DEVELOPMENT OF DATABASE SOFTWARE AND STUDY OF ITS IMPACTS ON
LEARNING AT HIGHER EDUCATION LEVEL

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ABSTRACT
Learning has been defined by different theorists in different ways. The essence of various
definitions is that learning is an enduring change in behaviour which results from experiences.
Constructivism is based on the premise that we construct learning new ideas based on previous
knowledge and experience. This approach will be helpful to the learners at the higher education
level because learning is unique to the individual learner. Modern digital technologies can be used
to make adequate provision for the learning experience. Digital technologies such as computer
and internet have been touted as potentially powerful tools for change and reform in the learning
experience. In this work, the author developed the database software using database technology
to enhance the learner to amplify their learning ability and potentiality. The purpose of the
database software is to develop personalization in learning. A Learner can organize the study
materials in the database. Database Technology will help the learner for managing the
information independently. This will lead to the approach called physical constructivism. By the
experimental method, the impact of database software in learning at higher education level was
studied. The investigators adopted the Two Group Experimental Design in which the
experimental group was exposed with the database software and the control group was treated
with the conventional method. Learning outcomes were analyzed through cognitive variables
such as Remember, Understand and Application. The higher difference in mean scores between
the experimental group and control group indicates that the database software was effectively
utilized by the learners.

Keywords: Constructivism, Cognitive variables, Database Technology, Database

1. Introduction
The need for learner-centered learning is emphasized heavily in higher education. The one-to-
one initiatives allow the learners to have far more access to relevant information. Constructivism
focuses exclusively on personalized learning. Learners are using various learning resources to
collect information. With the increasing amount of content available over the internet, the
major challenge for the learner is not just access to information and knowledge but to understand
what is more important to know and where the best source of that knowledge is
available. Technology-enabled learning is the application of some form of digital technology to
teaching and also learning in an educational context (Kirkwood, A.,& Price, L, 2016). This
approach will guide the learner towards progress in learning step by step.
Students are interested in using computers for their learning. Computer technologies presently
have a tremendous influence on learning. With the increasing amount of content available over
the internet, the major challenge for the learner is not just access to information and knowledge
but to understand what is more important to know and where the best source of that knowledge
is available. Though some software materials are developed to facilitate learning, they are still
used as readymade The software developed by using database technology will provide the learner
to search the content from different kinds of resources, store it in the memory space and retrieve
it for learning. The introduction of database technology for self-learning is still at the formative
stage. The software prepared for this study will provide a personalized environment on which
learner can store the learning material according to their need, interest and level of understanding. The learner can manipulate the information within the database quickly at any given time. The learner can also share the content with their peer group and teachers. The learner can easily retrieve the content by using the quick search option. Provision is given to take a print out of the required items. Students who need help to overcome deficiencies can use the technology available to enhance their learning.

2. Statement of the Problem
Higher education, also called post-secondary education is leading to an academic degree. Different learning styles are used by the students but still, there are problems in acquiring appropriate knowledge, thorough understanding, applying the principles and acquiring relative skills. Computer software materials in various forms are now available to resolve those problems. Though some learning packages are used, they are used as readymade tools and students cannot do their learning on their own. The software prepared by the professionals normally does not meet the local needs. Therefore attention has been drawn to the development, application and evaluation of database software in the field of learning at the higher education level. Specially designed software is applied to develop meaningful learning. The researcher has developed a software package using the database technology which will enable the learner to store, manipulate, update and retrieve the study material according to their learning ability. The researcher also made an attempt to study the effectiveness of database software with respect to the learning at the higher education level especially on selected cognitive variables such as remember, understanding, and application and hence the research is the study of 'Development of Database Software and Study of its Effectiveness in Learning'.

2.1 Operational Definitions
Effectiveness in this study refers to the ability to produce the desired result. It means it has an intended outcome and produces a deep, vivid and vibrant impression. Database technology is a core technology that links information management, processing data analysis, data visualization, presentation multimedia and hypermedia. The term cognitive is connected with thinking or the conscious mental process involved in knowing, learning and understanding things. Cognitive variables are used to process information. These variables are used to describe why one learner is lacking in learning ability, yet exhibits high competence in a specific area. In this study, cognitive variables associated with learning such as Remember, Understanding and Application are applied.

