Journal of Research in Education and Pedagogy
ISSN 3047-7131 (online) & 3047-6410 (print)
May 2026, Vol. 3, No. 2, pp. 168–179

Research Article

Instructional Design and Students' Performance: The Role of the ASSURE Model in Teaching Genetics

Salifu Kasim[1], Charles Amoah Agyei[2], Gyamfi Maxwell[2]

[1]Science Department, Vitting Senior High School, Tamale, Ghana
[2]Department of Integrated Science Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Asante Mampong, Ghana

Abstract
This study investigated the impact of the ASSURE instructional design model on the academic performance of Senior High School (SHS) students in genetics concepts in Ghana. The research was prompted by persistent conceptual challenges faced by biology students in genetics, as documented in prior studies and WAEC Chief Examiners' Reports. These challenges often result in poor academic outcomes, particularly in topics such as DNA, chromosomes, inheritance, and variation. To address this issue, the study employed a quasi-experimental design using a pre-test/post-test non-equivalent control group. A total of 104 SHS 3 Biology students from four intact classes in the Bawku, Pusiga, and Garu Districts of the Upper East Region were randomly assigned to either an experimental group taught using the ASSURE model or a control group taught using traditional methods. The Genetics Concept Test (GCT), developed by the researchers, was used to assess students' understanding before and after the intervention. Pre-test results showed the control group outperforming the experimental group. However, post-test analysis using ANCOVA revealed a statistically significant improvement in the experimental group's performance ($M = 23.938$, $SE = 0.279$) compared to the control group ($M = 19.483$, $SE = 0.268$; $F(1,101) = 121.251$, $p = .001$), with a large effect size (Partial Eta Squared = 0.546). Furthermore, no significant gender differences were found in the experimental group's post-test scores, suggesting that the ASSURE model supports equitable learning outcomes. The study concludes that the ASSURE instructional design model enhances students' academic performance in genetics and is gender-sensitive. It recommends its integration into biology instruction to improve conceptual understanding and performance, especially in regions with historically low achievement in genetics.

Keywords: Academic Performance, ASSURE Instructional Design Model, Genetics, Traditional Approach

Correspondence
Charles Amoah Agyei
caagyei@aamusted.edu.gh

Received
July 4, 2025
Accepted
March 15, 2026
Published
May 4, 2026

Citation: Kasim, S., Agyei, C. A., & Gyamfi, M. (2026). Instructional design and students' performance: The role of the ASSURE model in teaching genetics. *Journal of Research in Education and Pedagogy, 3*(2), 168–179.

DOI: 10.70232/jrep.v3i2.140

1. INTRODUCTION

Technology and science remain the pillars of individual and societal development (Ministry of Education, 2010). This suggests that both the survival of humans and the development of nations will depend more and more on science and technology. This makes every nation take issues of science education seriously at all levels of education. Consequently, science is taught in the Senior High School (SHS) stage in Ghana. Students at the SHS have the option to focus on any of the natural scientific disciplines, including biology, chemistry, and physics.

Particularly in the field of biology, researchers look at how living things interact with one another in their natural surroundings. According to the Ministry of Education (2010), the ultimate goal of teaching biology must be to help students understand how the living world can be explained in terms of scientific principles, even while acknowledging that organisms frequently behave in ways that seem to be outside the scope of their parts. One major biological concept studied in the SHS is genetics (Ministry of Education, 2010). Genetics, according to Ekong et al. (2015), is the biology of heredity and variation. According to Ekong and Anongo (2015), "variation" focuses on the reasons why people differ from one another, whereas "heredity," also known as "inheritance," centers on the transfer of traits throughout generations. Thus, the study of "similarities" and "differences" in living things can be referred to as genetics. Genetics classes in Ghana cover topics including chromosomes, inheritance, Mendel's laws of inheritance, hybrids, gene interactions, variation: causes and effects, continuous and discontinuous variations, heritable and non-heritable disorders, and more (Dzidzinyo, 2020; Ministry of Education, 2010).

However, it is established in the literature (Dzidzinyo, 2020; Etobro & Fabinu, 2017; Hadiprayitno et al., 2019) that the majority of SHS biology students have conceptual difficulties in genetics. In Ghana, Dzidzinyo (2020) carried out research and discovered that most of the SHS biology students have conceptual difficulties in DNA, chromosomes, and genes. The ensuing consequence is that students will register low academic performance in the area of genetics. This is indicated in the West African Examination Council's Chief Examiners' Report (WAEC), which said that "most applicants failed to bring clear differences between DNA and RNA" (WAEC, 2019, p. 279). Additionally, candidates' performance on variation questions was deemed unsatisfactory (WAEC, 2018).

According to the literature, teachers' pedagogical strategies and methods employed in the teaching and learning process (Bosu, 2022; Dzidzinyo, 2020; Hadiprayitno et al., 2019) have been found to impact learners' academic performance significantly. However, by employing the appropriate instructional methods, students will study the material effectively, which will improve their academic performance. Therefore, Hadiprayitno et al. (2019) argue that the techniques and approaches employed in the classroom influence students' interest in general scientific knowledge and biology specifically, as well as the degree of proficiency they demonstrate when completing a course of study. These teaching methods can be classified into two major basic approaches; thus, instructor-focused and learner-focused teaching methods, which are differentiated by who the instruction focuses on (Emaliana, 2017; Murphy et al., 2021).

Teacher-centered approaches are associated with conventional instructional models that position the teacher as the primary authority in the learning process. These approaches are also commonly referred to as expository teaching, deductive teaching, or direct instruction and are typically characterized by a lecture-based mode of delivery. In such settings, the teacher assumes a directive role by establishing learning objectives, designing structured activities to achieve them, regulating classroom interaction, and employing external incentives such as grades and assessment scores to motivate students' engagement and performance (Thomas, 2013).

In contrast, student-centered approaches prioritize learners as the focal point of the educational process. This pedagogical orientation promotes a more collaborative and balanced relationship between teachers and students, as learners actively contribute to knowledge construction (Swanwick & McKimm, 2018). Within this framework, students are encouraged to determine what they need to understand and accomplish in order to address a central problem or question, albeit with the teacher's support and guidance. Consequently, the teacher primarily functions as a facilitator who scaffolds learning and empowers students to take greater responsibility for their own educational development.

Instructional design, according to Basu (2018), is the systematic process of conceiving, producing, and delivering educational and training programs in a trustworthy and consistent manner. As a result, choices are made in instructional design, and these decisions, according to Swanwick and McKimm (2018), are founded on valid educational theory. The focus of instructional design, as Swanwick and McKimm (2018) explain, is on the pedagogical methodology, or the methods that a teacher might create to aid all students in learning, in greater depth.

To do this, teachers can use the ASSURE instructional design model, which will enable their learners to engage fully in the course of the instruction. This will enhance the learner's learning outcome in the long run (Lei, 2024). The abbreviation "ASSURE" refers to the following steps in the model: analysing learner attributes; stating the goal of the lesson, selection of material, modification, or design; use of materials; requiring learner response; and evaluation (Lei, 2024). The ASSURE model, according to Lei (2024), is a framework for planning and guiding students' academic activities toward the subject, including the use of various teaching tools within six processes.

1.1. Research Questions

1. What is the performance difference between SHS biology learners taught using the ASSURE instructional design model and those taught using the traditional method in genetics concepts?
2. What is the difference in learning outcomes in the gender of SHS biology students taught using the ASSURE instructional design model in genetics concepts?

1.2. Theoretical Review of the Study

This study operates from the constructivist paradigm. According to Bada (2015), constructivism is an educational philosophy that is predicated on the idea that cognition or learning is the outcome of "mental building." Constructivism's central tenet is that individuals construct their meaning via experience (Aljohani, 2017), interpreting the objects around them in the context of a given learning scenario. In other words, the learning is adaptive as it enables the creation of fresh ideas or works by fusing new knowledge with that already known by emphasizing inquiry and discovery. This means that, in constructivism, learners make use of their previous knowledge, which they enter the classroom with. As a result, the teacher helps students build upon the already existing knowledge that students have.

Constructivism, as a prominent theory of learning in the 21st century, is mainly categorised into cognitive constructivism, which is traced to the works of Jean Piaget, and socio-cultural constructivism, associated with Lev Vygotsky (Golder, 2018). Piaget argues that knowledge is the product of an active production process in which individuals participate. Constructivism, as defined by Piaget, is primarily concerned with the individual and how they create knowledge. In contrast to external manipulation, Piaget places more value on the internal process of thinking. So, both senses and reason are acknowledged to have some impact. Learning is a construct that each person builds on the inside, actively and independently. Without excessive instructor intervention, cognitive development is the progressive acquisition of increasingly sophisticated and organized mental processes. Piaget believed that learning is a constructivist process that depends on external simulation but is also impacted by internal and external growth levels. According to Piaget, assimilation and accommodation are internal processes that allow for learning rather than knowledge accumulation. Relationships between old and new knowledge must be established; adaptation is accomplished by reorganizing the knowledge itself (Torre et al., 2021).

