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The Role of Generative Learning Strategy in Bridging the Gap between High and Low Achievers in Genetics Studies in Sefwi-Wiawso Municipality, Ghana

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Abstract: The study sought to investigate the use of the Generative Learning Strategy (GLS) in bridging the performance gap between high- and low-achieving students in genetics in Ghana's Western North region's capital, Sefwi-Wiawso Municipality. The study adopted an embedded research design involving the quasi-experimental pretest/posttest groups with a sample size of 106 SHS 3 Biology students. Two intact classes were randomly selected, treated as one group and exposed to the same treatment conditions. The Genetic Concepts Test and a semi-structured interview guide collected the quantitative and qualitative data, respectively. The GCT's internal consistency was 0.784, indicating a preferable internal consistency. The quantitative data was analyzed using the SPSS version 26, by employing descriptive and inferential statistics. The study found no significant performance difference between high and low achievers after using the GLS. The approach improved the lower achievers' performance. The interview results revealed that Senior High School Biology students perceived that the Generative Learning Strategy improved the understanding, motivation, retention and self-directed learning of genetic concepts, thereby enhancing their learning outcomes. The study recommended that SHS Biology teachers employ the Generative Learning Strategy in teaching genetic concepts to bridge the performance gap between high and low achievers.

Keywords: Generative learning strategy; academic performance; high achievers; low achievers; genetics.

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Introduction

Growing body of research indicates that students need to learn basic genetic principles more thoroughly (Thomson & Stewart, 1985 as cited by Didem *et al.* (2016). Consequently, there is a need to put more emphasis on the topic of genetics in classrooms due to its growing significance in our daily lives. