



ANALYSIS, DESIGN AND DEVELOPMENT PHASES OF INSTRUCTIONAL DESIGNING SYSTEM (ADDIE MODEL) AND THE LEARNING OUTCOME OF STUDENTS IN TECHNICAL DRAWING IN TECHNICAL COLLEGES IN AKWA IBOM STATE

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Abstract

This study investigated the impact of the Analysis, Design, and Development phases of the ADDIE model on the learning outcomes of students in Technical Drawing within technical colleges in Akwa Ibom State. A quasi-experimental research design was adopted. The population comprised all technical drawing students in the state's technical colleges. A sample of 120 students was purposively selected and split into experimental and control groups. The experimental group was taught using instructional packages developed through the first three phases of the ADDIE model, while the control group was taught using conventional instructional methods. Data were collected using the Technical Drawing Achievement Test (TDAT) and analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA). The findings revealed that students taught with the ADDIE-structured system achieved significantly higher learning outcomes than those taught with conventional methods. Based on these findings, it is recommended that ministries of education and technical education boards organize regular capacity-building workshops for technical drawing instructors to master systemic instructional design frameworks.

Keywords: Analysis, Design Development, Instruction, System

Introduction

Technical education serves as the bedrock for industrialization and self-reliance in developing nations. Within the curriculum of technical colleges, Technical Drawing functions as the foundational language of engineering and technology. It provides students with the graphic communication skills necessary to interpret designs, fabricate components, and innovate structural solutions. Despite its critical importance, student performance in Technical Drawing in Nigerian technical colleges—particularly in Akwa Ibom State—has remained inconsistently low. Traditional pedagogical approaches often treat the subject as an abstract exercise, failing to bridge the gap between theoretical geometric principles and practical engineering applications. To address these pedagogical deficiencies, instructional technologists advocate for systemic frameworks that align learning objectives with structural development. The ADDIE



model (Analysis, Design, Development, Implementation, and Evaluation) is a globally recognized instructional systems design (ISD) framework. While the model contains five distinct stages, the foundational architecture relies heavily on its first three components:

Analysis: Identifying learner gaps, contextual constraints, and target objectives.

Design: Mapping out structural sequencing, assessment strategies, and cognitive architectures.

Development: Creating, validating, and assembling physical or digital instructional materials.

This study specifically isolates and analyzes the combined effect of the Analysis, Design, and Development phases of the ADDIE framework on the academic achievement and spatial cognitive outcomes of students tackling Technical Drawing in Akwa Ibom State.

Conceptual Framework: The ADDIE Model

Instructional design models provide structured blueprints to guide the creation of effective learning experiences (Gustafson & Branch, 2002). The ADDIE framework is an iterative instructional systems design process where the outcomes of each phase feed directly into the next.

The Analysis Phase

The analysis phase serves as the diagnostic foundation of the entire instructional system (Branch, 2009). During this phase, instructional designers identify the gap between current student capabilities and desired performance outcomes. In the context of Technical Drawing, this involves analyzing: Learner Characteristics: Assessing prior geometric knowledge, spatial visualization limitations, and attitude toward technical equipment. Contextual Analysis: Examining available facilities within Akwa Ibom technical colleges, such as drawing boards, tee-squares, computer-aided design (CAD) software, and laboratory lighting. Task Analysis: Breaking down complex drafting tasks (e.g., isometric projections, sectional views) into sub-skills.

The Design Phase

The design phase translates the diagnostic data from the analysis phase into a concrete pedagogical architecture (Dick, Carey, & Carey, 2015). It focuses on setting behavioral objectives, determining assessment parameters, and structuring content flow. For Technical Drawing, this phase specifies how concepts like orthographic projections are sequenced—moving from simple multi-view shapes to complex intercepted solids. It also involves designing rubrics that measure both cognitive comprehension and psychomotor drafting precision.



The Development Phase

The development phase involves the actual production of instructional units, media, and learning instruments outlined during the design phase (Molenda, 2003). In this study, development included building specialized instructional modules, step-by-step visual drafting guides, and formative self-assessment portfolios customized to the Akwa Ibom State technical college syllabus. This phase concludes with pilot testing and expert validation to ensure content validity and pedagogical clarity before classroom implementation.

Technical Drawing in Technical Colleges

Technical colleges are designed to produce craftspeople and technicians capable of driving industrial growth (Federal Republic of Nigeria [FRN], 2013). Technical Drawing is a compulsory core subject across various trades, including mechanical engineering craft practice, electrical installation, and building construction. Learning outcomes in Technical Drawing are not limited to memorizing rules; they require a high degree of spatial visualization and psychomotor accuracy. Students must mentally manipulate three-dimensional objects and project them onto two-dimensional planes (Sorby, 2009). When instructional delivery lacks a systemic, organized approach, students struggle with cognitive overload, leading to high failure rates in external examinations like NABTEB (National Business and Technical Examinations Board).