Once more, the constructivist method highlights how learners actively construct their knowledge through social and cultural contexts. This viewpoint stems from Vygotsky's theories, which hold that development happens when a process is internally regulated and incorporates new abilities into the cognitive structure. Learning happens in social interaction (Torre et al., 2021). Put differently, children's cognitive development occurs as a result of their socialisation and schooling (Devi, 2019). Devi (2019) believed that Vygotsky and Piaget both believed that children are active, productive beings. However, Vygotsky saw cognitive development as a socially facilitated process based on the help that children received from adults and more experienced peers in solving issues, in contrast to Piaget, who placed a focus on children's autonomous efforts to make sense of their environment. Additionally, a learner's cultural background affects how well they can pay attention and remember. Consequently, for learning to occur, the child needs to engage with the objects and symbols that comprise the culture to create new experiences. Such a culture must be fostered in the classroom by the teachers. The learners initially acquire social speech in a social situation, followed by private communication and ultimately inner speech. It implies the society has a part in knowledge or the growth of profound insight. Both new experiences and preexisting beliefs have an impact on the learner, who then uses self-control to form new beliefs.

Every learner can study the aspect series that corresponds to their developmental level, according to Vygotsky (1978). Other areas that are out of his grasp can be absorbed with the assistance of an adult or more experienced classmates. Vygotsky (1978) described these areas as the "Nearest or Proximal Development Zone" because they fall within what an individual learner can learn and what he can learn with guidance. Vygotsky proposes the Zone of Proximal Growth (ZPD) based on his studies of human development and learning (ZPD). This is a "spectrum of tasks that can be done with the help or guidance of adults or more-skilled peers, but are too challenging for an individual to master alone" (Vygotsky, 1978, p.86). Concepts that lie within a child's zone of proximal development are those most effectively acquired through learning. Children tend to be most engaged when participating in activities they cannot accomplish independently but can succeed in with guidance from more capable peers or adults. In collaborative settings, children often work alongside peers who possess slightly more advanced cognitive abilities, positioning the task within their zone of proximal development. According to Vygotsky, cognitive development is limited to a specific range that corresponds to a child's age and developmental stage. Learners can understand ideas and concepts that they could not understand on their own except with the assistance of social contact, such as guidance from a mentor (Devi, 2019).

1.2.1. Gender and Students' Learning Outcomes in Biology

In biology education, gender equality is a major concern, especially given the increasing attention being paid to methods of increasing the proportion of females employed in scientific fields, as well as the workforce required to drive technological progress. There is evidence of mixed reports with regard to gender differences having an impact on academic performance for students. Ekong (2015) examined how gender and school location influenced the learning outcomes of senior secondary school biology students in the Agbani Education Area of Enugu State. The study employed an ex-post facto research design involving four intact Senior Secondary School 3 classes selected from both rural and urban settings, with a total sample of 328 students comprising 164 males and 164 females from four coeducational schools. The findings revealed a statistically significant difference in the mean achievement scores between male and female students, with results favoring male learners, indicating that male biology students performed better than their female counterparts.

In contrast, Sarkodie (2023) used an ex-post-facto design using 56 male and 27 female students to undertake a "Comparative Analysis of Gender Performances in Biology, Chemistry and Physics among Pre-Degree Students of Federal University, Dutsinma". The data for students who pursued biology were examined using an independent sample t-test, which revealed that there was no discernible variation in the performance of students of both genders in biology.

Wrigley-Asante et al. (2023) investigated gender-based differences in academic performance among 252 undergraduate students enrolled in STEM (science, technology, engineering, and mathematics) programs at the University of Ghana. Their findings revealed that in biology, around 95.2% of male students and 88.2% of female students achieved grades in the A1–B3 range, indicating largely comparable performance levels between the two groups.

1.2.2. Students' Difficulties in Genetics Concepts

Numerous studies have demonstrated that students frequently lack a deeper understanding of genetics and have several misconceptions about the subject. For example, Etobro and Banjoko (2017) revealed that 75.1% of pre-service teachers, on average, had misconceptions about genetics concepts. In a similar vein, Gusmalini (2020) discovered that 22.4 per cent of students were ignorant of genetics principles and 42.1 per cent of students had misconceptions. Students display misconceptions about the genetic concept in general.

In Ghana, Dzidzinyo (2020) reported that SHS biology students exhibited conceptual difficulties in chromosome, DNA, and gene concepts. Additionally, an examination of the WAEC Chief Examiners' Report for biology papers showed that in 2017, applicants struggled to adequately respond to a question requiring them to (i) define the term recombinant DNA technology and (ii) list four uses of the technology (WAEC, 2017).

In 2018, it was requested of candidates to state five: (i) reasons why living things vary; (ii) effects of variation on living things. This question seemed to be a popular one, but the performance of candidates was inadequate (WAEC, 2018).

1.2.3 Empirical Studies of the ASSURE Model on Students' Academic Performance

Research examining the impact of the ASSURE instructional model on learners' outcomes remains relatively limited. Nevertheless, existing studies suggest that when the ASSURE model is implemented effectively, it can positively enhance students' academic performance. For instance, Lei (2024), in their study entitled "The Impact of the ASSURE Model on Mathematical Correlation and Achievement in Mathematics," found that students in the experimental group who were taught using the ASSURE model performed significantly better than those in the control group.

