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Impact of a Developed Computer-Based Instructional Package on Student Performance in Technical Drawing

by

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ABSTRACT

The study developed a Computer-Based Instructional Package for teaching Technical Drawing in Osun State Colleges of Education; and investigated the effect of the Computer Based Instructional Package (CBIP) on the academic performance of students of Technical Drawing. It also determined the effect of the package on the retention ability of learners; and assessed the effect of the CBIP on students' attitude towards Technical Drawing. The research was conducted with 100 National Certificate in Education (NCE) II pre-service teachers selected from the two public colleges of Education in Osun state. The two colleges were selected based on availability of Technical Drawing Studio and those that have been offering Technical Drawing for a period of five years and above. Students in the two colleges were randomly assigned to experimental group that used the computer-based package or the control group that received regular classroom teaching. The Computer-based instructional package utilized interactive multimedia lessons, simulations, and formative assessments aligned with the curriculum. Two instruments were used for data collection. These were (i) Technical Drawing Achievement Test (TDAT) and (ii) Students Attitude Towards Technical Drawing (SATTD) questionnaire. The (TDAT) test contained 30 multiple choice items and five practical questions. The study lasted eight weeks. Data collected were analyzed using mean, standard deviation and t-test. The Computer-Based Instructional Package (CBIP) for teaching technical drawing was designed using Microsoft Net framework. The results showed that students' performance in Technical Drawing increased significantly when CBIP was introduced ($t = 16.06$, $p < 0.05$). The results also showed that there was significant improvement in the retention ability of students exposed to CBIP ($t = 14.69$, $p < 0.05$). Finally, the results showed that there was a significant improvement in the attitude of the students exposed to CBIP when compared with those taught using the conventional mode of teaching ($t = 13.30$, $p < 0.05$). The study concluded that Computer Based Instructional Package (CBIP) was an effective instructional intervention for teaching Technical Drawing in colleges of education.

Keywords: *Computer-based instruction, Educational technology, Multimedia learning, Interactive lessons*

Introduction

Technology in educational settings has transformed teaching methodologies, particularly in technical education. The use of Computer-Based Instructional Packages (CBIP) has garnered attention for its potential to enhance student learning outcomes, engagement, and retention. It is a fundamental skill for students pursuing careers in various technical fields. Traditionally, technical drawing instruction has relied on pen-and-paper methods, emphasizing spatial reasoning and visualization skills. Also, traditional methods of teaching technical drawing can often be

challenging for students, leading to difficulties in grasping concepts and achieving proficiency (Nguyen, et al., 2023).

However, with the increasing integration of technology in the professional landscape, computer-aided design (CAD) packages has become necessary in education (Soliman, Taha, & El-Sayad, 2019). This shift has necessitated a reevaluation of pedagogical approaches to ensure students are well prepared. The introduction of computer-based instructional packages (CBI) in technical drawing presents a potential solution. These interactive programs offer a dynamic learning environment, incorporating multimedia elements like animations, simulations, and immediate feedback mechanisms (Munyemana, Nsanganwimana, & Gaparayi, 2023). Hence, in technical drawing classrooms, computer-based instructional packages (CBI) presents a potential solution. These CBI solutions offer a dynamic learning environment, incorporating multimedia elements like animations, simulations, and immediate feedback mechanisms. Research suggests that CBI can be a valuable tool in enhancing student learning across various disciplines.

Furthermore, Computer Based Instruction has had an impact on the development of the educational technology to a great extent in the 21st Century and this has resulted in the production of different software. The primary purpose of the educational software is to solve the learning problems in the courses encountered students, to increase their motivation and achievements and to protect them against the negative effects of the rote-memory based educational system.

In technical drawing, advocates argue that CBI can improve students' comprehension of complex spatial concepts by utilizing 3D modeling capabilities. Additionally, CBI can cater to diverse learning styles by offering visual and interactive components that complement traditional pen-and-paper exercises (Alhajiri & Alshuraiaan, 2023). Furthermore, technical drawing plays a crucial role in the field of education, particularly for aspiring teachers pursuing careers in technical and vocational education and training (TVET), as Colleges of education serve as a vital training ground for these educators, and including technical drawing in the curriculum a lot several advantages. It also equips future teachers with the ability to create clear, concise visual representations of objects, and processes, as this skill is essential for effectively communicating technical information to students in TVET programs (Khasawneh, A., & Khasawneh, 2023). Additionally, technical drawing is not only a means of communication but also a language in itself. It uses symbols, perspectives, units of measurement, notation systems, visual styles, and page layout to ensure that the drawing is unambiguous and easy to understand. By learning this visual language, pre-service teachers can develop their ability to convey information accurately and efficiently. Also, the attitude of students exposed to Computer Based Instructional Package (CBIP) is an important area of consideration in educational research. CBIP, a form of ICT-driven instructional technique, utilizes computer systems to enhance learning processes. Over the years, studies have shown the effects of CBIP on students' achievement, retention, and attitudes towards learning. Understanding how students perceive and engage with Computer Based Instructional Packages is essential for optimizing its effectiveness in educational settings (Agbo, Olaleye, & Bower, 2023).

