Effect of Database Technology on Some Cognitive Variables in Learning of Physics at Undergraduate Level

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ABSTRACT
Education for sustainable development is an emerging concept that encompasses a new vision in physics education that empowers the learner to assume responsibility for creating a sustainable future. Physics education is still struggling to adapt to the personalized approach in learning. Personalized learning thrives in this technology-rich environment, but it is not enough to revolutionize the learning experience. Physics is a challenging subject to learn at higher education level due to its heavy emphasis on problem-solving. Technologies in learning physics create a learner-centered learning environment that is individualized and interactive. The authors attempted to develop the software using database technology for assisting learners to keep their learning materials for learning physics step by step. Database tools are primarily used for storing, modifying, extracting and searching for information within the database. The tool used for this research was the Database software (CVLP) which was made available on the cloud platform. This tool was designed by using the relational database model. The researcher has used the experimental method in studying its effectiveness in learning physics. The samples selected for this study comprised of the students studying an undergraduate course in four colleges at Tamilnadu, India. In this study, t-Test was the statistical technique applied to draw conclusion. The higher difference in mean scores between the experimental group and control group indicates that the database software was effectively utilized by the learners. The results revealed that the database software developed by the researcher helped the learners in learning physics concepts and solving physics problems.

Keywords: Database Software, Database Technology, Physics Education

INTRODUCTION
Physics is the challenging subject to form an essential and unavoidable base for many professional subjects. Learners are facing many challenges in physics education at the undergraduate level. The major challenges faced by the students are that they should remember, understand and use so many constant values, standard laws, basic principles, important facts and phenomena frequently. A good physics education should be a blend of learning physics and also acquiring a skill to conduct experiments to solve problems. Physics has two areas such as theoretical physics and experimental physics. Theoretical physics deals with an explanation for the pattern in nature that is supported by scientific evidence and verified multiple times by various groups of physicists. Experimental physics deals with the systematic and sequential procedure which is based on empirical evidence. Students of Physics at undergraduate level find difficult to connect the concept they studied in the classroom with the laboratory experiments. Students also find difficulty in solving physics problems related to the concept they studied in the classroom (Natasha, 2017). With their problem-solving ability and understanding the principles of physics, they can fulfil the requirements of society. Meeting these goals will be a difficult task. It is necessary to gather so many related issues for understanding any concept. But with the advent of computer technology, it will be easy. In this line of thought, the authors attempted to use database technology to support the learner.

The one-to-one initiative will allow the learner to have far more access to relevant information. Technology-Enabled learning is the application of some form of digital technology to teaching also learning in an educational context (Kirkwood and Price, 2016). Database technology is one of the core areas of computer technology. Many researchers have conducted their research through developing tools using Data mining and Data warehousing. Data mining in an e-learning system favorably adopt students who need sufficient knowledge as well as analyzing students who have faced difficulties in acquiring new knowledge (Ananthi and Nazreen, 2018). After reviewing related literature, authors found the research gap that the personalized repository will be developed to assist learners to organize their learning materials in a personalized manner. Authors analyzed

many kinds of database tools and attempted to develop a simple software package by using the relational database model. It will provide the learner to search the content from various kinds of resources, store it in the memory space and retrieve it for learning. The researchers have developed a software package using database technology which will enable the learner to store, manipulate, update and retrieve the study materials according to their learning ability. Students can search and manage the content so that they can accelerate their level of learning from the knowledge level to understand level and then to skill level. Knowledge, understand, application and skill are the cognitive variables. The investigators adopted the Two Group Experimental Design in which the experimental group was exposed with the 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 influence of demographic variables such as gender, locality, medium of instruction and type of institution were also analyzed.

OBJECTIVES

- To develop and validate a database package for assisting undergraduate students in their learning.
- To compare the achievement of learners through the conventional method of learning and learning with the support of the database package.
- To find out the achievement of learners through the conventional method of learning and learning with the support of the database package for cognitive variables viz., Remember, Understand and Application.
- To know the influence of demographic variables viz., gender, the locale of the learners, type of institution, and type of institution and medium of instruction at higher secondary school level on their achievement.

