

Adapting LEARN-SQL to Database Computer-Supported Cooperative Learning

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ABSTRACT

LEARN-SQL is a tool that we are using since three years ago in several database courses, and that has shown its positive effects in the learning of different database issues. This tool allows proposing remote questionnaires to students, which are automatically corrected giving them a feed-back and promoting their self-learning and self-assessment of their work. However, this tool as it is currently used does not have the possibility to propose structured exercises to teams that promote their cooperative learning. In this paper, we present our adaptation of the LEARN-SQL tool for allowing some Computer-Supported Collaboration Learning techniques.

1. INTRODUCTION

Universities in Europe are involved in an uniformisation process in the so-called high European Space for Higher Education (ESHE). The adoption of this framework requires the reduction and optimization of the time spent in learning tasks with active participation of the student. ESHE also increases the importance of practice, personal relationships and the capacity to work within a team. These goals suggest the reduction of explanations in classes and the increase of personal and cooperative tasks performed by students.

Because of these reasons we began to introduce new didactic methods in the area of databases some time ago. On the one hand, since three years ago, we are using the LEARN-SQL tool (Abelló et al., 2007; Abelló et al., 2008; <http://www.upc.edu/learn-sql/>) that promotes self-learning and self-assessment, makes evaluation of exercises easier, and provides information about the knowledge of the students on different subjects of the database area. On the other hand, since one year ago, we have also introduced cooperative learning techniques in database courses.

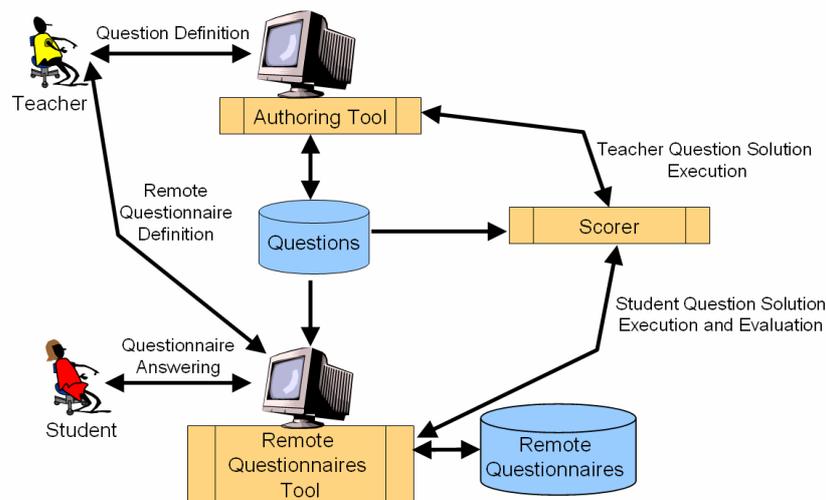
In both cases we began with a reduced number of students, in order to do not introduce changes that affect a big number of students, also to get used to the new learning techniques, and finally, because the preparation of classes and exercises, its evaluation, and also the feed-back that must be given to students requires much time from the teacher. Once extended gradually the application of these techniques, we have now practiced both didactic methods in courses with a considerable number of students. As the results obtained are satisfactory and promising, we will go further by using an adaptation of the LEARN-SQL tool that: provides the functionality of defining group exercises that

must be solved by some cooperative learning techniques; helps us in the evaluation of students; gives feed-back to groups of their effective learning; and facilitates Computer-Supported Cooperative Learning (CSCL), that is, the cooperative learning in an online framework.

In this paper we are presenting our adaptation of the tool, the particular cooperative techniques that the tool will provide, the results of the use of these techniques that we have already experienced without the help of computers, and how we can take advantage of the implementation of these techniques with the tool. The structure of the paper is the following: section 2 describes the tool; section 3 presents its adaptation to new learning techniques, the results of the use of these techniques in ordinary classes, and how we are taking advantage of the online implementation of these techniques; and finally, section 4 gives some conclusions.

2. LEARN-SQL

LEARN-SQL (Learning Environment for Automatic Rating Notions of SQL) is, in fact, a system composed of three tools, following the IMS QTI proposal (IMS learning Consortium, 2006). The Authoring Tool allows the teacher to manage the repository of questions or exercises, which can be used later on in several questionnaires. The students access remote questionnaires, to answer the questions that the teacher has assigned previously to them through the Moodle learning environment (Alier, 2007) which acts as the Remote Questionnaires Tool. Finally the Scorer evaluates the students solutions.