The importance of technical drawing in colleges of education is further emphasized by the fact that it is a trade-related course that should be taken by all students in vocational, engineering and construction-related fields (Labe & Gimba, 2021). This suggests that even if pre-service teachers do not directly work in these fields, the skills acquired through technical drawing can be transferable and beneficial in their teaching careers.

Pre-service teacher training aims to equip aspiring educators with the knowledge, and skills necessary for success in the teaching profession. Effective programs provide a combination of theoretical coursework and practical experiences, such as field observations and student teaching placements. By engaging in these activities, pre-service teachers develop a deeper understanding of the teaching and learning process, as well as the ability to apply their knowledge in real-world settings (Alrajeh, 2021). One important component of pre-service teacher training is the establishment of strong partnerships between colleges of education and local schools. These partnerships allow pre-service teachers to gain hands-on experience in diverse classroom settings, while also providing opportunities for collaboration between teacher educators and experienced classroom teachers.

For this study, the researchers examined how the performance and retention ability of National Certificate of Education (NCE) II Technical Drawing students in the two Osun State Colleges of Education can be better enhanced.

Problem Statement

Technical drawing is pivotal in various fields, including architecture, engineering, and design. It is a means of communicating complex ideas and concepts through visual representations. In Nigeria, the teaching of technical drawing to pre-service teachers has traditionally been conducted through conventional methods, such as chalk-and-talk lectures, demonstrations on blackboards or whiteboards, and the use of physical drawing instruments. However, with the rapid advancement of technology, there is a growing need to explore innovative approaches to enhance the learning experience and improve student performance in this subject. However, with the advent of the 21st-century information and communication technologies, there has been a shift towards more efficient and engaging methods of teaching Technical drawing, including the use of computer assisted tools. Furthermore, an inventory of the schools showed the availability of facilities, equipment, there is a serious deficit of the infrastructural facilities, equipment and materials available for teaching and learning in the schools. Most of the facilities available are used by the members of staff during the teaching periods, while the students have to provide theirs. Also teaching Technical Drawing in colleges of education has been challenged majorly by the dearth of instructional packages, workshop facilities and some basic equipment and Materials. While traditional teaching method has been beneficial for decades, advancements in technology have introduced Computer – Based Instruction as a viable alternative for technical drawing. This shift presents an opportunity to explore the potential benefits of integrating computer-base instructional packages into the teaching of technical drawing for pre-service teachers. These inadequacies have impacted negatively on the learning outcomes of students. In the traditional classroom situations, where there is very little motivation for teacher and students, classes in the drawing studios are too large for the teacher, making it difficult for every learner to have effective learning experiences and construction time. Also, because students differ in the ways they interpret situations, they perform significantly different from one another.

Theoretical Framework

This study is supported by the Constructivist theory of learning. The tenet of the constructivist theory focuses on the active engagement of the learner in the learning process. It is believed that when learners are engaged in learning activities, they internalize learning through the reconstruction of knowledge. Constructivist theories of learning dominate today and propagate

that learning is achieved by the active construction of knowledge supported by various perspectives within meaningful contexts and social interactions (Suhendi, Purwarno, & Chairani, 2021). These environments create engaging and content-relevant experiences by utilizing ICTs and resources to support unique learning goals and knowledge construction (Ghazal, Al-Samarraie, & Wright, 2020).

With the emergence of collaborative technologies, it has been recognized that behaviorist models do not fit with contemporary teaching and learning environments, therefore current research is focusing on developing models of constructivist computer-based instruction (Kong, 2021). In instruction, while there is still a requirement for memorizing and behavioral activities, there is a great emphasis on the instructor encouraging the student to appraise their own beliefs, challenge them in the light of new evidence and acquire new theories of the world which better fit the facts presented (Teo, 2019). The strengths of constructivism lie in its emphasis on learning as a process of personal understanding and the development of meaning, where learning is viewed as the construction of meaning rather than as the memorization of facts.

