Creation of Web based Tutor to Enhance Student Learning of Normalization

Harjeet Kaur
Dept. of Computer Science and Engg.
Lovely Profesional University
Phagwara, India
harjeet.kaur@lpu.co.in

Vinay Chopra
Dept. of Computer Science and Engg.
DAVIET
Jalandhar, India
vinaychopra222@yahoo.co.in

Abstract— **Relational database is an important subject area in computer science curriculum. Data normalization is one of the topics which is invariably found in database courses offered in different universities. To-date teaching-learning experience indicates that students find it difficult to understand the concepts of normal forms to obtain smaller well-structured relations. Very few commercial design tools are available to assist students in learning Normalization. Consequence is a big challenge for educators, in both, teaching as well as motivating students in learning Data base Design. This paper presents the design of an web based tutor to assist learning normalization, by resolving different issues in teaching database design. To reveal the effectiveness and positive impact of the tutor on student's perception, the paper is supported by the result of a survey made for assessing the performance of students on the tutor.**

keywords- Database Normalization, Teaching Methods, Learning Support, Web based Tutor

I. INTRODUCTION

Databases are a fundamental area of study in information and computer sciences courses. One of the main topics included in a prescription for a database course is data normalization. Normalization plays a vital role in both the theory and the practice of database design. The designers of database would normally be graduates majoring in computer science or information systems. Lack of understanding of basic concepts related to normalization and data design have a negative impact on student understanding of more complex topics which in turn hinders student achievement.

Until recently, traditional classroom methods of teaching supported by the textbook techniques have been used to enable students to do data normalization. However, now with the advances in software development and the power of the Internet to make available online learning resources, students have the opportunity to choose from alternative teaching learning tools and techniques. It will be interesting and informative to find out about the development of web based tutor for teaching students data normalization and compare its effectiveness in facilitating learning with those of traditional classroom textbook teaching methods.

This paper reports on a project exploring the potential of online learning tutor for supporting the teaching of basic concepts in designing of database systems and for enhancing the learning experience. The remainder of this paper is organized as follows. Section 2 covers issues in teaching databases and methods of resolution. Section 3 presents the overview of design and implementation of the web based tutor for learning normalization. The original abstract algorithms are omitted from this paper due to extensive coverage in the literature. Section 4 illustrates research design and data collection procedure. The effectiveness of the web-based tutor is evaluated and interpreted in this section, and section 5 concludes the paper with proposed future enhancements.

II. ISSUES IN TEACHING DATABASE NORMALIZATION AND THEIR RESOLUTION

When teaching databases, it has been found that students have problems in understanding some important concepts in normalization. For instance while applying normal forms to their database design students sometimes are unable to identify candidate keys, they may not be able to understand the theory of dependency correctly, and they may miss certain decomposition and get poorly designed relations containing redundancies. With suitable practice and assimilation we imagine these skills will be acquired, but interestingly, one of the skills companies consider to be most lacking in new IT graduate recruits is database design.

Relational-database normalization is a theoretical approach for structuring a database schema and it is very well developed. Unfortunately, theory is not yet understood well by practitioners. Major contributing factors behind this are

1. Traditional class room teaching environment
2. Lack of clarity and inaccuracies that persist in the presentation of some basic database concepts in textbooks
3. And, unavailability of good online visual tools which could aid the students during the learning process of relational database normalization.

The Traditional Teaching Model based on the traditional lecture format, in and of itself, is a big issue. The professor stands in front of the students and presents information. Lectures are used to discuss the various theories. Students rely on the professor to present the important concepts. Lab time usually occurs on a different day than the lecture. Therefore, there is a delay between learning new concepts and applying them. Lab assignments may not be related to lecture examples. And, it's not uncommon for students to become bored or frustrated. In a

978-1-4244-5265-1/10/$26.00 ©2010 IEEE

classroom of twenty to thirty students, there are going to be several students with differing learning styles and academic strengths and weaknesses. Some students learn better by visual means, others will learn better with auditory means, and still others are going to learn better with a hands-on approach. It is virtually impossible for a single teacher to accommodate all methods of teaching and learning. And woe to the teacher who has a couple of students who present themselves as "problem students," a student who is difficult to manage or who disrupts the classroom is also going to take away time that the teacher could be using to help with one-on-one time with his or her students.