Currently, the categories of exercises that may be taught with the help of our tool are: SQL queries, SQL table definitions, SQL row insertion/deletion/updating, SQL view definition, relational algebra, conceptual model translation to relational model, normalization, verification of properties of a relational model, multidimensional queries, materialized views, table access structures, optimization and access plan. There are other tools related with learning in the database area, but, as far as we know, they just correct SQL queries and in some cases relational algebra (Brusilovsky et al., 2010; Dekeyser et al., 2007; Kenny & Pahl, 2008; Mitrovic, 2003; Sadiq et al., 2004; Soler et al., 2006, 2007).

We have implemented our tool with a strategy that evaluates in an objective way the students' solutions, taking into account that the exercises may be solved in many different ways and that is not

possible to know the whole set of correct solutions in advance. The strategy is based on several executions (depending on the exercise and its category) of the student solution using different inputs. Each execution constitutes an experiment which verifies if one of the possible mistakes has been committed. Assuming that the set of inputs are complete, if each experiment done with the student question solution produces the same effect than the one produced by the teacher question solution, we may guarantee the correctness of the student solution.

Currently we use the tool in our courses proposing three types of questionnaires:

- When a new subject that drives to a new category of exercises is introduced, we propose training questionnaires that the students solve online not during a class. Training questionnaires are evaluated but just to give feed-back to the student of his learning progress.
- If the new subject is especially difficult, the training questionnaire is solved at class with help of the teacher.
- When we want to evaluate if the students have achieved the learning specific goal of a certain category of exercises, they do a questionnaire in class for evaluation purpose. In these questionnaires some penalty is applied taking into account the number of students attempts.

Taking into account our experience with the tool, we may see that its use has several advantages: the teacher is no required to take part on the evaluation (automatic evaluation, leaving to the teacher more time available for the preparation of new exercises); the student may use it at any time and in any place, since it may be used through Moodle obtaining an immediate answer from the tool (interactive, online); the student receives feed-back about his errors and has the possibility to correct them and to submit a new answer (self-learning); the use of the tool as a training tool has increased the questions of the student to the teacher in order to clarify their knowledge, showing an improvement in the maturity of their learning of the different database subjects (learning goals achievement and average grade increased from 6.5, on a 0 - 10 scale, to 8.5). Moreover, the tool can perform with good response time even if the number of students is very high (scalable) and it is easy to extend to support new categories of exercises (extensible).

From the student's point of view, the tool not only has been accepted; in addition it is considered a valuable help. This can be concluded from the answers to a six-monthly opinion poll, involving more than 400 students (175 of them answered the poll) and 3 courses. The results obtained were (1 stands for maximum disagreement, 5 for maximum agreement):

- Having the tool available outside the laboratory helps me learning: 4.08
- Knowing the grade and the possibility to retry helps improving the grade: 4.05
- Messages about mistakes are useful: 2.99
- This is a good tool to learn SQL: 3.86

3. CSCL LEARN-SQL

We are going to begin the section explaining the implementation of cooperative learning techniques (CoLT) to our database courses and, after that, we will describe each of the techniques used and our

adaptation of LEARN-SQL for implementing them. Finally, we summarise the results that validate our implementation and, thus, justifies the adaptation of LEARN-SQL.

3.1. Implementing cooperative learning

Before introducing computer-supported cooperative learning techniques we decided to test these kind of practices in ordinary classes without any use of computers, in order to do a kind of validation of its use in the databases area.

After assisting to different introductory cooperative learning courses, we studied the big diversity of techniques recommended that may be considered as cooperative learning that may be find in the literature (Barkley et al., 2005; Jonhson et al., 2006; Kagan, 1994). We also considered the types of exercises to which we wanted to apply this kind of learning. These exercises are concrete exercises of some of the categories introduced in section 2, which can be solved in one or two hours of students work, that may have more than one correct solution and the learning objectives of which correspond to the *Application* level in the Bloom' Taxonomy (Bloom, 1956). It was also important for us to promote the comparison and discrimination among multiple solutions to exercises together with the positive interdependence and both individual and group accountability of the learning advances.

