



Influence of Dick and Carey instructional model on secondary school biology students' performance in Katsina State, Nigeria

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ABSTRACT

The focus of this research is on the impact of Dick and Carey instructional model on the performance of secondary school biology students in Katsina State, Nigeria. Gender was also considered in the study to see if the Dick and Carey model could improve performance in biology regardless of gender. The study used a quasi-experimental design with pre- and post-test control groups. The study's population consists of all senior secondary II (SSII) biology students in Katsina State. The study's sample size is 140 SSII biology students. Purposive sampling was used to select four schools from the Funtua Educational Zone to participate in the study. Each school's intact SSII class was used for the study. Two schools were assigned to experimental and control groups at random. The instruments for the study were Dick and Carey instructional model guide (DCIMG) and biology performance test (BPT). BPT was validated by experts from Usmanu Danfodiyo University's biology department and experienced secondary school biology teachers. The split-half method yielded a reliability index of 0.71 for BPT. The study was guided by three null hypotheses, and the data collected was analyzed using descriptive statistics and t-test analysis. The results showed that the experimental group treated with DCIMG outperformed the control group treated with the traditional method. Furthermore, gender has no effect on student performance in biology. Thus, it was recommended, among other things, that DCIMG be used in biology teaching regardless of gender, especially when dealing with difficult concepts in biology.

Keywords: Dick and Carey instructional model, biology, traditional method, biology performance

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INTRODUCTION

Globally, a fruitful teaching and learning process necessitates an unquestionably qualitative and effective teacher force. This assertion is not limited to a particular level of education but has permeated all levels of education. No education can rise above the quality of its teachers, according to Nigeria's national policy on education (NPE, 2013); thus, teachers are essential to any meaningful educational system. According to Ajayi (2017), effective educational delivery requires good teachers, which leads to social change and national development. This is due to the fact that teachers actively facilitate learning by putting educational policies into action.

Adedoyin and Tayo (2018) argued that interaction between teachers and students, as well as the use of innovative instructional strategies to sustain greater positive outcomes, is critical in science education. Wasagu (2019) emphasized the significance of innovation in science education in boosting productivity and global competitiveness. According to some, science education is an unavoidable means of achieving national development. Thus, biology, chemistry, and physics are the building blocks of science education.

Biology, like chemistry and physics, is an essential component of science education. It is one of the core science subjects taught to secondary school students worldwide. It is a branch of biology that studies living things, including their structures, functions, and behavior (Matazu, 2021). To achieve biology curriculum objectives, teachers have no choice but to use an activity-oriented or learner-centered approach. This is enhanced when biology teachers employ a meaningful and effective interactive process involving the teacher, students, and relevant teaching and learning materials (Matazu, 2021). National policy on education was explicit in its biology objectives, which included, among other things (NPE, 2013):

1. Meaningful and relevant biological knowledge is required for successful living in a scientifically and technologically advanced world, as well as making room for technological advancement.
2. The ability to apply scientific knowledge in real-world situations such as personal and community health, agriculture, and the environment, to name a few.

The biology curriculum's content and context are expected to enable the achievement of these goals. This, however, will only be possible if biology teachers employ meaningful and effective teaching

methods (activity-based approach). According to Awobodu (2016), most biology teachers teach biology to their students using traditional methods. This approach does not promote biological content retention and internalization, and has reportedly resulted in poor student performance or, at best, regurgitation of content in the area, necessitating the need for a better alternative approach for effective learning and better student performance in biology.

INSTRUCTIONAL DESIGN

It should be noted that Dick and Carey instructional model is only one of many available. An instructional design (ID) process incorporates instructional principles and processes into teaching and learning plans through the differentiation of materials, activities, resources, and evaluation (Morrison et al., 2001; Smith & Ragan, 2004). In this systematic and reflective process, ID tasks include the analysis of knowledge and skills in a variety of contexts; the design of the learning situation and environment; and the evaluation of learning outcomes.

An ID model explains how to create instructional programs that adhere to appropriate learning theories and how to effectively teach content (Dijkstra, 1997, 2001). In other words, ID assists instructors and/or teachers in visualizing the instructional problems they are likely to face during their educational experience by breaking learning activities down into discrete and practicable units, allowing instructors and teachers to systematically analyze and adapt instruction. Furthermore, designers must understand and inquire about learning theories, systematic learner analysis, management techniques, and the ability to use information technology efficiently as part of ID process. Ability to evaluate teaching and learning process is required for systematic ID. ID, according to Ozdemir and Uyangor (2011), is process of determining how to learn better: They define ID as considering process, discipline, science, systems, performance, and theory.

