Combination of problem-based learning and case-based learning in SQL Programming for data analysis

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***Abstract*—** The 21st century, the need to develop students to learn continuously. This paper presents the combination methods between case-based learning and problem-based learning in the SQL programming for data analysis. Firstly, the case-based learning will apply for the beginning such as the basic command. Secondly, problem based learning will apply to practice analyzing from real world problem. At the end of the class, the presentation of all students had to be show to learn each other. The goal of this research is to build students abilities to make their own assumptions from problems taken from the real world and use SQL programs to properly analyze their hypotheses.

Keywords— database; problem-based learning; case-based learning; SQL programming; data analysis

I. INTRODUCTION

Since the academic year 2017, teaching in the SQL programming for data analysis practical course has been revised to apply an active learning pedagogical model, to create fundamental knowledge for students. Therefore, a case-based learning (CBL), processes [1][6-7] will have the following teaching.

1. Divide the teaching content into 4 sub-sections: Intro to SQL programming / Inner join & Outer join / Nested query / Store procedure programming.
2. Use sample problems for individual student. In which the teaching will focus on syntax practice on a short period, how to search new function and also to check on the new version syntax before making an example.
3. Take an individual assessment test before group activities.
4. In each subsection, group activities are performed. By the same case problem, students must help each other and also present to share information to other groups. There is a requirement that who does any part, must present in the other part that other friends do.
5. Teachers will summarize and suggest to increase efficiency in the solving problems, suggesting advantages and improvements for all groups to consider together, solving each group's problems that system for practicing critical thinking skills for communication.
6. Teachers will assess students with a group or single. In order to measure the performance of the each student in group, if any member does not help, they are also cut scores.
7. Examination by individual.

From teaching in this method, the results scores in each academic year are as shown in the Table 1.

TABLE 1: Evaluation score in SQL Programming for data analysis in year 2017-2019

Year	No. of Students	Full score	Max. Score		Min. Score		Mean Score		Standard deviation (SD)	
			Pretest	Final	Pretest	Final	Pretest	Final	Pretest	Final
2017	36	40	28	35	5	22	21.22	28.15	7.46	6.23
2018	41	40	30	38	12	27	18.50	26.45	10.08	8.54
2019	47	40	26	37	10	28	23.55	30.25	8.73	6.72

From the Table 1, it can be seen that after doing CBL, students have more programming ability to solve problems. Scores results in group are also increase. From observing the final examination, how should the assumptions be analyzed to resolve the situation? It appears that the some student cannot do this. The teacher did a causal analysis by doing a questionnaire and came to the conclusion that two main reasons were as follows:

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1. 85% of students read a problem and don't know what to do. Because usually the problems they've encountered are clearly defined.

2. 15% of students think they score high on the basic problems. Then, don't do this at all.

When the reason is clearly known, teachers adjust the teaching process. Because of this is the main problem. If students can write code but they can't analyze real-world problems. The success of this course will certainly not achieve its goals.

II. METOLOGIGAL

A. Problem-based learning (PBL)

Actually, students cannot analyze real-world problems. An approach is to use PBL because it is a process that develops learners to be competent and have a learning process as shown in Figure 1.

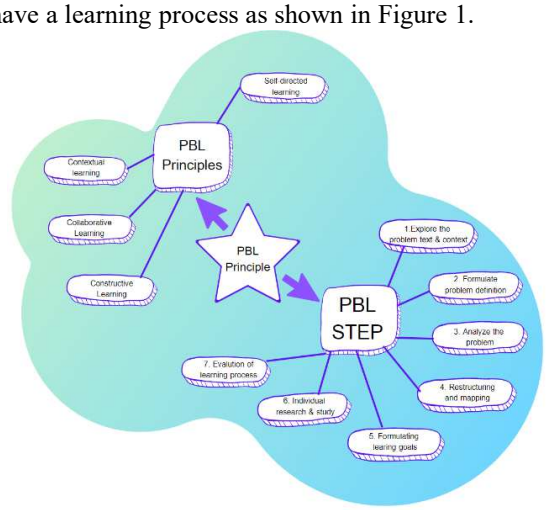


Figure1: PBL principle and PBL Steps [5]

However, the SQL programming focuses on building coding fundamentals for students first, thus changing the process in some lesson plans by adding PBL in sometimes.

B. Mix teaching-plan withCBL and PBL

SQL programming lesson plan maintains the use of CBL over weeks 1-10. The course will continue to focus on the fundamentals of SQL programming knowledge but will be more concise. There is a more concise time adjustment and adds the PBL as shown in this lesson plan, Table 2.

