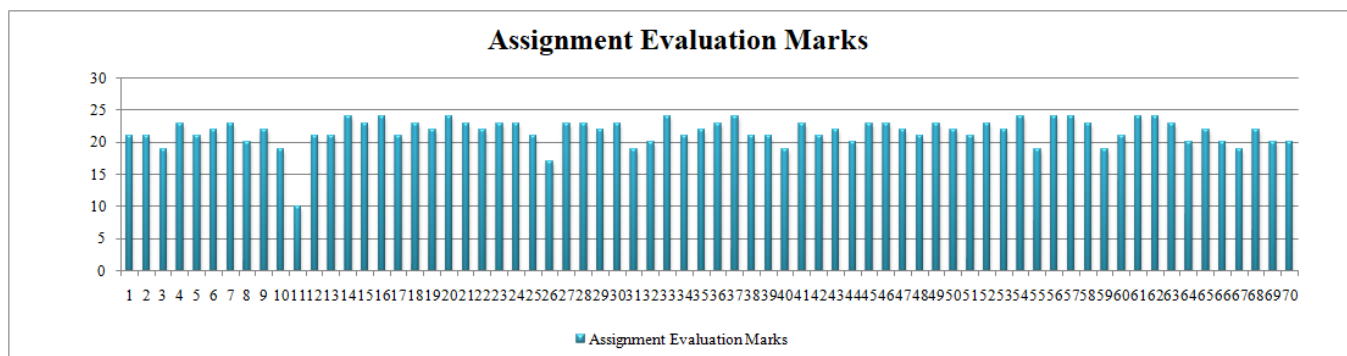


Fig.9. Assignment evaluation marks

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.

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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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.

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