HYPOTHESES

- Undergraduate students who have learnt the concepts of physics through Database technology and conventional learning methods differ significantly in their post-test achievement scores.
- There is no significant difference in the achievement of learners through the conventional method of learning and learning with the support of the database package for cognitive variables viz., Remember, Understand and Application.
- There is no significant difference in the achievement of male learners and female learners in their achievement in learning physics.
- There is no significant difference between the students from urban background and students from a rural background in their achievement in learning physics.

REVIEW OF RELATED LITERATURE

Review of literature on a research problem makes the researcher familiar with the concise of previous research, the writing of experts in the area of research, what is already known, and what is still unknown and untested and thus provides a background for the development of the study undertaken.

Bhupathi (2015) discussed in detail about the ailments in physics education in India. Some of the physics students in the students in UG colleges do have a target to go for higher studies and research. There is no mechanism to check the quality of resource materials used by the students for their studies. Dewi and Nur (2018) analyzed the problem-solving skill in physics. The success of college students is the main aim of education on tertiary education level. Students who do not reach success learn allegedly caused by many factors. Among them, the lack of supporting material is an important one. Based on these two researchers the authors realized the problems of learners who are opting Physics as their main subject. Govindarajan (2019) in an article on development and analysis of infotainment programme on learning of physical science at secondary school level pointed out that the main concern of the teachers in the secondary level is on making the student understand the concepts of physical science easily. The authors at this point realized that modern technologies will provide support to the learner. The authors attempted to use one of the emerging field called database technology.

Hongying, Lingling & Liyou (2018) have studied the application of database technology in the information society and its existing problem and analyzed the development of a knowledge database. Knowledge database can be defined as a collection of knowledge, experience, rules and facts. Rai and Pramod (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, Buffer overflow, weak audit, covert channel and weak authentication. HongYing, LingLing & Liyou (2018) analyzed the technology in the development of a knowledge database. The researcher got ideas to use database technology. The researcher reviewed the works of Mohammed and Yassir (2018), Adham (2017), Vodomin and Androrec (2015) & Mimoza (2016) and deeply understands the big data environment, database for educational

applications and use of SQL for the development of database software. Further, the researcher reviewed the next generation of databases analyzed by Guy (2015), Anupama (2018), Hemamalini and Suresh (2018). Naren (2018) discussed the suitable algorithm for the development of software for data mining. The concept of data mining is useful for the selection of study material from the websites and to store it in the data warehouses. The researcher attempted to use these two techniques in software development. Anupama (2018) have 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. With the help of all these and many more reviews, the authors attempted to construct new software using database technology.

METHODS

The investigator developed the database software and named it as CVLP. This tool was made available on the cloud platform. Students in the experimental group were registered and used the tool for learning physics. It is still available in the following IP address: **http://139.59.57.143/cvlp.** Another tool used for this research was achievement tests for pre and post-tests developed by the investigator and the 'Personal Data Blank' to collect data from the sample students. In this study, t-Test was used to analyze the differential hypotheses. The treatment variables were the learning strategies namely '**using the database software package' and 'the Conventional method of learning'.** The independent variables are Gender and Locale. The dependent variable was "Achievement of the students". The following experimental design was adopted for the study.

E_R	P_r	L_1	Po
C_R	P_r	L_2	Po

In the experimental design, E_R and C_R denote the samples chosen for the Experimental group and Control group respectively. P_r denotes the pre-test measure of the scholastic performance in learning physics. Po 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 learning through the conventional method.

The size of the experimental group was 46. The students of the experimental group preferred the learning of physics through software developed by using database technology. The experimental group was subjected to the achievement test (Pre-test) constructed by the investigator on the selected units of one of the course 'Electricity, magnetism and Electromagnetism' of undergraduate physics programme. Then the experimental group was exposed through individualized training to the handling of the software. During the training of operating the software, proper care was taken to clear the doubts and the problem likely to be faced by the students. They were provided with operating manual and permitted to take own time to complete the lesson. The students were again assessed with the help of the achievement test. The items in the post-test are similar to that of the pre-test, but the order of items was different. The medium of learning was English.

The size of the control group was 38. The students of the control group preferred the conventional mode of learning physics. The students of the control group were subjected to the achievement test (Pre – Test) constructed by the investigator on the selected units of one of the course Electricity, magnetism and Electromagnetism of undergraduate physics programme. The control group was then exposed to conventional study methods using reference books, notes prepared by the teachers and classroom observation. After the completion of the learning sessions, the investigator administered the post-test. The items in the post-test are similar to that of the pre-test, but the order of the items was different. The medium of learning was English.