In Ghana, Sarkodie (2023) also added a reflection stage to both ASSURE and ADDIE models to highlight the importance of reflection processes in instructional processes, thereby transforming ASSURE to ASSURER and ADDIE to ADDIER. These models were comparatively studied to determine their relative efficacy on final-year Technical University hospitality students in Sunyani. The research used a pretest/posttest experimental design using 40 students who were randomly sampled and divided evenly into the two groups. In this study, both groups were taught at different times using the conventional teaching method, after which they were subjected respectively to ADDIER and ASSURER treatments. A paired sample t-test for the ADDIER group revealed a significant difference ($t = -2.625$, $p = 0.017$) between the control class test scores (mean = 65.50, SD = 11.91) and experimental class test scores (mean = 77.75, SD = 12.08) of students, with an effect size of 0.266, indicating a large effect size. It is implied that the ADDIER model made a contribution to the enhancement of learners' academic achievements. To the ASSURER group, the outcome of the Paired Sample t-test indicated that, with an effect size of 0.325, the difference between the two is statistically significant: treatment group (M = 74.75; SD = 10.19; $t = -3.023$; $p < .05$) and control group (M = 63.75; SD = 12.34). According to Sarkodie, using the ASSURER Model helped students do better academically in the hospitality field. However, comparatively, Sarkodie established that since the values of the effect size statistics of the ASSURER Model (eta square = 0.325) on students' academic performance are greater than those of the ADDIE Model (eta square = 0.266), one can say that, by employing the ASSURE model in the classroom, students will perform better.

1.2.4. Implementation of the Intervention

Before the intervention, the schools were divided into experimental (SCHOOL A) and control groups (SCHOOL B) using simple random sampling. The participating students were pretested in order to have a fair idea about their entry behavior. They were pre-informed a week before the administration of the test. The subject matter was taught in two schools for two (2) weeks. During this period, both experimental and control schools were taught the identical material under different conditions. The experimental group was taught using the ASSURE model, while the control group was taught using the conventional technique. After the intervention, the students were given one week to revise their notes, after which the post-test was conducted. The posttest has similar characteristics to the pretest. The students were given 45 minutes to answer the test, just as in the case of the pretest. After the analysis of the results of the two tests, students from the control group outperformed their counterparts in the experimental group, which was before the intervention: conventional method (M = 11.22, SD = 1.89), ASSURE model (M = 9.50, SD = 1.94), $t(102) = -4.584$, $p = .001$. However, after the intervention, the results favored those students from the experimental group (M = 23.938, SE = 0.279) and the control group (M = 19.483, SE = 0.268; $F(1, 101) = 121.251$, $p = .001$). The experimental group's post-test scores were significantly different from the control group's with a Partial Eta Squared of 0.546, which, according to Pallant (2011), is of large effect.

2. METHODOLOGY

2.1. Research Design

This research employed the quantitative research approach. In this study, achievement test scores (to ascertain the effectiveness of the ASSURE model on students' performances) were used to gather quantitative data using a quasi-experimental design, more precisely, a non-equivalent pretest-post-test control group design.

2.2. Population

This research included a target population of all SHS 3 students in the Upper East Region, while the accessible population is made up of all SHS 3 students in the Bawku, Pusiga, and Garu districts of the same region.

2.3. Sample and Sampling Technique

Simple random sampling was used in this study to pick the four schools from the Upper East Region. Simple random sampling was then employed to choose the four classes. Additionally, since there were multiple intact classes at two of the chosen schools, simple random sampling was employed again to choose one intact class from each school (a total of four classes). Once more, the sampled classes were simply randomised and divided into experimental and control groups.

Again, there were more female participants than males. Out of a total number of 104 participants, 50 (48.08%) were males, while 54 (51.92%) were females. In terms of groups, it is revealed that within the experimental group, there were 24 males (23.08%) and 26 females (25.00%). In the control group, there were 26 males (25.00%) and 28 females (26.92%). As a consequence, the experimental group consisted of 50 SHS biology students (48.08 percent), while the control group consisted of 54 SHS biology students (51.92 percent). All participants fall within the ages of 16 to 20 years.

2.4 Research Instruments

Data from participants were gathered in this study using a Genetics Concept Test (GCT) instrument.

2.4.1. Achievement Test

This study employed the Genetics Concepts Test (GCT), which was designed by the researcher. The test consists of two essay-type items, with Question 1 having five sub-questions while Question 2 has four sub-questions. The test covered the concepts of Inheritance and Variation. These concepts were chosen because they formed part of the difficulties students have concerning genetics, as indicated by the Chief Examiner's reports (2018 and 2019 reports). The assessment was employed to ascertain the achievements of SHS biology students before and after exposure to the ASSURE model. Before the intervention, the student's prior knowledge and entry behaviours were evaluated using the pretest, while the ASSURE model's impact on SHS biology students' understanding of genetics topics was evaluated using the posttest. Both the pretest and the posttest have varied questions, but under the same concept.