A number of excellent textbooks on dependency theory already exist. Nevertheless, although textbooks can offer very good coverage of the material on dependency theory, they offer only limited forms of interactivity and limited scope for students to test their own understanding of database design principles. Many textbooks provide no practical exercises and, even when they do, these exercises are often limited in size and sophistication. Moreover, textbooks that do provide exercises do not necessarily provide "solutions", so students cannot determine whether they were able to "solve" the problems. The lack of clarity in defining the terms tables, relations, and normal form in textbooks is another potential source of confusion. Several database design concepts and techniques are commonly presented ambiguously in textbooks and are problematic for students..

Commercial DB design tools do not serve our purpose of teaching normalization and require high level programming skills. According to Mitrovic (2002) [3] web-enabled educational systems offer several advantages like minimizing the problems of hardware and software compatibility and distributing software to individual users. As such the students can access web-enabled tutors from anywhere at any time. Apparently, the best advantage of this method seems to be its flexibility. It would also imply that students would take responsibility for their learning. Some students may find it less intimidating to work with a machine than with people. The machine will not get tired of repeating something and the possibility of negative reactions that may emanate from a human teacher does not exist. When students use this method, the teacher may be more available to attend to their problems on individual basis. In order for online learning to be successful, teachers as well as learners must take on new roles in the teaching-learning relationship, and faculty must be willing to release control of learning to the students. As a result, the quality, quantity, and patterns of communication students practice during learning are improved.

III. Design of Web based Normalization Tutor

A. Architecture of Web Based Normalization Tutor

Figure I illustrate the architecture of Web Based Normalization Tutor. Due to the fact that web-enabled educational systems are becoming the dominant type of systems available to students, we designed our tutor as a web-based application. In addition to this, web-based systems offer several advantages in comparison to standalone systems. They minimize the problems of distributing software to users and hardware and software compatibility. It is a centralized Tutor, performing all tutoring function on server side, where database of users, comments and assignment are present. The client-side solution consists of an application which runs entirely on the user's computer within a browser. All implementations have been done using .net frameworks, ASP.net, C# with MS SQL Server as backend.

Student needs to login to the tutor first, in order to create his/her own space. Otherwise he will be able to practice on ready-made assignments only. Different options provided to a student include, creation of new assignments, loading of existing assignment, checking solutions to evaluate his or her own work and finally getting the correct solution of the problem given. Beside exercise solving, student can post and view comments to present his or her perception on the usability of the tutor.

B. User Interfaces and a Learning Session

In this section we briefly introduce how a student session starts in given web-based Tutor Figure II shows the overview of the most important part of the user interface. The lack of user-friendly UI can often lead to unpopularity of the software among students, that's why we put a lot of our attention in finding a good layout for the UI. The requirements for the layout were to give the user as much information possible about an assignment without losing the general view. In order to achieve this goal we split the UI in different views using tabs. Students have to first choose an assignment from a list with assignments, submitted by other users (students or lecturers). In addition, student may enter his or her own problem to work with. An assignment consists of a relational-database schema in universal-relation form (URF), i.e., all the attributes in a single relation and a set of FDs on the attributes. After an assignment has been loaded, we require the students to go through the following steps:

1. Identification of Candidate Key
2. Determination of Minimal Cover of FD's
3. Decomposition in 2, 3 and BCNF

The sequence of the steps is fixed. However, a student may ask for new problem any time during problem solving.

IV. Evaluating Student's Performance on Tutor

A. Design and Procedure of Evaluation

Based on the literature review of the existing evaluation methods and their characteristic [19] [20], the informal interview and survey evaluation approach is used to measure both teachers' and students' perceptions about the effectiveness of the textbook technique and the web-based tutor in helping them teaching or learning database

normalization. We sought comments from several colleagues involved in teaching database in the University. After their positive response and consent to conduct the survey on their students, tutor was used in a classroom environment. Total 75 third year students of 3 different programmes of odd term of 2009-10 academic year(current term), participated in the survey.

Students were given two identical set of Functional Dependencies, one set contained hypothetical attributes and other was close to real life example. Students were asked to identify the candidate keys and to give valid decompositions up to BCNF. Each student was asked to complete a survey questionnaire after they applied the textbook technique and the web-based tutor to solve the given problems. Students were asked to provide their perceptions of their performance of both the techniques. The questionnaire, which was administered at the end of the problem solving session, consisted of 5 questions, about

1. Using the textbook technique/tutor the extent of problems faced in finding
    a. Full functional dependencies
    b. Candidate keys
    c. Lossless decomposition
2. Helpfulness of the textbook technique/tutor
3. Perceived improvement in scores of normalization after using the textbook technique/tutor

The questions were answered in percentage. An open-ended question was also included on the survey to enable the students to include their comments about the textbook normalization technique and the tutor.