The students at the undergraduate level opting for physics as a major subject in the four colleges affiliated to the Bharathidasan University, Tamilnadu, India formed the universe of the study. 84 students were selected from the Second year B. Sc., Physics programme as the sample for this research. Purposive sampling method was used for sample selection. There were 46 students in the experimental group and 38 students in the control group.

DEVELOPMENT OF DATABASE SOFTWARE

The software package prepared for this study will provide a personalized environment on which learner can store the learning material according to his need and manipulate the information within the database quickly at any time. In order to study the effectiveness of database technology in learning physics, the pre-test and post-test experimental design were used. The sample was divided into different groups viz. 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 technology. At the end of the study, the difference between the mean scores of the control group and the experimental group in their learning outcome was analyzed.

SOFTWARE DETAILS (OPEN SOURCE):

1. **Relational database: MySQL version 5.5.60 / MariaDB**
2. **Web Server: Apache 2.4.6**
3. **Web Development language: PHP Version 5.6.38**
4. **Front –end frame work: Bootstrap 4, HTML5/CSS3/JavaScript/Ajax/Slim REST API**

The first page called Home Page, the title and the login credentials are given. User can type their valid user name and password to enter into the software. Captcha code is provided in order to tell computers and human apart. In the second-page user details are given on the top of the page. By clicking the 'syllabus' tab, the syllabus prescribed by the University for the Selected Course will be displayed. The Learner should type the unit number, unit name and name of the topic. At this stage, if the learner wishes to access the web site then students should open and search the content.

The selected content can be copied from the website partly or wholly and can be pasted in the 'notes' tab. Students can store the URL of the web page in the 'Source' tab. The learner can directly type the content from the book or their own notes. The learner is instructed to type the source for future reference. By clicking the 'save' tab the content will be stored in the database. There is a provision for taking printout of the material. This can be done by clicking ' Print my Learning material' The 'Clear' tab will make all the parts of the working space blank to enable the learner to store the next subsequent content. The learner can edit and remove the previously stored content in the workspace. The admin database of the software keeps track of the user details, memory space and metadata about the database. Admin database has the overall control. Registration for the utilization of software can be done by the admin database only. Thus there are three databases in this system namely, Database for a user account, Database for admin and User database.