Technical Drawing lectures needs an instructional content that will give learners the opportunity to interact with text and images to be able to distinguish them by their characteristics. In addition, the use of instructional videos will pave way for consistent drill and practice. This means presenting material in a variety of forms, to facilitate positive effect on learning. It also means examining different concepts from the same perspective which can lead to new insights.

However, this study assumes that for the use of Computer Based Instructional Package to effectively impact learners' performance, attitude and retention, it must have the capability to present instructional contents from different perspectives and using text, pictures, graphics and instructional videos and will allow for time-to-time revisiting of concepts as learners browse through and also offer them the opportunity to appraise their performance by engaging in multiply choice quiz questions and practical questions.

Review of Literature

Teacher Education in Nigeria

Teacher education refers to professional education of teachers towards attainment of attitudes, skills and knowledge considered desirable so as to make them efficient and effective in their work. It includes training/education occurring before commencement of service (pre-service) and education/training during service (in-service or on-the-job). In Nigeria the need for well qualified teachers has gained pre-eminence because it is considered that teacher education is a means of not only providing teachers with the necessary skills and knowledge needed to adequately carry out their teaching jobs as well as for professional growth (Adefunke & Micheal, 2019). Also, it is the process of training that deals with the art of acquiring professional competencies and professional growth. It is an essential exercise that enhances the skills of learning and teaching. Teacher education is designed to produce highly motivated, conscientious and successful classroom teachers who will handle students' effectively and professionally for better educational achievement (Henriksen, Gretter, & Richardson, 2020).

One key issue is the need to reform teacher education to better prepare pre-service teachers for the realities of the 21st-century classroom. (Adeyemi & Adedayo, 2023) argued that teacher education institutions in Nigeria must focus on developing literacy skills and technological pedagogical

content knowledge among pre-service teachers to improve the quality of education. Furthermore, teacher education programs in Nigeria are under the supervision and control of governmental organizations. The National Commission for Colleges of Education (NCCE) has responsibility for teacher education in Nigeria with respect to Colleges of Education. The National Commission for Colleges of Education was established in 1990 to lay down minimum standards for all programs of teacher education and accredit their certificates and other academic awards.

Technical Drawing

The Federal Republic of Nigeria (FGN) in National Policy on Education made technical drawing as an elective subject offered at secondary school level but National Board for Technical Education (NBTE) stipulated that in technical colleges, technical drawing should be taught as a trade related course and should be taken by all students in engineering trade and construction trades except craft practice, this is due to the basic knowledge and skills it provides in engineering and construction courses. Therefore, technical drawing as a trade related course in technical college must be studied by all students in the technical related areas for an improved academic achievement. One of the objectives of technical drawing in technical education is to solve practical and technological problems through the process of communication skills which are central to design and planning (Belbase, et al., 2022) . It therefore becomes imperative that all efforts must be made to enhance learners' learning outcomes.

For this, the curricula at both the primary and junior secondary levels comprise elements of general and Technical education in an increasing order of vertical complexity and intensity. At the completion of junior secondary education, only two options are available to students for further formal education, namely, a 3-year senior secondary or a 3-year technical college education. The curriculum at senior secondary level is designed to be both academic and vocational to provide further general education, as well as prepare students for higher education and provide pre-professional exposure. The formal tertiary institution offers professional and technical education. They are: the conventional and technological universities, the polytechnics and colleges of education. Professional education and training are the proview of universities through their various degree programs. To successfully meet these objectives, sound and qualitative teaching and learning task must be obtainable particularly getting the required competent teachers that could teach the courses very well.

Further, the importance of technical drawing is aimed at inculcating practical skills, attitudes and competencies necessary for gainful employment in any recognized and emerging occupation (Azonwu, 2023). Also, it gives training and imparts the necessary skills to individuals who shall be self-reliant. When this goal is adequately achieved, it would lead to a sustainable technological development. In this regards it will make technical education and training an interesting one by gearing the students towards self -reliant to discourage unemployment syndrome (Alam, 2022). Therefore, an individual who is potently self-reliant will ensure an effective control of his resources over national life for proper national development.