3. Significance of the study
Information, communication and collaboration are at the core of the educational process. Rapidly evolving technologies have influenced, and often transformed, the ways we think, learn and communicate and create knowledge. Creative technological applications allow information to be represented in different modes. Technologies are effectively used and creatively applied when

- The students are in control of learning (Personalized learning)
- Peer learning and collaboration are facilitated
- The diversity of learning strategies are needed

A quality higher education in the present century needs to address the outlook and creative thinking of learners. This includes their attitude towards learning, understanding the society and preparing them to meet the challenges. Students should be taught to learn efficiently and effectively with the support of technology by using database directly rather than commercial search engines. Students need to know how to handle with information ethically and safely as these are issues they are facing in higher education. They go beyond skills and technology to cover all aspects of personal, social and psychological development of learners. In the present world students must be aware of the implications of activity on digital media and open minded about the opportunities today we know that the amount of data generated online is several quadrillions of bytes per day. Student will be able to understand individual element and finally fit
into an overall system. The purpose of this paper is to explain the innovations in learning with database technology and how to enrich its usefulness in the learning of higher education institutions.

4. Review of Related Literature
Ananthi Sheshasayee and Nazreen Bee M (2018) in their research paper discussed the modes of improving the higher education system. Educational data mining can be applied to automate the learning process. Data mining in an e-learning system favourably adopt students who need sufficient knowledge as well as analyzing students who have faced difficulties in acquiring new knowledge. The researchers compared the new intellectual styles with old intellectual styles and proposed a new architectural design for educational technology system. Anupama Chodha (2018) has prepared an efficient clustering algorithm in Educational data mining. The Handbook of research on knowledge management for contemporary Business Environment prepared by the author suggested a suitable algorithm for knowledge management. In order to help the educational administration, the author developed an efficient clustering algorithm in educational data mining. Clustering is a technique of segregating the object into partitions such that the object on a group is more similar to each other than objects of other groups. Rai P.K and Pramod Singh (2017) analyzed the security threats to the databases. The developers of the database management system must understand the security aspects. The attackers will try to perform privilege abuse, privilege elevation, inference, SQL injection, misconfiguration, buffer overflow, weak audit, covert channel and weak authentication. The author pointed out the important aspects to be included as security factors such as authorization and authentication, encryption, access control etc. The authors suggested the discretionary access control, mandatory access control and role-based access control. Raji N.S and Kaur R (2019) conducted research on meta-cognition skills among college-going students. Their objectives of this study were to assess the differences among college-going students in academic achievement and metacognitive skills based on gender and to evaluate the relationship between academic achievement and metacognitive skills among college-going students. Descriptive survey method was used for this study. Simple random sampling was employed to select 200 college-going students from Jalandhar district of Punjab state. It is clear from the statistical analysis that the mean score of the metacognition skill of males and females are 78.910 and 76.450 respectively. The t-value is 1.938 which is not significant at 0.05 levels. It reveals that males and females do not differ significantly on their mean score of metacognition skill. Eileen O Donnel and Liam O Donnel (2018) have studied the challenges in developing adaptive educational hypermedia systems. The purpose of an adaptive hypermedia system is to provide each learner with learning experiences which have been specially tailored to their specific learning requirements. Guy Harrison (2015) in his book entitled 'Next Generation Databases' explained the three database revolutions. In the chapter on database models, he proposed that ideal database architecture would support multiple data models, languages, processing paradigms and storage formats within one system.

5. Objectives of the study
1. To develop and validate a database package for assisting undergraduate students in their learning.
2. To compare the achievement of learners through the conventional method of learning and learning with the support of a database package.
3. To find out the achievement of learners through the conventional method of learning and learning with the support of database package for cognitive variables viz., Remember, Understanding and Application.

6. Hypotheses
1. Undergraduate students who were learnt through database technology and conventional learning methods differ significantly in their post-test achievement scores.
2. There is a significant difference between the learning outcomes through the database package and conventional method at Undergraduate level in their i. Remember ii. Understanding iii. Application

7. Database Technology

Computer technologies are used to perform varieties of tasks in the field of education. One of the characteristics of computers is that they can handle large volume of data with great accuracy. However computers require memory to process the data. The undying search for data management has led to the development of database technology. A database is a computerized record keeping system. Database is a base for data. Before we define database we should understand the two terms data and information.