TABLE 2: Lesson plan in SQL programming for data analysis

Week	Content	Learning Format	Learning Objective
1-3	Introduction to Sql	CBL	- Syntax - Semantic - select normal
	Join Table		- Select multiple table
	Aggregate / group		- Generate simple report
4-5	Inner & Outer join		- Specify and appropriate - Choose between inner / outer join
6	Nested Queries		- Can join and sub-queries
7-10	Overall Experimental by using teacher cases	CBL	- Can solve teacher cases by using their own idea but the problem is totally clear
Individual Testing #2 with real world problem			
11-14	Overall Experiment by using real-world case	PBL	- Can clarify problem - Can solving problem - Can formulate their own goal - Can choose appropriate hypothesis to solve problem
15	Conclusion of each group solution		
Individual Final Test#3 with real world problem			

C. Diffrence problem between CBL and PBL

From different purposes and teaching styles, the questions must also differ. In the CBL [6] the questions are extremely clear. Students can immediately begin the process of finding solutions. The resulting question requires students to follow seven steps as shown in Figure 2.

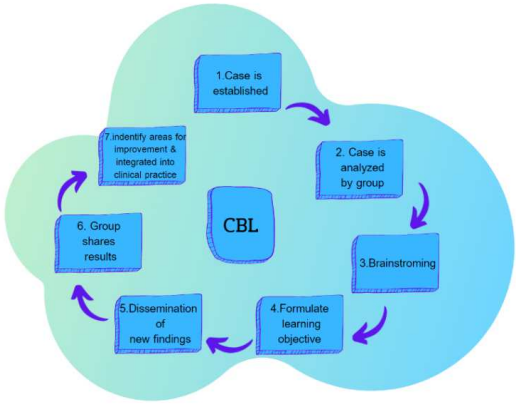
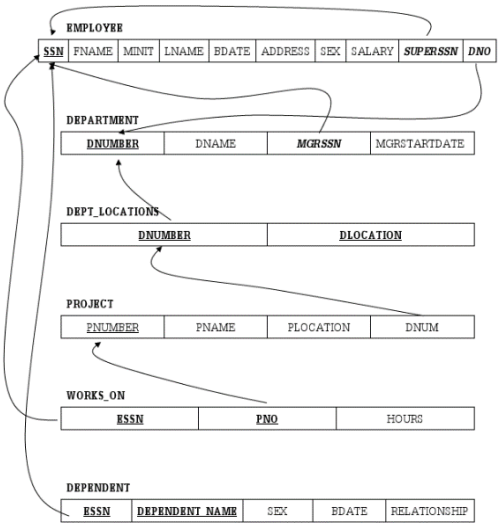


Figure2 Case-based learning Step [6]

An example of a question would be as follow. The problem provides structure, definition, meaning and sample data in database tables shown in Figure3.



(a) a structure of data

EMPLOYEE

SSN	FNAME	MINIT	LNAME	BDATE	ADDRESS	SEX	SALARY	*SUPERSSN*	*DNO*
123456789	John	B	Smith	1955-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
333445555	Franklin	T	Wong	1945-12-08	638 Voss, Houston, TX	M	40000	888665555	5
999887777	Alicia	J	Zelaya	1958-07-19	3321 Castle, Spring, TX	F	25000	987654321	4
987654321	Jennifer	S	Wallace	1931-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
666884444	Ramesh	K	Narayan	1952-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
453453453	Joyce	A	English	1962-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
987987987	Ahmad	V	Jabbar	1959-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
888665555	James	E	Borg	1927-11-10	450 Stone, Houston, TX	M	55000	null	1

DEPARTMENT

DNUMBER	DNAME	*MGRSSN*	MGRSTARTDATE
1	Headquarters	888665555	1971-06-19
4	Administration	987654321	1985-01-01
5	Research	333445555	1978-05-22

DEPT_LOCATIONS

DNUMBER	DLOCATION
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

(b) Example Data

Figure3: Example of given data for solving problem

Example of a problem: Use an SQL program to find the following information. There is a condition that must be the most efficient in the search.

1. Find the employees who are most responsible for the project in the department.
2. Show employee name and the number of subordinates of employee by showing everyone in the company.
3. Show group of people are working in each project?

It can be seen that the problem clearly states what is needed. Each group can brainstorm to code the correct results. It's probably the best results in searches that may take a different approach. Students must present to share their knowledge at the final stage of their work.

In [5] PBL, the question is ambiguous or ill-problem. Therefore, the group of students must brainstorm to find the problem definition. Then create a learning plan to solve problems in the group according to 7 steps as shown in Figure 4.

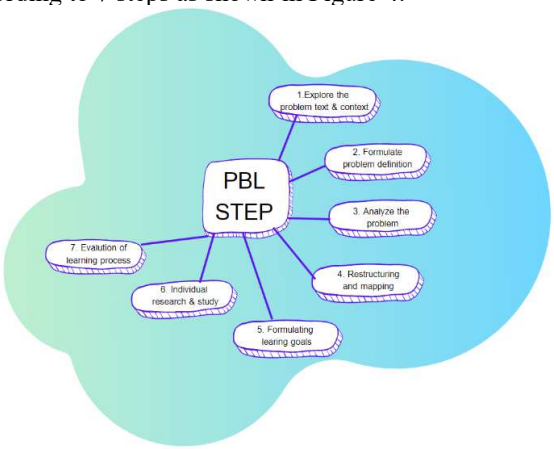


Figure 4: Problem-based learning step [5]

An example of a question would be as follows.