The key point here is that an ID approach instructs the expert designer to construct instruction from the perspectives of the learners as opposed to the traditional educational approach of designing instruction from the perspective of content. As a result, learner consideration, objectives (or learning outcomes and attainments), method, and evaluation should be the primary components of an ID process. Three major questions that instructional designers should consider are: where instructors are going with instructional outcomes; how instructors will get there; and how instructors will know that students have mastered instructional outcomes (Duchastel, 1990; Merrill, 2001; Ozdemir & Uyangor, 2011; Sims, 2006).

Popular early design models include those proposed by Goksu et al. (2014), Merrill (1983), and Reigeluth (1999). Educators have long pondered the implications of applying ID principles to educational design as well as criticized emerging design practices. Some argue that early ID-models were useful for designing a single unit of content, but they were limited in their ability to integrate multiple units of content and guide learners to use flexible units of analysis to solve problems in complex educational contexts. According to Goksu et al. (2014), four of the most well-known ID models are those proposed by Dick et al.'s (2005), Morrison et al. (2001) (generally abbreviated as Kemp's), Posner and Rudnitsky's (2006) (generally abbreviated as Posner's), and Smith and Ragan's (2004). Each of these models has distinct features designed to address specific challenges associated with teaching and learning processes.

DICK AND CAREY'S INSTRUCTIONAL DESIGN MODEL

Some ID approaches reflect a variety of viewpoints. For example, Dick and Carey model (proposed by Walter Dick and Lou Carey) is based on an eclectic mix of elements from behaviorist, cognitivist, and constructivist approaches. This model claims to be adaptable to a wide range of learners, goals, aims, learning outcomes, instructional content, and learning performances (Dick et al., 2005). This model's proponents believe that realizing and formalizing an instruction event necessitates looking at the instructional setting as a whole rather than as a collection of isolated parts. Dick and Carey (1996) believe that the whole is greater than the sum of its parts in a learning environment.

The uniqueness of their model stems from their attempt to support interrelationships between learning context, content, learning, and instruction. Their instructional approach is based on the notion that system components include the learner, the instructor, any equipment or instructional tools, instructional activities, transfer systems, learning and performance environments, and so on. They go on to say that in order to support each student's learning attainments and instructional learning outcomes, these components must be compatible with one another. Dick and Carey (1996) propose three formative evaluation strategies: small group, field trial, and one-to-one evaluation. To identify learners' entry behaviors, an instructional analysis considers learners' current skills and prerequisite knowledge, as well as learners' preferences and attitudes. Following the analysis, the design process tries to exert control over the instructional environment. Dick and Carey model explicitly states performance learning objectives, and assessment tools are aligned with the designer's instructional objectives. The designer selects materials to deliver the instruction after determining the instructional strategy, such as text, videotape, or hypermedia. The final steps in Dick and Carey model are revision of instruction, if necessary, and summative evaluations (Dick et al., 2005).

It is important to note that ID is defined as a set of procedures used to improve education and training programs on a consistent basis (Gustafson & Branch, 2002). Analysis, design, development, implementation, and evaluation are widely accepted as the foundation for ID. Dick and Carey model, in general, follows the steps of this basic ID model (Akbulut, 2007). In Dick and Carey's model, a series of events identify the designer's learning goals and the instructional strategies required to achieve those goals.

Dick and Carey model is relevant, according to Adedoyin and Tayo (2018), because

1. learners know what they are expected to learn,
2. the model aids in the pursuit of maximum and effective utilization of both human and material resources,
3. it provides feedback that serves as a foundation for determining whether educational goals have been met, and
4. it enables teachers to adequately prepare for lesson.

Dick and Carey instructional model, as depicted in **Figure 1**, is composed of nine elements, each exerting a significant influence over the others, as described below:

1. **Identification of instructional goals:** This is a statement that states what a learner is expected to do at the end of a given instruction.