Data can be defined as a set of isolated and unrelated raw facts represented by values. The values are represented in the forms of numbers, characters or symbols. Although these data is represented as words, it is difficult to figure out the significance of these values. When the data is processed and converted into a meaningful and useful form, it is known as information. Hence information can be defined as a set of organized and validated collection of data. Database is an assembled group of data. Database is a computerized record keeping system. A database allows easy and efficient storage, retrieval and modification of data regardless of the amount of data being used. Techniques and technological devices have been developed to store and manage information. A database is an organized collection of data which is stored based on the same context. For example a student database contains similar data of all students and every student’s entry contains similar type of information.

There are two types of database viz., Centralized database and Distributed database. In centralized database system, all data is stored in a single site. It offers a great control in accessing and updating data. In distributed database system, the database is stored in several computers. Computers may communicate with one another through internet or telephone lines. Centralized database is used in the application of database technology in learning.

7.1 Database Management System

The software system that manages a database is called the database management system. A Database management System is a collection of interrelated files and set of programs which allows users to access and modify files. It provides convenient way to store, modify and retrieve information. Application programs request DBMS to retrieve, modify/insert/delete data from the file system which receives data from the database. For interacting with DBMS, query languages are used. A database system is a collection of data items. Data modeling is a way of organizing a collection of information pertaining to a system under investigation. Every database and database management system is based on particular database model. A database model consists of rules and standards that define how data is organized in a database. Before developing the program for database management system, the selection of appropriate database model is important. The relational model has become the standard model. The main advantage of this model is that the entire file format is visible to the user.

7.2 Relational Database Model

The relational database model is used to develop database software for learning. The relational database model was first developed by Edgar F.Codd in the year 1969. The relational model represents the database as a collection of relations. In relational model the data are stored in tables. Each table has rows and columns. The collection of all the fields in a row is known as a record. The columns are organized by the attributes. Primary key is used to identify a record in the tables. For example COURSE – ID is the primary key. Foreign key is the field in the table which is the primary key in another table. The advantage of relational model is simplicity, easy to access, structural independence, query capability and data independence.

Four basic operations performed on relational database models are

● Insert which is used to insert data into the relation.
Delete which is used to remove the data permanently.
Modify which allows the user to change values of some attributes
Select which allows the user to choose the specific data.

7.3 Database management technique

Database management techniques come in many shapes and colours. Putting each part of data in its own technique and identifiable cubbyhole allows programs to find and display it when required. On the one hand, using text files requires low overhead in terms of their creation and storage. On the other hand it demands that the developer write a search engine to extract information. This approach will work for simple applications but it quickly breaks down as information becomes more complex or searching requirements become more sophisticated. The alternative is to use database management software. Such systems not only provide structure to the data, making it easier to search and retrieves data, but they also provide tools to facilitate searching, data maintenance and system security.

8. Building a database software

Before creating a database, it is important to figure how to use the pages of the desired software, what data must populate the database for it to fulfill that purpose and where to find that data. In making this decision, it is helpful to define the purpose of the page. The first step in this process is to create an account in the database software that gives permission to log into the database and execute the desired query (Fig 1). It is good to create unique user accounts for each application and to provide those accounts for the applications to do in job.

The components of database software are to be prepared as separate modules. The components of a database include user account. Separate accounts can be created for database administrator, program developer and the end user. Data is one of the components in the database. A very huge amount of data is stored in the database which forms the basis for all other operations in the database. There are two types of data. One is user data which is based on the requirement of the end user and other one is meta data which stores the information like how many tables, names of the tables, primary keys, foreign keys etc., Next important component is the Database Management System which helps to interact with the user (Fig 2). It allows the user to insert, update, delete and retrieve the data. Database application is another component which helps the user to interact with the database by means of query languages.

8.1 SOFTWARE DETAILS (OPEN SOURCE)
1. Relational database: MySQL version 5.5.60 / MariaDB
2. Web Server: Apache 2.4.6
4. Front – end frame work: Bootstrap 4, HTML5/CSS3/JavaScript/Ajax/Slim REST API

The researcher has adopted the following eight stages in the development of database software package.

i. Define the purpose of using the relevant study materials
ii. Provide login credentials to the learner
iii. Display of the prescribed syllabus of the course
iv. Collection of learning materials
v. Generation of ideas for the collection of learning materials
vi. Organize the learning materials
vii. Storage and retrieval of content
viii. Evaluate the effectiveness of the content

i. Defining the Purpose of using the relevant study materials

This stage refers to determining what the investigator wants the learner to know or will be able to do at the end the learning. A more complete elaboration of very specific learning objectives both at the entry and terminal points of the content is desirable. This will be useful for
a number of purposes particularly to use relevant study material appropriate to their learning ability. Keeping the above in mind as the basis for framing objectives the investigator identified the entry behaviour and terminal behaviour and determined the learning outcome of the selected students.