B. Results and Analys

Some very interesting facts can be extracted out from Table I. The students all reported that the software was useful in terms of helping to develop their understanding of dependency theory, and all agreed that the facility for testing their own solutions to normalization problems was motivating to use and important in developing understanding. They were unanimous in concluding that the tool was a major improvement, in terms of carrying out practical exercises, over the textbook.

Definitely the students prefer the use of tutor to learn the concepts instead of text book. Still some strange answers, of student contradicting his/her own point could also be seen. Preference for the tutor over textbook normalization technique was also observed in responses to the open-ended question on the survey questionnaire. Most comments about the traditional technique were negatively toned. They suggest that students felt that the textbook technique took more time and effort to master (especially after exposure to the tutor). In contrast, most comments about the tutor were positive.

V. CONCLUSION AND FUTURE WORK

Until recently, traditional classroom methods have been used to teach students how to normalize data. A web-based normalization tutor has been developed to enhance teaching and learning of database normalization. The tutor is user friendly and can be accessed through the Internet. Students' responses to the tutor were mostly favorable. The tutor can further be expanded to incorporate other types of dependencies also. A next step for this tutor would be to support other normal forms such as the fourth normal form (4NF), which is the next level of normalization after BCNF

REFERENCES

[1] Ronnie A. Fanguy,Betty A. Kleen, "Normalization Shootout: A Competitive Game That Impacts Student Learning", Issues in Information Systems, Volume VI, No. 1, 2005, pp. 21-27

[2] George C. Philip," Teaching Database Modeling and Design: Areas of Confusion and Helpful Hints" Journal of Information Technology Education Volume 6, 2007, pp. 482-497

[3] Mitrovic, A. "NORMIT: A Web-Enabled Tutor for Database Normalization", International Conference on Computers in Education (ICCE'02). p. 1276, 2002

[4] H. Mannila & K. J. Raiha, "Practical Algorithms for Finding Prime Attributes and Testing Normal Forms". 8th ACM SIGACT-SIGMOD-SIGART Symposium on Principles of Database Systems 1989, pp. 128–133.

[5] Bernstein, P. A. "Synthesizing Third Normal Form Relations from Functional Dependencies", *ACM Transactions on Database Systems*, Vol. 1. No. 4, pp 277-298, 1976

[6] Silberschatz, A., Korth, H. F., and Sudarshan, S., 2002, *Database System Concept*s, 4th Edition, Boston, MA: McGraw Hill.

[7] R. Elmasri and S. B. Navathe. Fundamentals of Database Systems (5th Edition). Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 2006.

[8] Yazici, A. and Karakaya, Z.: Normalizing Relational Database Schemas UsingMathematica, LNCS, Springer-Verlag, Vol.3992 (2006) 375-382.

[9] Kung, H. and Case, T.: Traditional and Alternative Database Normalization Techniques:Their Impacts on IS/IT Students' Perceptions and Performance, International Journal of Information Technology Education, Vol.1, No.1 (2004) 53-76.

[10] Kung, H-J. and Tung, H-L.: A Web-based Tool to Enhance Teaching/Learning Database Normalization, Proc. of the 2006 Southern Association for Information Systems Conference (2006) 251-258.

[11] Diederich, J. and Milton, J.: New Methods and Fast Algorithms for Database Normalization, ACM Trans. on Database Systems, Vol.13, No.3(1988) 339-365.

[12] Connolly, T.M., Stansfield, M.H., McLellan, E.: Using an Online Games-Based Learning Approach to Teach Database Design Concepts. Electronic Journal of e-Learning 4(1), 103–110 (2005)

[13] Connolly, T.M., Begg, C.E.: A Constructivist-based Approach to Teaching Database Analysis and Design. Journal of Information Systems Education 17(1), 43–53 (2006)

[14] Proceedings of the 6th Workshop on Teaching, Learning and Assessment in Databases (TLAD 2008), Cardiff, UK, HEA (2008)

[15] Lei Zhang; Kaschek, R.; Kinshuk, "Developing a knowledge management support system for teaching database normalization" IEEE ICALT 2005. Fifth IEEE International Conference on
Volume , Issue , 5-8 July 2005 Page(s): 344 – 348

[16] A.P. Sexton (Eds.), "Ideas in Teaching, Learning and Assessment of Databases: A Communication of the 7thInternational Workshop on Teaching, Learning and Assessment of Databases (TLAD 2009)" BNCOD 2009, LNCS 5588 pp. 213-224, 2009, Springer-Verlag Berlin Heidelberg 2009

[17] Y. Shi et al., "JMathNorm: A database normalization tool using Mathematica" ICCS 2007, Part II, LNCS 4488, pp. 186–193, 2007 @ Springer– Verlang Berlin Heidelberg 2007

[18] Samuel Mann and Mike Lopez (Eds), "Teaching Data Normalization: Traditional Classroom Methods versus Online Visual Methods – a Literature Review" 2008, 21st Annual Conference of the National Advisory Committee on Computing Qualifications (NACCQ 2008), Auckland, New Zealand 2008

[19] J. Prümper, "Software-Evaluation Based upon ISO 9241Part 10",Human Computer Interaction, Vienna Conference, VCHCI´93, Finde Siècle Vienna, Austria, 1993, pp255-265.