Kappa's measure of agreement was used to assess the inter-rater reliability of the GCT. Mchugh (2012) states that values ≤ 0 indicate no agreement, 0.01–0.20 indicate none to slight agreement, 0.21–0.40 indicate fair agreement, 0.41–0.60 indicate moderate agreement, 0.61–0.80 indicate substantial agreement, and 0.81–1.00 indicate almost perfect agreement. Table 1 displays the value of Kappa's measure of agreement for this study, which is 0.709, indicating a considerable level of agreement. As a result, it was decided that the GCT would be a reliable tool for the pretest and posttest.

Table 1. Reliability of GCT

	Kappa Value	Asymptotic Standard Error
Measure of Agreement	.709	.066
N of Valid Cases	48	

2.5. Data Collection Procedure

A pretest was carried out before the administration of the intervention for both control and experimental groups. The intervention stage started after the pretest was completed. To account for teacher variations, the researcher taught the subject matter in the two (2) grouped schools. During the two-week intervention phase, both experimental and control schools were taught the identical material under different conditions. The ASSURE method was employed in teaching the experimental group, while the traditional teaching method was applied to the control classes. After the intervention stage, students were given one week to revise their notes, after which the post-test was conducted. Students from both groups were allowed 45 minutes to provide answers to the post-test items and were to score a maximum of 25 out of 30 marks.

3. RESULTS AND DISCUSSION

This study examined the effectiveness of the ASSURE instructional design model on SHS biology students' learning outcomes in genetics concepts. The research questions provide the basis for the presentation of the findings. The Statistical Package for the Social Sciences (SPSS) version 26 was used to compile, sort, and code the participant data. For all statistical tests, the level of significance was set at $\alpha = 0.05$. This threshold was used to determine whether observed differences were statistically significant, meaning there was less than a 5% probability that the results occurred by chance.

3.1. Results for Research Question 1

What differences exist in performance between SHS biology students taught using the ASSURE instructional design model and those who were instructed through the conventional method in the genetic concept?

The research question aimed to compare the learning outcomes of the experimental (taught using the ASSURE methodology) and control groups in genetics concepts (taught using the conventional teaching method). In order to assess whether the two groups' pretest performance was similar, an independent sample t-test was employed. Table 2 shows the results. The preliminary assumption tests for linearity, homogeneity of variance, and normality showed no violations. The independent samples t-test was used to compare the mean scores of two unrelated groups, namely, the experimental and control groups, on both the pre-test and post-test assessments. This test was appropriate because the groups were randomly assigned and consisted of different participants, satisfying the assumption of independence. The t-test enabled the researchers to determine whether there were statistically significant differences in academic performance between students taught using the ASSURE model and those taught using traditional methods prior to and after the intervention.

Table 2. Independent Sample t-test Results of Pretest Scores for Experimental and Control Groups

Teaching Approach	N	Mean	SD	t	df	p
ASSURE	50	9.50	1.94	-4.584	102	.001
Conventional	54	11.22	1.89			

$p<0.05$.

Table 2 revealed that learners taught using the ASSURE model (M = 9.50, SD = 1.94) and learners taught with the traditional method (M = 11.22, SD = 1.89; t(102) = 4.584, p =.001) had significantly different pretest results. This indicates that before the intervention, the performance of the learners in both the experimental and control groups varied. After the treatment was put into practice, the outcomes of the learners taught genetics concepts using the ASSURE model, and those using the conventional approach were examined to see whether anything had changed. The post-test findings of the students taught genetics using the two approaches were compared using One-way ANCOVA. The pretests' results were used as covariates and are shown in Table 2. Once again, the assumptions of linearity, homogeneity of regression slope, and variance were not violated.

To further refine the post-intervention analysis and control for initial differences in pre-test scores, a one-way Analysis of Covariance (ANCOVA) was conducted. ANCOVA was chosen because it adjusts the post-test scores based on pre-test performance, thereby isolating the effect of the instructional method. This approach enhances the validity of the findings by accounting for baseline variability and providing a clearer picture of the intervention's impact.

Table 2. Results of One-Way Analysis of Covariance on Posttest Scores for Experimental and Control Groups

Teaching Method	N	Adjusted Mean	Std. Error	F	p	Partial Eta Squared
Experimental	50	23.938	.279	121.251	.001	.546
Control	54	19.483	.268			

After controlling for the impact of the pretest on the posttest, which was significant, Table 2 shows that the experimental group performed better on the posttest (M = 23.938, SE = 0.279) than the control group (M = 19.483, SE = 0.268; F (1, 101) = 121.251, p =.001). The post-test scores of the experimental group were significantly different from the control group with a Partial Eta Squared of 0. 546, which, according to Pallant (2011), is of large effect.