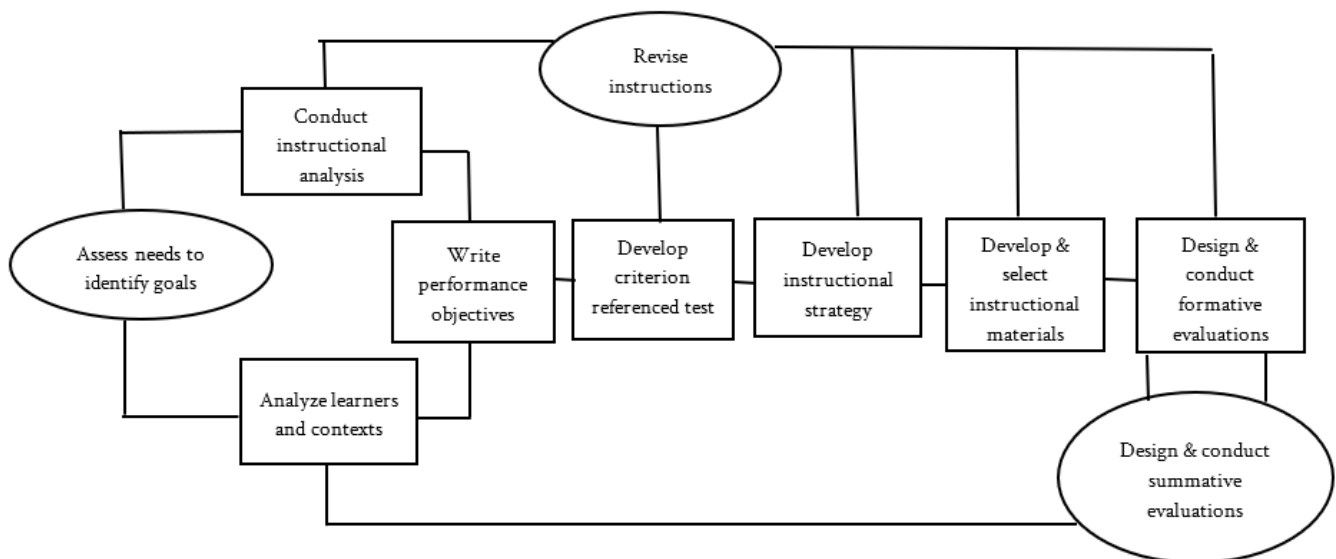


Figure 1. Dick and Carey instructional design model (Dick & Carey, 1996)

2. **Instructional analysis:** The breakdown of various components of teacher-student activities during teaching and learning is known as instructional analysis.
3. **Learner and context analysis:** This includes the context in which the skills are learned and used.
4. **Behavioral objectives:** This is a presentation of the expected change in behavior at the end of the instruction. Development of assessment instruments: In consideration of the stated objectives, learners are evaluated to find attainment.
5. **Development of instructional strategies:** Learners' oriented strategies are developed and utilized for effective attainment of objectives.
6. **Instructional materials development and selection:** Relevant original or improvised instructional materials are provided for an effective and meaningful teaching and learning process.
7. **Formative evaluation design and implementation:** This includes both diagnostic and ongoing (formative) evaluation of instructional materials and learner performance.
8. **Correction:** Because feedback information is obtained in step 7 above, areas of difficulty encountered by learners are easily identified and measures are taken to correct them.
9. **Summative evaluation:** This is final assessment performed to determine the value of the entire instructional process.

The preceding explanations demonstrate that Dick and Carey instructional model is a very strong ID capable of significantly improving students' academic performance, particularly in the sciences, because it contains elements conducive to science teaching and learning. In a related development, Bello and Aliyu (2012) examined the impact of Dick and Carey instructional model on the performance of electrical and electronic technology education students in some selected concepts in Northern Nigerian technical colleges and discovered that students taught with the model performed better. Adedoyin and Tayo (2018) discovered that students exposed to Dick and Carey instructional model outperformed those exposed to the lecture method.

When a teacher directs students to learn through memorization and recitation techniques, they are not developing critical thinking,

problem-solving, or decision-making skills, according to the traditional method. As a result, traditional education is focused on the teacher.

Traditional, also known as conventional, teaching methods are still widely used in schools. Traditional teaching methods, according to Matazu (2021), require students to recite and memorize the study content and what they teach in the classroom, and students recite the lesson one by one when their turn comes. With the exception of those who are reciting, the other students listen and wait their turn. In this manner, students complete the entire lesson. The students are then asked to memorize the lesson, and the teachers assign homework, write tests, or give oral exams based on this recitation.

Traditional teaching methods are used in the classroom to reward students for their efforts in the classroom during the periods of each subject. Rules and regulations are enforced in the classroom in order to keep students' behavior in check. These rules and regulations were derived from long-standing customs that had been used successfully in schools for many years. Teachers are in charge of imparting knowledge and enforcing school-wide behavior standards.

Gender is thought to be a potential variable that can influence student performance, particularly in science. However, there is some debate over the effect of gender on student performance. In their separate studies, Adedoyin and Tayo (2018) and Ogunleye and Babajide (2011) found no differences in performance between boys and girls. This implies that students, regardless of gender, perform significantly better. Adekunle (2005) discovered that girls performed significantly better than boys in a related development.

Statement of the Problem

Science education, particularly biology education, cannot be overstated. However, as important as biology is to the pursuit of pure and related science disciplines at higher institutions of learning, secondary school student performance in biology, which is the foundation, is not encouraging. This is reflected in the observed decline in student performance, particularly in the biology external examination (WAEC, 2017).

Clearly, the bleak scenario of this decline in performance may not be entirely due to problems with students; it may also be traceable to ineffective/insufficient instructional methodologies used by biology

teachers. Effective teaching and learning in biology, according to Adedoyin and Tayo (2018), cannot be achieved without positive and meaningful interaction between the teacher, students, and environmental resources. Dick and Carey instructional model has been shown to be effective in other fields of endeavor, but little research has been conducted on it in relation to biology teaching and learning. Despite several other relevant and efficient methods used by biology teachers, this study used Dick and Carey instructional model to improve biology teaching and learning and possibly offer a more viable solution to students' persistent decline in biology performance.

Objectives of the Study

To guide this study, the following objectives are put forward:

1. Determine impact of Dick and Carey instructional model and the traditional method on the academic performance of biology students in Katsina State.
2. Determine impact of Dick and Carey instructional model on the academic performance of male and female biology students in Katsina State.
3. Determine impact of traditional method on academic performance of male and female biology students in Katsina State.

Null Hypotheses

The following hypotheses were generated for purpose of the study:

1. There is no statistically significant difference in the mean score of Katsina State biology students taught using Dick and Carey instructional model versus the traditional method.
2. There is no statistically significant difference in the mean score of male and female Katsina State biology students taught using Dick and Carey instructional model.
3. There is no statistically significant difference in the mean score of male and female Katsina State biology students taught using the traditional method.

METHODOLOGY

A pre-test, post-test quasi-experimental non-equivalent design was used for this study. This method was chosen over others because it was one of the best for dealing with significant differences between variables, testing hypotheses, and developing universally valid generalizations. The study included all Funtua Educational Zone senior secondary school II (SSII) biology students. They are 14 to 17 years old. Four secondary schools were purposefully chosen for the study: two co-educational, one male and one female, and one intact class of SSII from

each. Each class has 35 students, for a total of 140 participants in the study. Biology performance test (BPT) was one of the study's instruments, and it consisted of 30 multiple-choice questions drawn from the SSII biology curriculum.

Experts from biology department at Usmanu Danfodiyo University Sokoto and some experienced secondary school biology teachers validated it. The split-half method was used to assess the instrument's reliability, yielding an index of 0.71. Dick and Carey instructional model guide (DCIMG) was reviewed by some Educational Psychology experts before being used as an intervention guide for the experimental group. The treatment was carried out for four weeks prior to the administration of the instrument, using SSII biology curriculum content. At the 0.05 level of significance, t-test statistics were used to test the null hypotheses.

Data Presentation and Analysis

Null hypothesis 1 (H₀₁): There is no statistically significant difference in the mean score of Katsina State biology students taught using Dick and Carey instructional model versus the traditional method.

Table 1 summarizes t-test analysis performed to compare the academic performance of the experimental and control groups. **Table 1** revealed that the p-value of 0.001 is less than the p-value of 0.05 ($p=0.001 \leq 0.05$), implying that the null hypothesis is correct. There is no statistically significant difference in the mean score of Katsina State biology students taught using Dick and Carey. The traditional method and instructional model were rejected, while the alternative hypothesis (H₁) was retained in favor of the experimental group.

Null hypothesis 2 (H₀₂): There is no statistically significant difference in the mean score of male and female Katsina State biology students taught using Dick and Carey instructional model.