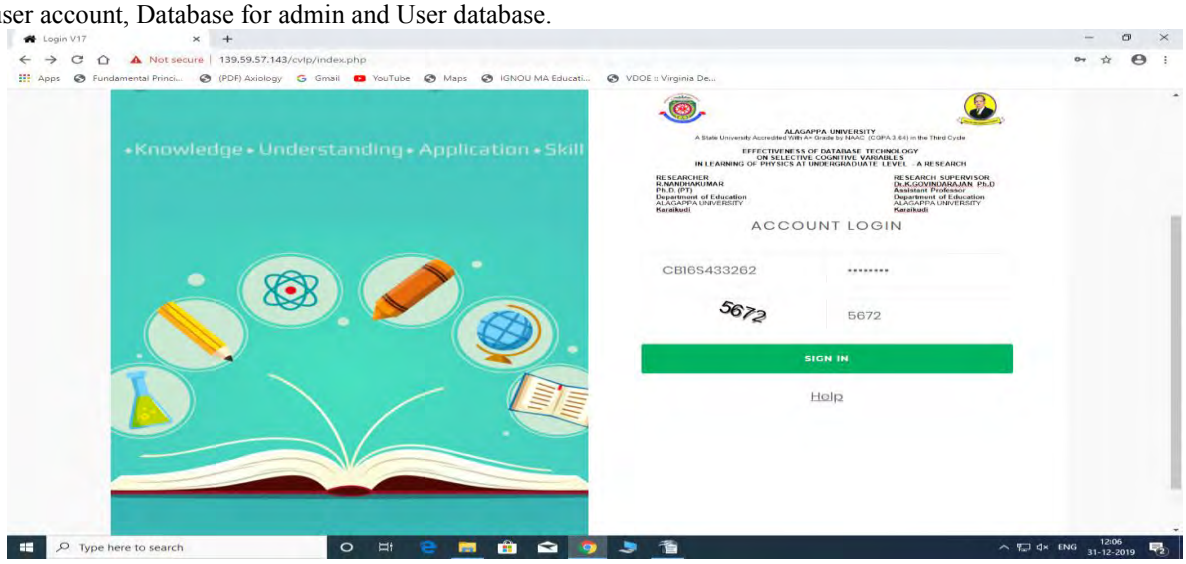

Fig.1. Home Page

In the first page called Home Page (Fig.1), the title and the login credentials are given. User can type their valid user name and password to enter into the software. Captcha code is provided in order to tell computers and human apart. In the second-page user details are given on the top of the page. By clicking the 'syllabus' tab, the syllabus prescribed by the University for the Selected Course will be displayed. In Fig.2. The repository is shown. The Learner should type the unit number, unit name and name of the topic. At this stage, if the learner wishes to access the web site then students should open and search the content. The selected content can be copied from the website partly or wholly and can be pasted in the 'notes' tab. Students can store the URL of the web page in the 'Source' tab. The learner can directly type the content from the book or their own notes.

The learner is instructed to type the source for future reference. By clicking the 'save' tab the content will be stored in the database. There is a provision for taking printout of the material. This can be done by clicking ' Print my Learning material' The 'Clear' tab will make all the parts of the working space blank to enable the learner to store the next subsequent content. The learner can edit and remove the previously stored content in the workspace shown in the Fig.3.

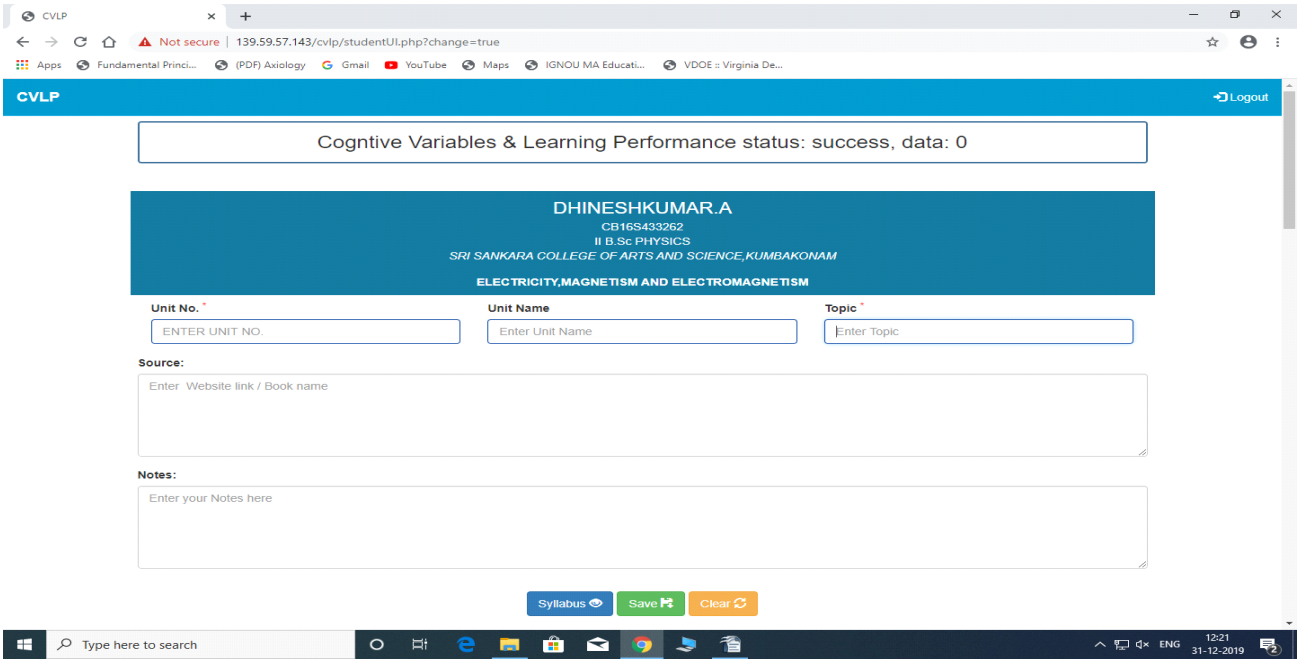

Fig.2. Repository

The admin database of the software keeps track of the user details, memory space and metadata about the database. Admin database has the overall control. Registration for the utilization of software can be done by the admin database only.