We finally considered the types of students that we have and our experience in asking them to do team-work. Our students are more or less homogeneous in morning classes taking into account their previous knowledge of the databases area (we think this is the only kind of diversity to currently take into account), but not in the afternoon classes, since there are a lot of students that already use databases in their jobs and also some students that repeat the course. Our experience in team-work is that having big teams (of more than three people) increases the chance to have students that do not do anything, although we knew that this must be solved by means of a proper design of the cooperative learning techniques and the evaluation.

All these previous considerations helped us to decide the following:

- The teams of students would be of three people, which would be randomly generated, with a requirement to have (as much is possible) students with previous knowledge about the database area distributed among the different teams. The teams are meant to be stable in order to increase fidelity, complicity and harmony in the personal relationships.
- We began with the implementation of three different kinds of techniques on a non computer supported framework. We have made variations of the techniques found in the literature in order to fulfill our requirements.
- We decided to begin the adaptation of LEARN-SQL to allow team support. This support is necessary whatever technique is going to be applied. As we said before, the Remote Questionnaire tool is used through Moodle and we use as much as possible Moodle functionalities. Thus, our courses are Moodle courses and our students are Moodle participants of the courses. However, Moodle does not give us the concept of team of students. For this reason we implemented functionalities for team management that allow the teacher to create randomly the teams, defining their size and if it is necessary defining incompatibilities among students. In spite of the initial requirements stated above, the new Moodle module for defining teams allows also the students to create and enroll to teams. Another functionality already

defined at this stage was the possibility to obtain lists of students and teams and to assign grades individually or by team.

3.2. CoLT techniques and online implementation

We present now the three techniques practiced (which we refer to as CoLT1, CoLT2 and CoLT3, borrowing this naming procedure from Barkley et al., 2005) for which we are going to provide an online implementation adapting them to LEARN-SQL, giving the possibility to use them outside the classroom. In the existing literature we just have found the approach in (de Raadt et al., 2007) that tries to add cooperative learning techniques to online database learning. Their approach proposes the use of just one technique that is similar to the one referred here as CoLT3.

3.2.1. CoLT 1

This is an instance of the *write-pair-share* technique (Barkley et al., 2005). We used it to teach the students how to make the translation of an UML class diagram to a relational database schema and also view creation exercises. The procedure was:

1. Give the same exercise to each member of the team; each student has to solve it individually. In the particular case of relational databases design, the exercise was an UML class diagram to be translated. Every student had to propose a relational schema.
2. Ask the students to join with the other members of their team and discuss about the proposed solutions. The difference with the *write-pair-share* technique is in the number of people that join to discuss their solutions.
3. Each team must create a joint solution that must be given to the teacher. The solution is corrected by the teacher and the feed-back is given to the students in the next class. This part is different from *write-pair-share* technique, where the students present the solution of the pair to the class, because we have observed that sometimes, when the students know that they can be asked to present something, they are just worried about his presentation and do not hear what the other students present nor the comments of the teacher to other students.

The purpose of the use of this technique was to promote the discussion and discrimination among different solutions. The grade obtained by each student becomes the grade of the other members of the team, trying to achieve positive interdependence.

LEARN-SQL can assist to publish the statement of the problem as a questionnaire; during stage 1 (individual thinking), the students are not allowed to submit any answer; during stage 2 (discussion) the tool can be the communication channel; finally, during stage 3 one chosen student is allowed to submit an answer in behalf of the entire team. Submitted answers are made public to all the students together with the grade and corresponding feedback.

3.2.2. CoLT 2

We designed this technique as an extension of the *Structured Problem Solving* techniques (Barkley et al., 2005). We used it to teach the students how to do exercises on serialization and concurrence control of transactions. The procedure was:

1. Give to the team one or more exercises and the steps that the team must follow to solve the exercises. In our case the steps were specific of the problem to be solved.
2. Ask the students to solve the exercises in group. The teacher gives feed-back if it is necessary during this part of the activity.
3. Give to each student one or more exercises similar to the ones solved before that, this time, must be solved individually. This stage does not exist in the *Structured Problem Solving* technique, but we think that it is important to achieve the learning of each member of the team.

The purpose of the use of this technique was to promote the students to practice together and learn from each other. Another purpose is to increase the positive interdependence, since individual students' solutions grades affect positively or negatively to the other members of the team and, thus the students are interested that all other members of the team learn to solve the exercises.