Table 2 summarizes the t-test analysis performed to compare the academic performance of male and female biology students taught using Dick and Carey instructional model. The results revealed that the p-value of 0.074 is greater than the p-value of 0.05 at the 0.05 level of significance, implying that the null hypothesis, which states that there is no significant difference in the mean score of male and female Katsina State students taught biology using Dick and Carey instructional model, is retained, and the alternative hypothesis (H₁) is rejected. This is due to the fact that the p-value is greater than the alpha value. As a result, Dick and Carey instructional model is gender neutral.

Null hypothesis 3 (H₀₃): There is no statistically significant difference in the mean score of male and female Katsina State biology students taught using the traditional method.

Table 1. Summary of analysis of mean score of Katsina State students taught biology using Dick & Carey instructional model & traditional method

Groups	n	Mean	SD	df	t-cal	p-value	α-value	Decision
Experimental	70	18.145	2.5842	138	5.07	0.001	0.05	Rejected
Control	70	14.478	5.5131					

Note. Source: Field Work (2022)

Table 2. Summary of analysis of mean score of male & female Katsina State students taught biology using Dick & Carey instructional model

Gender	n	Mean	SD	df	t-cal	p-value	α-value	Decision
Male	35	17.779	2.8799	68	1.75	0.074	0.05	Retained
Female	35	18.589	2.1130					

Note. Source: Field Work (2022)

Table 3. Summary of analysis of mean score of male & female Katsina State students taught biology using traditional method

Gender	n	Mean	SD	df	t-cal	p-value	α -value	Decision
Male	35	11.550	3.5600	68	1.43	0.066	0.05	Retained
Female	35	10.430	3.3400					

Note. Source: Field Work (2022)

Table 3 is a summary of the t-test analysis performed to compare the academic performance of male and female biology students taught using the traditional method. The results revealed that the p-value of 0.066 is greater than the p-value of 0.05 at the 0.05 level of significance, implying that the null hypothesis, which states that there is no significant difference in the mean score of male and female Katsina state students taught biology using traditional methods, is retained, and the alternative hypothesis (H1) is rejected. This is due to the fact that the p-value is greater than the alpha value. As a result, the traditional method is also gender neutral.

DISCUSSION OF FINDINGS

The findings of this study revealed a significant difference in the mean score of Katsina state students taught biology using Dick and Carey instructional model versus the traditional method. This study's findings agree with those of Adedoyin and Tayo (2018), who discovered that students exposed to Dick and Carey instructional model performed significantly better than those exposed to the lecture method. The findings revealed that biology students in Katsina State secondary schools who were taught using Dick and Carey instructional model outperformed those who were taught using the traditional lecture method of teaching biology. This implies that Dick and Carey instructional model is a better approach to presenting biological concepts if the goal is meaningful and effective teaching and learning. Traditional methods for improving student performance, on the other hand, are unappealing, particularly in biology.

The study also discovered no statistically significant difference in mean scores between male and female Katsina State biology students taught using Dick and Carey instructional model. The results are consistent with those of Ogunleye and Babajide (2011); Adedoyin and Tayo (2018) discovered no differences in performance between boys and girls in their separate studies. This means that, regardless of gender, students perform significantly better when Dick and Carey instructional model is used. The results showed that using the Dick and Carey instructional model in biology class improves students' academic performance. This implies that Dick and Carey instructional model is gender agnostic when it comes to improving performance. On the contrary, the findings contradict Adekunle's (2005) findings, which found that girls performed significantly better than boys. When the traditional method was used, no gender discrimination was discovered, but no improved performance was either. This is due to the findings of the study, which revealed no significant difference in the mean score of male and female Katsina State biology students taught using the traditional method. This is consistent with Matazu's (2021) findings that traditional methods do not improve students' biology performance.

CONCLUSIONS

The following conclusions were drawn from the study's findings:

1. Dick and Carey instructional model is a successful method for teaching biology to secondary school students in Katsina State.
2. There is no statistically significant difference in mean scores between male and female Katsina State biology students taught using Dick and Carey instructional model.
3. There is no statistically significant difference in the mean scores of male and female Katsina State biology students taught using the traditional method.

Recommendations

The following recommendations are made based on the findings and conclusions of this research:

1. Biology teachers in secondary schools should use Dick and Carey instructional model because it results in a meaningful understanding of biology concepts and improved academic performance in biology among students.
2. That the government and other relevant stakeholders promote the use of several activity-based approaches to biology teaching, such as Dick and Carey instructional model.
3. Gender should not be an impediment to teaching and learning science, especially biology, because evidence shows that all that is needed is a relevant teaching model or approach, such as Dick and Carey instructional model.

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