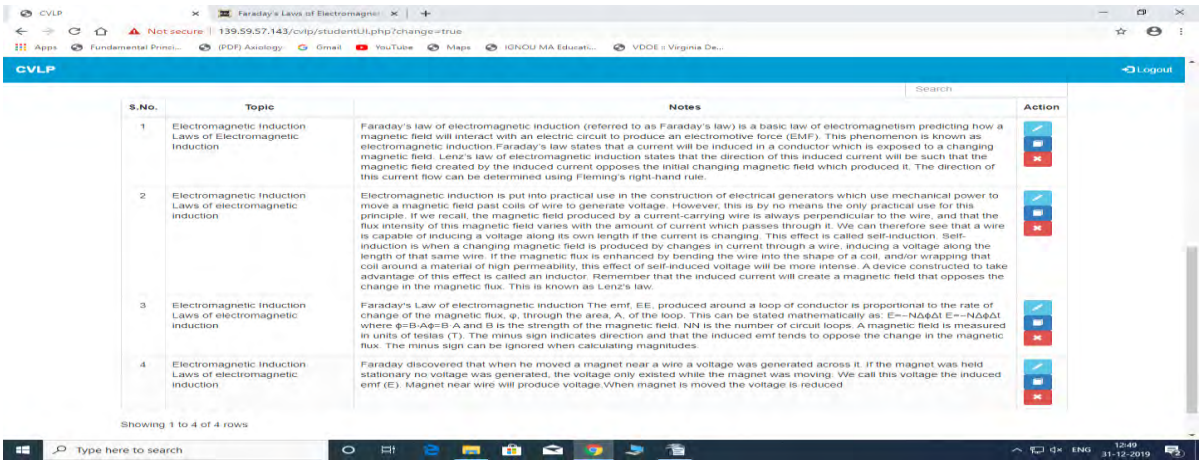

Fig.3. Workspace

Thus there are three databases in this system namely, Database for a user account, Database for admin and User database.

ANALYSIS AND INTERPRETATION

Hypothesis 1: Undergraduate students who have learnt the concepts of physics through Database technology and conventional learning methods differ significantly in their post-test achievement scores.

TABLE 1: Comparison of Post Test scores

Group	Size (N)	Mean (ẍ)	SD	t - value	Remark
Experimental	46	25.98	5.3	7.73	Significant at 0.05 level
Control	38	18.50	2.98		

From Table 1. it is observed that 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 no significant difference in the achievement of learners through the conventional method of learning and learning with the support of the database package for cognitive variables viz., Remember, Understand and Application.

TABLE 2: Comparison of mean gain Scores with respect to cognitive variables.

Cognitive variable	Group	Size (N)	Mean gain score	SD	Remark
Remember	Experimental Control	46 38	8.30 2.32	3.80 1.54	Significant at 0.05 level
Understand	Experimental Control	46 38	1.85 0.87	1.98 1.07	Significant at 0.05 level
Apply	Experimental Control	46 38	1.20 0.47	1.54 0.69	Significant 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 rejected at 0.05 level of significance.

Hypothesis 3: There is no significant difference in the achievement of male learners and female learners in their achievement in learning physics.

TABLE 3: Gender-wise Comparison of mean gain scores

Cognitive variable	Group	Size (N)	Mean gain score	SD	Remark
Remember	Female Male	35 11	8.20 8.64	4.15 3.74	Not Significant at 0.05 level
Understand	Female Male	35 11	1.86 1.82	1.89 2.31	Not Significant at 0.05 level
Apply	Female Male	35 11	1.20 1.18	1.60 1.40	Not Significant at 0.05 level

From Table 3, it is inferred that the mean gain scores of female and male students did not differ significantly at all the levels of knowledge viz. remember, understand and apply. The mean scores obtained by the female students and male students were equal. It is concluded that both male and female students performed equally when they used database technology for their learning.

The hypothesis is accepted at 0.05 level of significance

Hypothesis 4: There is no significant difference between the students from urban background and students from a rural background in their achievement in learning physics.