Statement of the Problem

Despite the strategic role of technical colleges in Akwa Ibom State, stakeholders have expressed concern over the declining quality of graduates' practical drafting skills. Chief examiners' reports consistently show that many students struggle with basic concepts like auxiliary views, intersections of solids, and isometric scaling. This educational deficiency is often linked to poor instructional planning. Many instructors rely on unstructured, impromptu teaching methods without conducting proper learner analysis or systematically developing customized media. While research has explored the general application of the ADDIE model, limited empirical focus has been placed on isolating how its preparatory phases (Analysis, Design, and Development) directly affect technical drawing outcomes within this specific geopolitical region. This study addresses that gap.

Purpose of the Study

The primary purpose of this study was to determine the effect of the Analysis, Design, and Development phases of the ADDIE model on the learning outcomes of students in Technical Drawing in technical colleges in Akwa Ibom State. Specifically, the study sought to:

1. Determine the difference in the mean achievement scores of students taught Technical Drawing using ADDIE-structured instruction and those taught using the conventional method.



2. Assess the influence of gender on the learning outcomes of Technical Drawing students when exposed to ADDIE-structured instruction.

Research Questions

The following research questions guided the study:

1. What is the difference in the pre-test and post-test mean achievement scores of Technical Drawing students taught using an instructional package based on the Analysis, Design, and Development phases of the ADDIE model and those taught using conventional methods?
2. What is the difference in the post-test mean achievement scores of male and female students taught Technical Drawing using the ADDIE-structured instructional package?

Research Hypotheses

The following null hypotheses were tested at a .05 level of significance:

H₀₁: There is no significant difference in the mean academic achievement scores of Technical Drawing students taught using the ADDIE-structured package and those taught using conventional methods.

H₀₂: There is no significant difference in the mean academic achievement scores of male and female Technical Drawing students exposed to the ADDIE-structured instructional package.

Methodology

This study utilized a quasi-experimental, pre-test, post-test, non-equivalent control group design. This design was appropriate because administrative constraints prevented the random assignment of individual students to classes, requiring the use of intact, pre-existing classroom groups. The population consisted of all National Technical Certificate II (NTC II) students offering Technical Drawing in all public technical colleges in Akwa Ibom State. The sample size comprised 120 students selected from two distinct technical colleges via a purposive sampling technique. The selected colleges had comparable facilities and standard drawing studios. One college was randomly assigned as the Experimental Group ($n = 62$), while the other served as the Control Group ($n = 58$).

Research Instrument

The primary tool for data collection was the Technical Drawing Achievement Test (TDAT), developed by the researcher based on NABTEB syllabus standards. The TDAT consisted of two sections:



Section A contained 40 multiple-choice questions testing cognitive knowledge, and Section B contained two practical drafting problems evaluating psychomotor execution.

The instrument was content-validated by three experts in industrial education and measurement evaluation. Internal consistency was determined using the Kuder-Richardson Formula 20 (KR-20) for the objective section, yielding a reliability coefficient of 0.84, while the practical section yielded an inter-rater reliability index of 0.79 using Cronbach's Alpha.

Experimental Procedure

Before the intervention, a pre-test was administered to both groups to establish baseline academic equivalency.

Experimental Group Treatment: This group was taught by instructors using an instructional system explicitly designed through the first three stages of the ADDIE model. The Analysis Phase identified specific visual gaps and spatial difficulties among the students. The Design Phase carefully mapped performance objectives directly to structured visual guides. The Development Phase produced physically printed step-by-step modular drafting guides and multi-angle 3D physical models. This systematic delivery ran for six weeks. **Control Group Treatment:** This group was taught the exact same curriculum topics over the same six-week period but through standard, teacher-centered blackboard demonstrations without the systematic, ADDIE-aligned materials. At the conclusion of the treatment period, the post-test was administered to both groups using re-shuffled TDAT questions to minimize testing bias.

Method of Data Analysis

Mean and standard deviation scores were used to answer the research questions. The null hypotheses were tested at a .05 alpha level using Analysis of Covariance (ANCOVA), with pre-test scores serving as the covariate to account for any initial differences between the groups.

Results

Research Question 1: What is the difference in the pre-test and post-test mean achievement scores of Technical Drawing students taught using an instructional package based on the Analysis, Design, and Development phases of the ADDIE model and those taught using conventional methods?

Table 1: Summary of Mean difference in the pre-test and post-test mean achievement scores of Technical Drawing students taught using an instructional package based on the Analysis,



Design, and Development phases of the ADDIE model and those taught using conventional methods

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Score	Gain
Experimental (ADDIE)	62	42.15	6.82	74.60	5.12	+32.45	
Control (Conventional)	58	41.80	7.11	53.25	6.45	+11.45	

The descriptive data in Table 1 shows that the experimental group achieved a post-test mean score of 74.60, indicating a substantial mean gain score of 32.45. In contrast, the control group achieved a post-test mean score of 53.25, yielding a smaller mean gain score of 11.45. This descriptive difference suggests that the systematic preparation of materials via the ADDIE model improved student outcomes more effectively than conventional methods.