[20] M. E. Wiklund, "Usability in Practice: How Companies Develop User-friendly Products", Academic Press Professional, Inc., San Diego, CA. 1994.

Table I: Result of Survey

Question	Text Book Technique					Web based Tutor				
	I	*II*	*III*	*IV*	*V*	*I*	*II*	*III*	*IV*	*V*
Difficulty in finding full functional dependencies	18	12	4	37	4	19	19	12	21	4
Difficulty in finding candidate keys	12	20	29	14	0	16	21	25	13	0
Difficulty in finding decomposition	3	16	22	33	1	6	15	19	33	2
Helpfulness	10	35	23	7	0	9	33	25	8	0
Improvement in Perceived grades	22	35	17	5	0	18	21	29	7	0

Category, I: 0-25% II: 25-50% III 50-75% IV: 75-100% V: No answer (Values indicate number of students who answered in specified category)

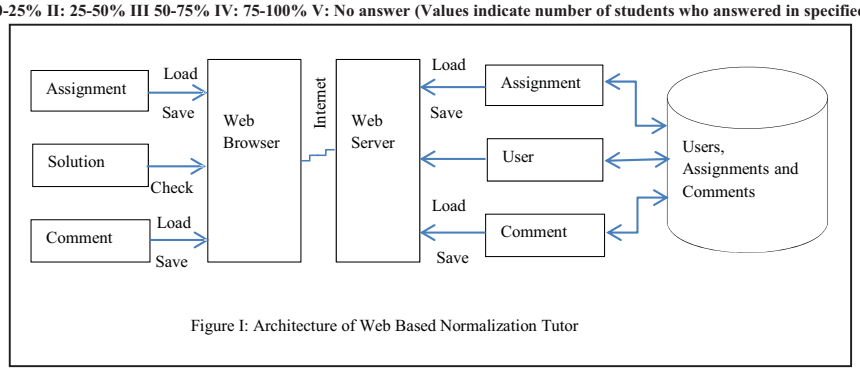

Figure I: Architecture of Web Based Normalization Tutor

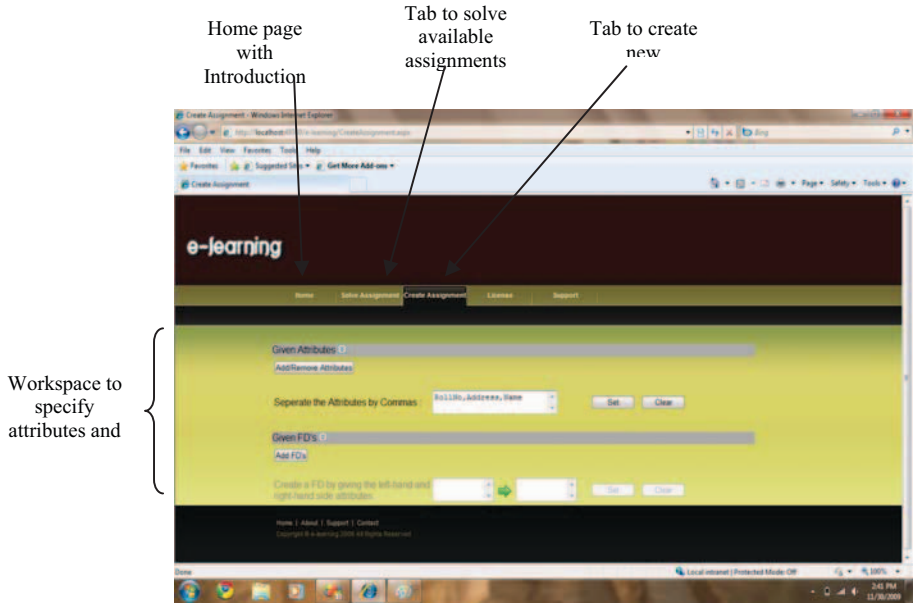

Figure II: A Snapshot from Web Based Normalization Tutor