Provide structure of data collection in each organization system as shown in the figure 5.

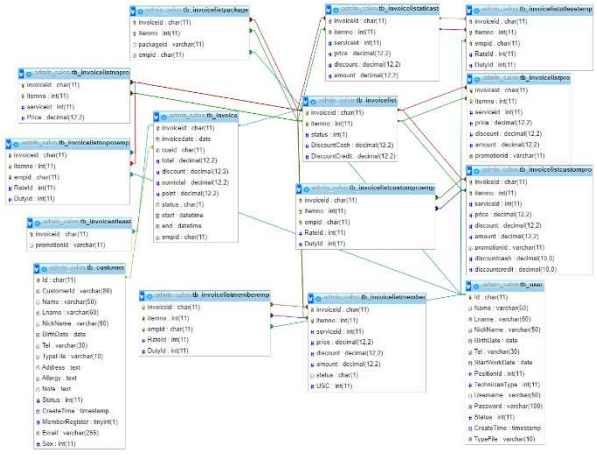


Figure 5: Example of company's data

1. Set the situation like the company operates at a loss for 3 years if the student is a data engineer in this company. How can there be help? In each method, the student must have evidence to support that idea.
2. Find a possible solution using SQL to find the result of the hypothesis.

D. Evaluation Model

The evaluation model [6-7] for CBL and PBL activities is the same as follow:

1. Allow students to be able to choose whether in the presentation and answering the questions will be selected as a group score or individually. To prevent the problem of having some people not working in the group. Whenever a single score is disbanded, that means the group is likely having trouble working together. Teachers will be able to solve problems in a timely manner.
2. Presentation must be presented in all parts. The instructor will choose from the topics students summarize. It is not necessary to present only the topic of learner's work. So that in the group there is truly knowledge sharing with each other.
3. There is a score in the evaluation of the friend's work in the group.
4. There is a score in the rating of the audience in other groups.

III. EXPERIMENT

In the experiment, an experiment was conducted with learners in the 2020 academic year in semester 1 and semester 2. The situation was set as follows. From Table 2 Lesson plan in SQL programming for data analysis will have:

1. Individual test #2 where the learners will not be doing group activities. Problem-based learning, but the exam contains real-world problems.

2. Individual final test #3 in which learners practice in group activities. Problem-based learning

and in the exam, there will be a real-world problem consisting of

Assumptions set in the experiment

1. Learners in the 2020 academic year for both semester 1 and semester 2 should have a greater percentage of those who took the Real-world problem test, and at least 30% on test #3.

2. Students in the 2020 academic year for both semester 1 and semester 2 should have better grade point averages. Last academic year, because it should be able to do more Real-World problems.

TABLE 3: Result of No. of student done on problem #2 & #3

Semester / Year	No. of Student	No. of Student do real-world problem #2		No. of Student do real-world problem #3	
		Persons	Percent	Persons	Percent
1/2020	49	25	51.02%	36	73.47
2/2020	46	30	65.22	39	84.78

From Table 3, it can be seen that the hypothesis in item 1 is true, the number of learners who were able to achieve at least 30% correctness increased from the second test.

TABLE 4: Evaluation score in SQL Programming for data analysis in 2017-2020

Year	No. of Students	Full score	Max. Score		Min. Score		Mean Score		Standard deviation (SD)	
			Pretest	Final	Pretest	Final	Pretest	Final	Pretest	Final
2017	36	40	28	35	5	22	21.22	28.15	7.46	6.23
2018	41	40	30	38	12	27	18.50	32.45	10.08	8.54
2019	47	40	26	37	10	28	23.55	31.25	8.73	6.72
1/2020	49	40	29	38	13	29	18.5	35.5	9.53	6.12
2/2020	46	40	22	37	15	27	16.45	34.5	8.75	6.17

From Table 4, it can be seen that the scores of the 2020 academic year for both the 1st and 2nd semesters were the most adaptive parts of the scores. Still unable to judge but the obvious part is the average score was higher for both semesters, and the distribution of scores was also reduced. Enough to conclude that the process of adjusting teaching. It can be seen that the hypothesis in item 2 is true. So that students learn to solve problems from the real-world, resulting in learners to learn together, share knowledge and be able to begin to analyze problems from real situations This means that learners will be able to relate what they have learned to their real-life work. Which will be more or less partly depends on the practice of the learners.

IV. CONCLUSION

From the experiment, it was found that the students showed improvement in problem solving. However, some interesting issues were the correctness of the problem analysis. Due to the assumptions set out in this test. There was only 30% or more accuracy in this research. That issue has not yet been considered. So in the next step, further analysis will be required to determine the validity. In addition, the professors noted that in some cases, the 2020 academic year revealed several types of alternatives. Some people only choose to deal with real-world problems. The teacher gave half the score for the basic problem. Some people choose to do just the basic case and some choose the real world. It's just an assumption. This information is analyzed by teachers to further improve teaching. This is for the development of the students themselves.

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