Research Question 2: What is the difference in the post-test mean achievement scores of male and female students taught Technical Drawing using the ADDIE-structured instructional package?

Table 2: Summary of mean difference in the post-test mean achievement scores of male and female students taught Technical Drawing using the ADDIE-structured instructional package

Gender (Experimental Group)	N	Pre-test Mean	Post-test Mean	Post-test SD	Mean Gain Score
Male	44	42.30	75.10	4.95	+32.80
Female	18	41.78	73.38	5.30	+31.60

The data indicates that within the experimental group, male students achieved a post-test mean score of 75.10, while female students achieved a post-test mean score of 73.38. The mean gain difference between the genders was minimal, suggesting that the ADDIE framework supported learning outcomes relatively equally across male and female students.

Research Hypothesis 1: There is no significant difference in the mean academic achievement scores of Technical Drawing students taught using the ADDIE-structured package and those taught using conventional methods.



Table 3: Summary of ANVOVA result on the significant difference in the mean academic achievement scores of Technical Drawing students taught using the ADDIE-structured package and those taught using conventional methods

Source of Variation	Sum of Squares	df	Mean Square	F-value	Sig.	Decision
Corrected Model	13420.50	2	6710.25	196.42	.000	Sig.
Intercept	8912.45	1	8912.45	260.88	.000	Sig.
Pre-test (Covariate)	14.20	1	14.20	0.42	.521	Not Sig.
MainTreatment Group	13110.15	1	13110.15	383.76	.000	Reject
Error	3996.80	117	34.16			
Total	512400.00	120				

The Table 3, indicates that the main effect of treatment group on post-test scores yielded an F-value of 383.76, which is statistically significant at $<.001$. Because the calculated significance value (.000) is less than the established alpha level of .05, the null hypothesis is rejected. This statistical result confirms that the higher learning outcomes achieved by the experimental group were directly due to the ADDIE-structured instruction.

Research Hypothesis 2: There is no significant difference in the mean academic achievement scores of male and female Technical Drawing students exposed to the ADDIE-structured instructional package.

Table 4: summary of ANOVA analysis on the significant difference in the mean academic achievement scores of male and female Technical Drawing students exposed to the ADDIE-structured instructional package

Source of Variation	Sum of Squares	df	Mean Square	F-value	Sig.	Decision
Corrected Model	45.10	2	22.55	0.86	.428	Not Sig.
Pre-test (Covariate)	5.80	1	5.80	0.22	.640	Not Sig.



Gender	38.40	1	38.40	1.46	.231	Accept
Error	1547.20	59	26.22			
Total	346210.00	62				

The Table 4, shows that the effect of gender within the experimental group yielded an F-value of 1.46, with a significance value of .231. Because this significance value is greater than the .05 alpha level, the null hypothesis is accepted. This confirms that the ADDIE model's preparation phases benefit male and female students equally in Technical Drawing.

Discussion of Findings

The results of this study demonstrated a significant improvement in the learning outcomes of technical college students exposed to instructional materials designed through the Analysis, Design, and Development phases of the ADDIE model. This finding aligns with the work of Branch (2009), who emphasized that treating instructional planning as a systematic science prevents arbitrary teaching practices. By analyzing learner capabilities and institutional limitations before designing materials, instructors can align their curriculum with the cognitive load constraints of the students (Sweller, 2011). The significant post-test performance of the experimental group suggests that when technical drawing tasks are broken down into logical sub-skills and paired with verified visual aids, students understand spatial concepts more effectively.

Furthermore, the study showed that gender did not significantly affect learning outcomes when using the ADDIE framework. This finding matches the conclusions of Sorby (2009), who noted that structured spatial training and systematically designed technical courses reduce historical gender gaps in engineering and design fields. By standardizing content delivery through structured modules, both male and female students had access to identical conceptual scaffolds, minimizing variations in performance.

Conclusion

This study demonstrates that the introductory planning components—Analysis, Design, and Development—of the ADDIE model significantly improve the learning outcomes of students in Technical Drawing within Akwa Ibom State technical colleges. Shifting from conventional, unstructured teaching methods to a systemic instructional design framework helped reduce cognitive difficulty and improved practical performance. Additionally, the structured approach proved equitable, benefiting both male and female students equally.

Recommendations

Based on the empirical findings of this research, the following recommendations are made:



1. Mandatory Capacity Building Workshops: The Akwa Ibom State Technical Schools Board (AKSTSB) should sponsor regular, hands-on training workshops for technical instructors to master systemic instructional models, specifically focusing on the Analysis, Design, and Development phases of the ADDIE framework.
2. Standardized Curricular Restructuring: Technical drawing curricula should be reformatted into structured, self-paced modular instructional units that integrate verified learner diagnostics and 3, custom multi-media kits before classroom delivery.
3. Resource Upgrading and Studio Standardization: Institutional administrators should provide specialized drawing studios equipped with the tools identified during the instructional analysis phases, ensuring that modern pedagogical frameworks are supported by adequate physical facilities.

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