In LEARN-SQL we will have four questionnaires. One of them will be available to all the students of the team and the students will discuss and communicate with the tool as a communication channel. They will be allowed to send to the scorer as many solutions as they want, with no penalty. Afterwards, each of the other three questionnaires will be available to a single member. Some penalty will be applied as the students use more attempts. Submitted solutions will be made public to all the students together with the grade and corresponding feedback.

3.2.3. CoLT 3

The last technique that we practiced and that we are going to adapt in LEARN-SQL is based in the *Send-A-Problem* technique (Barkley et al., 2005). We used it to teach the students how to do relational algebra exercises and also in teaching methods for accessing data, and their efficiency implications. The procedure was:

1. There are three sets of exercises (each one with one or two exercises). Each member of a team solves one set of exercises.
2. Afterwards, each member of the team checks the solutions of another member of the team without interaction. In the original technique, *Send-A-Problem*, the different sets of exercises are solved by teams, and in this stage the solutions are passed to another team that proposes its own solution.
3. Finally each member of the team takes the solutions and the correction done by the other two members and gives an agreed solution to the teacher. In the *Send-A-Problem* technique it is a third team that decides which must be the agreed solution.

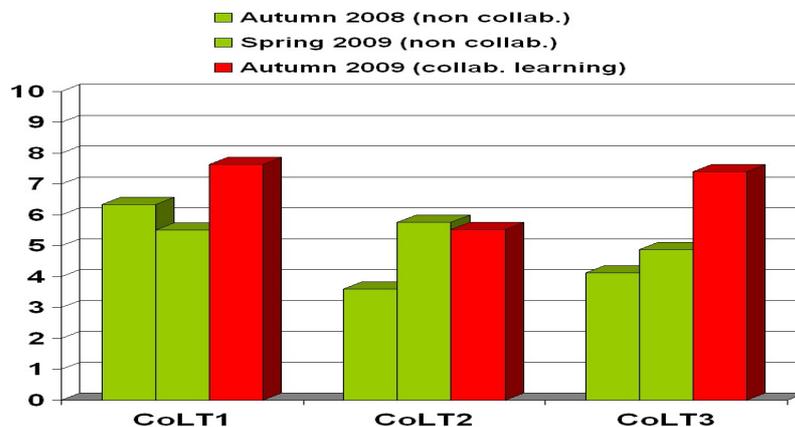
The purpose of the use of this technique was to promote learning to compare and discriminate among multiple solutions; it also promotes positive interdependence since the corresponding grade is assigned to each member of the team.

In this kind of activities, the students will use LEARN-SQL in each stage of the procedure. In the first and second stage, we do not consider the solution for grading the students; thus, the grade will depend just on the last solution sent, which will receive a penalty in case of multiple submissions.

Submitted solutions will be made public to all the students together with the grade and the corresponding feedback. The teacher will have information about the individual learning based in stage 3, but also in the solutions provided in stages 1 and 2, since is in this stage when the student has to show his knowledge about the subject.

3.3. Results of the experience with collaborative techniques

The graphic below shows the mean grade obtained by students in three exercises during three consecutive semesters on one course (involving 104, 137 and 123 students). Green bars correspond to semesters prior to the introduction of collaborative techniques and the red ones to the semester in which the same exercises were done using the techniques stated in the graphic itself (CoLT1, CoLT2, CoLT3). There is only one case out of six in which the result for an exercise is slightly better with no collaborative techniques (CoLT2, autumn 2009 vs. spring 2009). We did realize that the exercises to be solved individually were significantly more difficult than the ones solved in group; we think that this is the reason that caused this result.



4. CONCLUSIONS

The importance given to the active involvement of the students in the learning process is increasing every day. In particular, using teams to make the learning be the result of discussion, reasoning and sharing of knowledge within the team is a strategy that is getting very used.

In this paper we have presented our experience on the application of cooperative learning techniques in the area of databases. We have shown the positive results obtained and how we are making a step forward incorporating such techniques in LEARN-SQL, a self-assessment and self-learning of SQL tool that we have been using since three years ago. Our aim is to make it easy to work within a team without the need to meet in the same space, and time and to save time to students and teachers increasing thus the efficiency of the learning process.

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