TABLE 4: Area-wise comparison of mean gain scores

Cognitive variable	Group	Size (N)	Mean gain score	SD	Remark
Remember	Rural Urban	40 6	8.40 7.67	4.03 1.75	Not Significant at 0.05 level
Understand	Rural Urban	40 6	1.82 2.00	2.01 1.89	Not Significant at 0.05 level
Apply	Rural Urban	40 6	1.23 1.00	1.47 2.09	Not Significant at 0.05 leve

From Table 4, it is inferred that the mean gain scores of the rural background students and urban background students who have used the database technology did not differ significantly at 0.05 level of significance in all the levels viz. remember, understand and apply. Hence it is concluded that both the rural background students and urban background students performed equally well.

The hypothesis is accepted at 0.05 level of significance.

FINDINGS

The researchers compared the post-test achievement scores of experimental group and control group with the assumption that undergraduate students who have learnt the concepts of physics through Database technology and Conventional learning methods differ significantly in their post-test achievement scores. From Table – 1, it is observed that the achievement level of the undergraduate students who have used the database software package is better than the achievement of the students who have used conventional learning methods. Database technology is found to be more effective on learner's achievement than the conventional method of learning physics at the undergraduate level. The achievements of learners were analyzed with the selected cognitive variables such as remember, understand, application and skill with the assumption that there is no significant difference in the achievement of learners through the conventional method of learning and learning with the support of the database package for cognitive variables viz., Remember, Understand and Application. There is a significant difference between the experimental group and control group. In learning physics at the undergraduate level, the database software using database technology is more effective in the realization of instructional objectives viz. remember, understand and apply than the conventional method of learning. The researchers analyzed the performance of students with a rural background and students with an urban background in the realization of instructional objectives viz. 'remember' 'understand' and 'apply'. As far as the gain in achievement is concerned, the effectiveness of the database technology is same for the students with a rural background and students with an urban background in learning physics at the undergraduate level, The researchers analyzed the performance of male and female students in the realization of instructional objectives viz. 'remember' 'understand' and 'apply'. with the use of database technology, the male students and female students performed equally in the realization of instructional objectives viz. 'remember' 'understand' and 'apply'. Similarly, the difference between the mean gain scores of rural and urban students is marginal. Thus there is no significant difference between the students from the rural background and students from the urban background.

DISCUSSION

Physics is a challenging subject to learn at higher education level due to its heavy emphasis on problem-solving. Physics is one of the important disciplines in all the universities and a few good students are still attracted to this knowledge-rich and challenging subject which continues to form an essential and unavoidable base for many professional subjects. The learners at the undergraduate level are facing problems in both the theoretical and practical aspects of this discipline. There is a need for a personalized approach to enhance learning. Keeping these things in mind the authors developed the database software and studied its effectiveness. The researchers have used the experimental method in studying its effectiveness in learning physics. Pre Test and Post-test was conducted for the two groups' namely experimental group and control group separately. The results of the post-test revealed that the students in the experimental group who have used database software performed well. The difference in mean gain score is high in the case of the experimental group. In another study, the performance of the experimental group and control group were analyzed on selected cognitive variables namely remember, understand and skill. The students in the experimental group were performed well in all the three variables. The difference in the mean gain score is very high in the case of Remember. This means the software can be effectively used to enrich the basic knowledge of physics concepts. The gender-wise comparison of mean gain scores revealed that both the male and female students are doing well and there is no significant difference between the male and female students. Similarly, the difference between the mean gain scores of rural and urban students is marginal. Thus there is no significant difference between the students from the rural background and students from the urban background.

CONCLUSION

The investigator has developed the database software package with the use of database technology. In order to examine its effectiveness in learning of physics at the undergraduate level, this has been implemented in the colleges affiliated to the Bharathidasan University, Tiruchirapalli, Tamilnadu, India. The database software developed by the investigator is simple to access and user- friendly. Students in the experimental group performed better than the control group. For self-learning, database software is an effective tool. 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 who are learning physics at the undergraduate level. 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. There is no significant difference between male and female students in using database software. Similarly, there is no significant difference between the students from rural background and students from an urban background. As experienced by the researcher, the use of database software package helped the learners to enrich their knowledge. Thus the database technology

influences the achievement level of the students to a great extent on selected cognitive variables. In future, this type of database software can be enhanced with data mining and data warehousing.

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