Computer Based Instruction

CBI encompasses various instructional approaches that use computers and related technologies to deliver educational contents. The evolution of CBI can be traced back to the early days of educational technology in the 1960s, but its widespread adoption has been driven by the proliferation of personal computers and the internet. (Soomro, Kale, Curtis, Akcaoglu, &

Bernstein, 2020) stated that, CBI includes the use of multimedia presentations, educational software, online courses, among other tools, to enhance the learning experience. Leveraging technology, CBI offers an interactive and engaging approach to education, supplementing traditional methods and personalizing the learning experience.

CBI, also known as computer-assisted instruction (CAI), utilizes computers to deliver instructional content (Ghazal, Al-Samarraie, & Wright, 2020) (Abanyam & Terkuma, 2021). This instruction can encompass various formats, including tutorials, simulations, practice exercises, and educational. Also, CBI could provide personalized learning experiences. This technology can tailor instructional content to meet the specific needs and learning paces of individual students. (Liu, et al., 2023) highlight that personalized learning environments created through CBI can lead to improvements in academic performance and student engagement. For instance, this learning systems can analyze student data to identify areas of weakness and adjust the content accordingly, ensuring that each student receives the support they need to succeed. Another advantage of CBI is its interactive nature. Unlike traditional lectures, CBI programs allow learners to engage with the material directly. This can involve answering questions, making choices, or manipulating. This interactivity helps with deeper understanding and knowledge retention compared to passive learning methods (Riopel, et al., 2019).

Furthermore, CBI systems often incorporate a variety of features to enhance the learning experience, such as multimedia content, interactive simulations, and gamification elements. These features can help to engage students, improve retention, and make learning more enjoyable and effective (Tay, Goh, Safiena, & Bound, 2022). However, CBI is not without limitations. One concern is the potential for technical difficulties. Hardware or software malfunctions can disrupt the learning process and create frustration for students (Gashi, 2020). Additionally, the initial development and implementation of high-quality CBI programs can be expensive (Gamage, et al., 2020). Resistance to change among educators and institutions is another challenge. Traditional teaching methods are deeply ingrained in educational systems, and transitioning to technology-based instruction requires a shift in mindset and practices. Studies show that variability in teachers' pedagogical relationships with ICT, indicating that while some educators readily embrace technology, others may struggle with its integration due to a lack of confidence or familiarity with digital tools (Ifinedo, Rikala,, & Hämäläinen, 2019).

Purpose of the study

The objectives of this study are to;

1. develop a Computer Based Instructional Package (CBIP) for teaching Technical Drawing
2. investigate the effect of Computer Based Instructional Package (CBIP) on academic performance of students in Technical Drawing;
3. determine the effect of the package on retention ability of learners; and
4. assess effect of the package on students' attitude towards Technical Drawing.

Hypotheses of Study

The following hypotheses were generated for this study:

1. there is no significant difference in the academic performance of students taught technical drawing with Computer Based Instructional Package and those taught with conventional method;
2. there is no significant difference in the retention of students taught Technical drawing using Computer Based Instructional Package and those taught using the conventional method;
3. there is no significant difference in the attitude of students taught Technical Drawing using the Computer Based Instructional Package and those taught using conventional method.

Methodology

Research Design:

This study employed a quasi-experimental design with a pretest-posttest control group. The independent variable was the instructional method (Computer-Based Instructional Package or traditional classroom teaching), and the dependent variables were academic performance, retention ability, and attitude towards Technical Drawing. The study involved 100 National Certificate in Education (NCE) II pre-service teachers from two public colleges of Education in Osun State. The two colleges were selected based on the availability of a Technical Drawing Studio and having offered Technical Drawing for at least five years. Participants were randomly assigned to either the experimental group (Computer-Based Instructional Package) or the control group (traditional classroom teaching).

Research Instrument

Two instruments were used for data collection namely Technical Drawing Achievement Test (TDAT) which consisted of 30 multiple-choice items and five practical questions to assess students' academic performance in Technical Drawing and a questionnaire titled Students' Attitude Towards Technical Drawing (SATTD) questionnaire.

The content validity of the achievement test and questionnaire items were conducted by experts in the field of technical drawing and test and measurement, while the Computer Based Instructional Package (CBIP) was validated by Technical Drawing, programmers and educational technology experts. The Technical Drawing contents of the package were validated by two expert teachers of technical drawing. Also, that the subject matter content of the CBI package adequately and sufficiently covered the Nigerian Colleges of Education curriculum. Suggestions and commendations were used for modifying the package.