**Entry behaviour**

The entry behaviour of the learner has helped the investigator to do the research work in right direction.

**Terminal behaviour**

The success of any course in an educational programme depends upon the attainability of the terminal behaviour.

ii. Providing accessibility to the learner

The researcher has developed the software with the provision for user login. Login credentials such as Username and password is assigned to them. The students of experimental group are registered with all their particulars including their university register number, programme of study, course name and name of the college. Their University Register number will be their user name. User can set their password and it is kept confidential. Since the database software is available in the cloud computing, the user can use at any time. Accessibility is available 24 x 7.

iii. Display of prescribed syllabus of the course

The syllabus prescribed by the university is displayed in the software. The user can select the topic by copying the topic.


The user can select the search engine through the web browser. User can enter the topic or easily students can paste the selected topic from the syllabus in the specified location. The search engine will display the list of websites related to the topic. User can choose the suitable material from the desired website.

v. Storing, updating, retrieving and deleting the content.

The user can store the subject material collected from the website in the location available in the software along with the name of the topic, name and URL address of the website. The learner has the privilege to alter the content according to the level of understanding of the learner. User can copy the content of reference books and store it in the location. User can also type the content directly in the workspace and store it for future reference. Provision is made to retrieve the desired content by searching with the help of the keyword. Students can also delete the least recently used or unused content to accommodate other information.

vi. Generation of ideas for the collection of learning materials

It is at this stage in the design process that the researcher encountered difficulties. It was far easier to decide what to learn, that is, to define the purpose of learning. For the generation of creating ideas, the researcher followed the brainstorming procedure.
9. Experimental Design

The experimental method was used by the investigator. The investigator has developed database software for managing the learning materials. To study the effect of database technology as compared to the conventional methods of learning, the investigator adopted the Two Group Experimental design in which the two groups were treated with different learning strategies. This design was used to compare the status of a group that has received an experimental treatment with one that has not. The Pre-test and Post-test Experimental Design was followed for this study. The sample was divided into two different groups’ viz., the Experimental group and Control group. The control group was allowed to learn through a conventional method whereas the experimental group was exposed with the database package.

The students at the undergraduate level in the Bharathidasan University, Tamilnadu, India formed the universe of the study. 84 students studying UG programmes in four Arts and Science colleges were selected as sample for this purpose. Purposive sampling method was used for sample selection. There were 46 students in the experimental group and 38 students in the control group. The treatment variables were the learning strategies namely
(a) Using the database software package and
(b) Conventional method of learning.

The dependent variable was “Achievement of students”. The tools used by the researcher consisted of the database software developed by the researcher called CVLP, achievement tests for pre-test and post-tests developed by the investigator and the personal data blank to collect data from the sample students. The database software developed by the researchers is available in the URL: http://139.59.57.143/cvlp.

An achievement test is a tool generally used to test the learning outcome of the learner. In consultation with the professors in the field of Education, due weightage was given to the instructional objectives viz., Remember, Understanding, and Application.

The period of research was one semester. At the start of the research pre test was conducted with the same tool for the experimental group and control group. At the end of the study, post test was conducted and the difference between the mean scores of the control group and the experimental group in their learning outcome was analyzed statistically.

In this study, t-Test to analyze the differential hypotheses using SPSS package is the statistical technique applied to draw conclusion. The following experimental design was adopted for the study.

\[
R = \begin{bmatrix}
E_R & P_l & L_1 & P_0 \\
C_R & P_l & L_2 & P_0
\end{bmatrix}
\]

Where \(E_R\) and \(C_R\) denote the samples chosen for
the Experimental group and Control group respectively. \( P \) denotes the pre-test measure of the scholastic performance in learning physics. \( P_0 \) denotes the post-test measure of the scholastic performance of in learning physics. \( L_1 \) denotes learning through the software developed using the database technology and \( L_2 \) denotes the learning through the conventional method.

10. **Analysis and Interpretation**

**Hypothesis - 1**

Undergraduate students who were learnt through database technology and conventional learning methods differ significantly in their post-test achievement scores.

In the experimental study, it is also essential to find a significant difference in the achievement level of the experimental group and control group at the post-test level. The outcome of the analysis will help the researcher to study the effect of database technology in learning physics at the undergraduate level. Hence this study was conducted to study the significant difference between the two groups. In the present study, the achievement of students in the post-test was studied.