3.2. Results for Research Question 2

What differences exist in learning outcome in the gender of SHS biology students taught employing the ASSURE instructional design model in genetics concepts?

Research question 2 sought to find out the disparities in learning outcomes in the gender of SHS biology students taught using the ASSURE instructional design model in genetics concepts. To achieve this, an independent sample t-test was carried out on the pretest of the students. This aimed to determine whether males and females performed similarly or if there was a substantial difference in performance between them before the intervention. The outcome of the independent sample t-test on the pretest on the difference in performance in the gender of SHS biology students taught using the ASSURE instructional design model in genetics concepts is presented in Table 3.

Table 3. Results of the Independent Sample T-Test for the Male and Female Students in the Experimental Group's Pretest Scores

		Gender	N	Mean	SD	T	df	p
Equal assumed	Variances	Males	24	9.50	2.126	.000	48.000	1.000
		Females	26	9.50	1.794			

The pre-test scores between males (M = 9.50, SD = 2.126) and females (M = 9.50, SD = 1.74; t (48) = -1.000, p>.05) students taught using the ASSURE instructional design model in genetics concepts after the independent-sample t-test analysis revealed no significant difference. This signifies that the students from both genders (males and females) in the ASSURE design model were academically performing at a similar level prior to the interventions' implementation. This circumstance offers a strong basis for comparing the learners' post-test results in the ASSURE instructional design model. To examine the post-test scores of gender differences in the ASSURE instructional design model, an independent sample t-test was used. Table 4 shows the results. Once again, the assumptions of linearity, homogeneity of regression slope, and variance were not violated**.**

Table 4. Results of the Independent Sample T-Test For the Posttest Scores of the Gender of Students Taught with the ASSURE Instructional Design Model

Gender	N	Mean	SD	T	df	p
Male	24	22.83	2.514	-1.492	48	.142
Female	26	23.81	2.098			

p>0.05

According to Table 4, there was no discernible statistical difference in the posttest scores of male students (M = 22.83, SD = 2.514) and female students (M = 23.81, SD = 2.098; t(48) = -1.492, p = 0.142) after exposure to the ASSURE model. Thus, learners from both gender groups (males and females) in the ASSURE instructional design model were performing at a similar level after the treatment was put into practice. That is the ASSURE instructional design model implemented could not discriminate among genders.

4. DISCUSSION

The first research question aimed to determine the disparities in academic performance in genetics concepts between SHS biology students taught through the ASSURE instructional design method and those taught through the conventional method. In so doing, the effectiveness of both teaching methods was compared. Results from Table 2 show that there was a discernible statistical difference in posttest scores between students taught using the ASSURE model (M = 23.34, SD = 2.335) and students taught using the conventional teaching method (M = 20.04, SD = 2.197; F (1, 101) = 121.251, p =.001) after the intervention was introduced. This difference was found to favour the students taught using the ASSURE model. This may be because the use of the ASSURE model incorporated various resources, including real-world examples, multimedia, and interactive materials. According to Bossu (2022), the use of these resources provides authentic contexts for learners to construct their knowledge, which, in the conventional classroom, was not the case. The conventional classrooms were dominated by lectures, where students only listened to every explanation from the teacher without any active involvement by the students. It has already been discussed that, when learners are given the opportunities to construct their knowledge during the instructional process, their understanding is enhanced, and this makes them perform better. According to Bossu (2022), the ASSURE model, being a series of procedures, is designed to help teachers plan how to use technology in the learning environment and to create a further convenient and conducive environment possible for better performance.

This study is also in line with Sarkodie (2023). According to him, the ASSURE model has a stronger impact on students' academic performance. By this, he meant that when a lesson is planned based on ASSURE with the needed technological resources, students have a greater chance of performing better. Comparatively, in traditional settings, little attention is paid to the use of technology and students' general characteristics in the learning environment. Lei (2024) contended that students' poor academic performance may be linked to the traditional teaching methods that are mostly dominated by lectures. However, lessons that are designed according to the ASSURE model have positive impacts on students' academic performance.

Research question two sought to evaluate the differences in academic performance between both genders of SHS biology students using the ASSURE model in the area of genetics concepts. Consequently, an independent sample t-test on the posttest results indicated that the posttest scores of both genders did not significantly differ from one another: male students (M = 22.83, SD = 2.514) and female students (M = 23.81, SD = 2.098; $t(48) = 1.492$, $p = 0.142$). This may be attributed to the fact that the ASSURE instructional design model has features that are gender sensitive. For instance, the evaluations of students' characteristics before the instruction enabled the selection of teaching and learning materials that suited all students regardless of gender. This study's findings are consistent with the study conducted by Eshun and Amoah (2018). They found gender not to be substantially correlated with biology students' performance on reasoning skills tests. Additionally, Sarkodie (2023) indicated that there was no discernible statistical difference between gender and teaching technique and students' academic achievement. Gender was found to have no bearing on students' academic achievement in biology because males and females did not respond to the treatment differently.

5. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the impact of the ASSURE instructional model on students' performance in genetics, revealing statistically significant improvements among learners exposed to the model compared to those taught through conventional methods. The integration of multimedia resources, learner-centered strategies, and structured instructional planning contributed to enhanced conceptual understanding and engagement with complex genetic content. The findings underscore the value of systematic instructional design in science education, particularly models that prioritize learner analysis, active participation, and continuous evaluation. By aligning pedagogical strategies with cognitive principles and contextual realities, educators can foster deeper learning and improved academic outcomes. These results advocate for the broader adoption of technology-enhanced, participatory teaching frameworks like the ASSURE model in science curricula. Such approaches not only support content mastery but also promote equity and accessibility in learning, especially in diverse educational settings where traditional methods may fall short.

A few recommendations have been made based on the study's findings that should be taken into account when making important decisions about education.

1. It is advised that biology instructors in senior high schools in Bawku, Pusiga, and Garu districts use the ASSURE model in their genetics classes because it helps to improve students' performance.
2. The ASSURE instructional model is gender-sensitive, hence it is recommended in teaching genetics at SHSs irrespective of the gender in the schools.

6. LIMITATIONS

While the findings of this study provide valuable insights into the effectiveness of the ASSURE instructional model in genetics education, several limitations were acknowledged:

1. The study was conducted with a relatively small sample drawn from a specific educational context. As such, the results may not be fully generalizable to broader populations or different educational systems without further replication.
2. Although efforts were made to ensure group equivalence, the use of a quasi-experimental design limits the ability to establish definitive causal relationships. Uncontrolled variables, such as teacher differences or classroom dynamics, may have influenced outcomes.
3. The evaluation focused primarily on immediate post-intervention performance. Longitudinal data would be needed to assess the sustained impact of the instructional model on students' retention and transfer of genetics knowledge.

7. FUTURE RESEARCH DIRECTIONS

1. Further studies should investigate the effectiveness of the ASSURE model in teaching other complex science domains such as ecology, chemical reactions, electricity and circuits, or human physiology, where abstract concepts often challenge student understanding.
2. Future studies should apply the ASSURE model in lower secondary and upper primary classrooms to assess its adaptability for younger learners.
3. Further studies can explore its impact on students with learning difficulties, gifted learners, or those from linguistically diverse backgrounds, to evaluate its inclusivity and differentiation potential.
4. Further studies should include teacher disposition to gain a more holistic understanding of the model's effects.
5. Further studies should implement longitudinal designs to track knowledge retention, conceptual transfer, and sustained academic growth over time.
6. Further studies should investigate the role of teacher professional development in enhancing fidelity and effectiveness of ASSURE-based instruction.

Acknowledgments. We sincerely thank the heads, teachers, and students of the participating Senior High Schools in the Bawku, Pusiga, and Garu districts for their cooperation and active participation throughout this study.

Research Ethics. This study received Kwame Nkrumah University of Science and Technology ethics approval on 30th July 2025 (reference number: CHRPE/AP/708/25).

Data Availability Statement. All data can be obtained from the corresponding author upon reasonable request.

Conflicts of Interest. The authors declare no conflicts of interest

Funding. This research received no external funding.

REFERENCES

Aljohani, M. (2017). Principles of "constructivism" in foreign language teaching. *Journal of Literature and Art Studies, 7*(1), 97–107. https://www.davidpublisher.com/Public/uploads/Contribute/583d2297ba95a.pdf

Amoah, C. A., Gyang, N. O., & Agbosu, A. A. (2018). Assessing the planning skills of biology students in selected senior high schools in Eastern Region of Ghana. *International Journal of Science and Research, 7*(4), 657–662.

Bada, S. O. (2015). Constructivism learning theory: A paradigm for teaching and learning. *IOSR Journal of Research & Method in Education, 5*(6), 66-70. Retrieved from https://iosrjournals.org/iosr-jrme/papers/Vol-5%20Issue-6/Version-1/I05616670.pdf

Basu, R. (2018). Instructional design models: Benefits and challenges. *UGC Approved Journal, 41*(1), 31–36.