To test the reliability of the instruments, Cronbach Alpha was used to analyze the Technical Drawing Achievement Test (TDAT) and Students' Attitude Towards Technical Drawing (SATTD) questionnaire which were found to have reliability values 0.68 and 0.75 respectively, which means the research instruments are consistent and fit for use.

Procedure for Data Collection

The experimental group received instruction through the Computer-Based Instructional Package (CBIP), which utilized interactive multimedia lessons, and formative assessments aligned with the

curriculum. The CBIP was designed using Microsoft Net framework. The control group received traditional classroom teaching of Technical Drawing.

1. Pretest: Both groups (experimental and control) were administered the TDAT and SATTD questionnaire to establish baseline knowledge.
2. Intervention: The experimental group received instruction through the CBIP, while the control group received traditional classroom teaching for eight weeks.
3. Posttest: After the intervention period, both groups were administered the TDAT and SATTD questionnaire again to assess academic performance, retention ability, and attitude towards Technical Drawing.

Data Analysis Techniques

The collected data were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics (t-test) to compare the experimental and control groups in terms of academic performance, retention ability, and attitude towards Technical Drawing.

Ethical Considerations:

To ensure high standard of professionalism, complete consent was obtained from the respondents, educational technology experts, instructional design experts and agricultural science experts prior to the study. The protection of the privacy of research participants was ensured. Also, respect for the dignity of research participants was prioritized. All levels of participants mentioned participated on their own free will in the study and there was no compulsion of any kind. The respondents were informed to participate freely and withdraw as they wish at any time during the course of the study.

Results

1. *Develop a Computer Instructional Package (CBIP) for teaching Technical Drawing in Osun State Colleges of Education.*

This is a data driven software created using the Microsoft **.Net framework**. Specifically, the C# programming language was used. It was backed by a Microsoft SQL Server database for storing the exercises and their answers. The windows graphical interface toolkit was used in presenting a graphical interface through which the user interacts with the application. This tool kit provides access to native Microsoft Windows interface elements. Applications built with the **.Net framework** were able to enclose the windows media player as a video playing user interface control. This is taken advantage of, by providing a video playing capability in this application to enable users play the course videos that were packaged with the application.

On the home page, the learner will be able to click on any of the lesson contents as instructed by the teacher. The performance objectives were stated on the next page for the learner to determine the learning outcomes expected of him at the end of the lesson. The first two lessons were made up of pictures, text and graphics, while the third lesson is an instructional video on construction of angles. At the end of each lesson, the learner proceeds to the quiz section. This section provided the learner with different questions and multiple-choice answers.

2. *Investigate the effect of Computer Based Instructional Package (CBIP) on academic performance of students in Technical Drawing.*

To achieve this objective, the Computer Based Instructional Package was used in teaching Technical Drawing and the academic performance of learners in Technical Drawing was compared.

Hypothesis one states that there is no significant difference in academic performance of students taught technical drawing with Computer Based Instructional Package (CBIP) and those taught with conventional method. In testing this hypothesis, the pre-test and post-test scores of participants in the experimental and control groups were subjected to the test of significance. The results are presented in table 1.

Table 1:

mean scores of students' performance in experimental and control groups

Test	Group	N	Mean	S.D	d.f	t-value	p	Remark
Pre-test	Experimental	50	31.36	2.57	98	1.02	0.31	Not significant
	Control	50	31.88	2.54				
Post-test	Experimental	50	48.16	4.18	98	16.06	0.00	Significant
	Control	50	36.70	2.18				

$P \leq 0.05$

From table 1, it was found that students in the experimental group had a mean score of 31.36 and standard deviation of 2.57, while the control group had a mean of 31.88 and a standard deviation of 2.54. When these were subjected to t-test, it showed that the obtained value was not statistically significant. However, at the post-test it was established that the experimental group had a mean score of 48.16 and standard deviation of 4.18, while the control group had a mean of 36.70 and a standard deviation of 2.18. When these were subjected to t-test, ($t = 16.06$, $P \leq 0.05$) it showed that the obtained value was statistically significant. Hence the null hypothesis was rejected. This implies that the students exposed to the Computer Based Instructional Package (CBIP) understood more and performed better than students taught with conventional teaching method.

3. *Determine the effect of the package on retention ability of learners.*

To achieve this objective, the Computer Based Instructional Package was used in teaching Technical Drawing and the retention ability of learners in Technical Drawing was compared.