**Table 1**

<table>
<thead>
<tr>
<th>Group</th>
<th>Size (N)</th>
<th>Mean (( \bar{x} ))</th>
<th>SD</th>
<th>( t )-value</th>
<th>( p )-value</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>46</td>
<td>25.98</td>
<td>5.3</td>
<td>7.73</td>
<td>&lt;0.00001</td>
<td>Significant*</td>
</tr>
<tr>
<td>Control</td>
<td>38</td>
<td>18.50</td>
<td>2.98</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at 0.05 level

The calculated \( t \)-value 7.73 and the \( p \)-value is less than 0.00001 and thus it is significant at 0.05 level. This implies that the difference in mean scores between the two groups is significant. Therefore, it is evident from Table 1 that the achievement of the experimental group was significantly different from the achievement of the control group. The students in the experimental group performed better than the control group. The hypothesis is accepted at 0.05 level of significance.

**Hypothesis - 2**

There is a significant difference between the learning outcomes through the database package and conventional method at Undergraduate level in their i. Remember ii. Understanding iii. Application

The mean gain scores of the experimental group and control group are studied in the three dimensions namely Remember, Understand and Apply.

**Table 2**

<table>
<thead>
<tr>
<th>Cognitive variable</th>
<th>Group</th>
<th>Size (N)</th>
<th>Mean gain score</th>
<th>SD</th>
<th>( t )-value</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remember</td>
<td>Experimental</td>
<td>46</td>
<td>8.30</td>
<td>3.80</td>
<td>9.09</td>
<td>Significant*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>38</td>
<td>2.32</td>
<td>1.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand</td>
<td>Experimental</td>
<td>46</td>
<td>1.85</td>
<td>1.98</td>
<td>2.74</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>38</td>
<td>0.87</td>
<td>1.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply</td>
<td>Experimental</td>
<td>46</td>
<td>1.20</td>
<td>1.54</td>
<td>2.55</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>38</td>
<td>0.47</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*At 0.05 level
From Table 2, it is inferred that the mean gain scores of the experimental group and control group differed significantly at 0.05 level of significance in all the three variables viz. Remember, Understand, apply. The higher mean scores of the experimental group indicated that their performance based on remember, understand and application of the concept, through database technology were better than the students who used the conventional method for learning. The hypothesis is accepted at 0.05 level of significance.

11. Discussion
The database software developed with an objective to enhance the learning at higher education level is simple to access and user-friendly. Students used this software to manage their learning materials. Students are capable of acquiring knowledge at their own level of intelligence. This will help them to understand the specific concept without ambiguity. This will naturally help them to apply into the construction of new, novel and innovative ideas. The achievement level of the undergraduate students who have used the database software is better than the achievement of the students who have used conventional learning methods. From the Table -1, it is inferred that database technology is found to be more effective on learner's achievement than the conventional method. At the higher education level, the database software is more effective in the realization of learning objectives viz., remember, understand and apply than the conventional method of learning. For self-learning, database software is an effective tool. It is inferred from the result that database technology will help the learner to develop their potentiality step by step. The Learner can use the software to select the desired content based on their potentiality and stored it in the database. Whenever and wherever required the content can be retrieved easily. This helps to increase the achievement level of the students. From the Table -2, it is evident that database software will assist learner to perform well in all the dimensions of the cognitive domain. The difference in mean gain score between the experimental group and control group is high with respect to the cognitive variable, ‘remember’. In the case of other cognitive variables ‘understand’ and ‘apply’ the difference between the experimental group and control group is marginal. Thus the potentiality is high at knowledge level. It will be accelerated to the next higher levels by increasing the application of database technology for learning. Database will become a permanent asset to the learner. They can their own database for future reference and all time reference. When the learners are accelerated into the next levels in future, they can modify and update the content.

Conclusion
This learning package accelerated the power of acquisition of knowledge than the conventional method. In terms of understanding and application of knowledge, the effect of database software developed by using the database technology does not differ much from the conventional method of learning. When the students are using the database software continuously, they will perform well in the understanding and application levels. As experienced by the researcher, the use of database software package developed using database technology has helped the learners the effective use of knowledge. It acts as a supportive mechanism in learning. It will stimulate learner towards effective learning. Students can select the learning materials independently and store it in their database. This kind of softwares can be enriched with the support of data mining and data warehousing techniques in future.

References