Bosu, L. (2022). Pedagogical strategies in lesson planning: an assessment of senior high schools accounting teachers in Ghana. *Canadian Journal of Educational and Social Studies, 2*(3), 109–138. https://doi.org/10.53103/cjess.v2i3.45

Devi, K. S. (2019). Constructivist approach to learning based on the concepts of Jean Piaget and Lev Vygotsky an analytical overview. *Journal of Indian Education, 44*(4), 5-19. Retrieved from https://ejournals.ncert.gov.in/index.php/jie/article/view/2553

Dzidzinyo, A. F. (2020). Exploration of senior high school biology students' conceptual understanding of genetics. [PhD. Thesis, University of Cape Coast]. Retrieved from http://hdl.handle.net/123456789/7190

Ekong, N. J., Akpan, G. A., Anongo, M. C., & Okrikata, E. (2015). Influence of selected variables on students' academic performance in genetics and their implications for effective application of STEM Education. *Journal of Emerging Trends in Educational Research and Policy Studies, 6*(4), 331–337. https://www.scholarlinkinstitute.org/jeteraps/articles/Influence%20of%20Selected%20Variables%20NEW.pdf

Emaliana, I. (2017). Teacher-centered or student-centered learning approach to promote learning. *Jurnal Sosial Humaniora, 10*(2), 59–70. http://doi.org/10.12962/j24433527.v10i2.2161

Ertmer, P. A., & Newby, T. J. (2012). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 26*(2), 43-71. https://doi.org/10.1002/piq.21143

Eshun, E., & Amoah, C. A. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management, 6*(4). https://doi.org/10.18535/ijsrm/v6i4.el12

Etobro, A. B., & Banjoko, S. (2017). Misconceptions of genetics concepts among pre-service teachers. *Global Journal of Educational Research, 16*(2), 121–128. https://doi.org/10.4314/gjedr.v16i2.6

Etobro, A. B., & Fabinu, O. E. (2017). Students' perceptions of difficult concepts in biology in senior secondary schools in Lagos state. *Global Journal of Educational Research, 16*(2), 139–147. https://doi.org/10.4314/gjedr.v16i2.8

Golder, J. (2018). Constructivism: A paradigm for teaching and learning. *International Journal of Research and Analytical Reviews, 5*(3), 678–686. Retrieved from https://ijrar.org/papers/IJRAR1903214.pdf

Gusmalini, A., Wulandari, S., & Zulfarina. (2020). Identification of misconceptions and causes of student misconceptions on genetics concept with CRI method. *Journal of Physics: Conference Series, 1655*(1). https://doi.org/10.1088/1742-6596/1655/1/012053

Hadiprayitno, G., Muhlis, & Kusmiyati. (2019). Problems in learning biology for senior high schools in Lombok Island. *Journal of Physics: Conference Series, 1241*(1), 1–8. https://doi.org/10.1088/1742-6596/1241/1/012054

Lei, G. (2024). Influence of ASSURE model in enhancing educational technology. *Interactive Learning Environments, 32*(7), 3297–3313. https://doi.org/10.1080/10494820.2023.2172047

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica, 22*(3), 276. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC3900052/

McKimm, J., & Swanwick, T. (2018). Educational leadership and management. In T. Swanwick, K. Forrest, & B. C. O'Brien (Eds.), *Understanding medical education: Evidence, theory, and practice* (pp. 549-568). https://doi.org/10.1002/9781119373780.ch37

Ministry of Education, G. (2010). Teaching syllabus for biology (senior high school).

Murphy, L., Eduljee, N. B., & Croteau, K. (2021). Teacher-centered versus student-centered teaching. *Journal of Effective Teaching in Higher Education, 4*(1), 18–39. https://doi.org/10.36021/jethe.v4i1.156

Pallant, J. (2011). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (4th ed.). Allen & Unwin.

Sarkodie, N. A. (2023). Do Teaching Models Affect Students' Academic Performance? *Journal of Engineering Applied Science and Humanities, 8*(1), 102-113. https://scholarindexing.com/uploads/files/i4xzpyqabd1gn_e.pdf

Thomas, M. (2013). Teachers' beliefs about classroom teaching – teachers' knowledge and teaching approaches. *Procedia - Social and Behavioral Sciences, 89*, 31-39. https://doi.org/10.1016/j.sbspro.2013.08.805

Torre, N. O., Vidal, O. F., & Ferran, A. P. (2021). *Constructivist learning models in training programs.* Omnia Publisher SL. https://doi.org/10.3926/oms.407

Vygotsky, L. S. (1978). *Mind in society: Development of higher psychological processes* (M. Cole, V. Jolm-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

WAEC. (2017). Chief Examiners' Reports: Science Subjects.

WAEC. (2018). Chief Examiners' Reports: Science Subjects.

WAEC. (2019). Chief Examiners' Report: Science Subjects.

Wrigley-Asante, C., Ackah, C. G., & Frimpong, L. K. (2023). Gender differences in academic performance of students studying Science Technology Engineering and Mathematics (STEM) subjects at the University of Ghana. *SN Social Sciences, 3*(1), 12. https://doi.org/10.1007/s43545-023-00608-8