Hypothesis two states that, there is no significant difference in the retention of students taught using the Computer Based instructional package (CBIP) and those taught using conventional method. To test this hypothesis, test scores of participants in the experimental and control groups were subjected to the test of significance. The results are presented in table 2.

Table 2:

Mean scores of students' post-test and retention test in experimental and control groups

Test	Group	N	Mean	S.D	d.f	t-value	P	Remark
Post-test	Experiment	50	48.16	4.18	98	16.06	0.00	Significant
	Control	50	36.70	2.18				
Retention test	Experimental	50	48.48	4.99	98	14.69	0.00	Significant
	Control	50	35.06	2.98				

$P \leq 0.05$

Table 2 presents the post-test and retention test scores of both experimental and control groups. The students in the experimental group have a post-test mean score of 48.16, a retention mean score of 48.48. While the students in the control group have a post-test mean score of 36.70 and the retention mean score of 35.06. Since the mean difference of experimental group is less as compare to control group, it shows that students in the experimental group taught with Computer Based Instructional Package retain what was taught better than the students in the control group taught using the conventional method.

However, at the retention test, it was established that the experimental group had statistically significant higher score (mean = 48.48, S.d = 4.99), compared to the control group (mean = 35.06, S.d = 2.98), t = 14.69, $P \leq 0.05$). Hence the null hypothesis was rejected. This implies that the students exposed to the Computer Based Instructional Package (CBIP) had a significant improvement on the retention ability.

4. *Access effect of the on students' attitude towards Technical Drawing.*

To achieve this objective, the Computer Based Instructional Package was used in teaching Technical Drawing and the attitude of learners towards Technical Drawing was compared.

Hypothesis three states that, there is no significance difference in the attitude of students taught Technical Drawing using Computer Based Instructional Package and those taught using the traditional method. The results are presented in table 3.

Table 3:

Summary of difference in mean scores of students' attitude in experimental and control groups.

Group	N	Mean	S.d	d.f	t-value	p	Remark
Experimental	50	32.80	7.71	58	13.30	0.00	Significant
Control	50	16.98	3.37				

$P \leq 0.05$

On table 3, it was established that the experimental group had statistically significant higher score (mean = 32.80, S.d = 7.71), compared to the control group (mean = 16.98, S.d = 3.37), t = 13.30, $P \leq 0.05$. Hence the null hypothesis was rejected. This implies that the students exposed to the Computer Based Instructional Package (CBIP) exhibited a better attitude than those taught conventional method.

Discussion

The results of this study showed the effectiveness of the Computer-Based Instructional Package (CBIP) in improving academic performance, retention ability, and attitude towards Technical Drawing among pre-service teachers in Osun State Colleges of Education. The experimental group, which received instruction through the CBIP, outperformed the control group that received traditional classroom teaching.

The multimedia lessons, and formative assessments incorporated in the CBIP likely facilitated better understanding and retention of the technical drawing concepts. The multimedia elements could have catered to different learning styles, enhancing the overall learning experience. The simulations provided hands-on practice, allowing students to visualize and apply the concepts more effectively. Additionally, the assessment test enabled continuous feedback and reinforcement, which could have contributed to improved academic performance and retention.

The positive effect of the CBIP on students' attitudes towards Technical Drawing is noteworthy. The interactive and engaging nature of the CBIP increased students' interest and motivation, leading to a more favorable attitude towards the subject. This finding aligns with previous research suggesting that technology-enhanced learning environments can positively influence students' attitudes and engagement.

Conclusion

The findings of this study provided empirical evidence for the potential of computer-based instructional packages in enhancing teaching and learning experiences in Technical Drawing. The CBIP developed in this study proved to be an effective tool for improving academic performance, retention ability, and attitude towards Technical Drawing among pre-service teachers.

Based on these positive results, the implementation of the CBIP or similar technology-enhanced learning environments could be considered in other Colleges of Education and institutions offering

Technical Drawing courses. However, it is important to ensure proper training for teachers and adequate infrastructure to support the effective implementation of such interventions.

Future research could explore the long-term effects of the CBIP on students' performance and retention, as well as investigate the impact of such interventions on other technical or vocational subjects. Additionally, studies could examine the potential of integrating the CBIP with other instructional strategies or incorporating advanced technologies, such as virtual reality or augmented reality, to further enhance the learning experience.

This study contributes to the growing body of knowledge on the use of technology-enhanced learning environments in technical and vocational education, providing a promising avenue for improving teaching and learning outcomes.

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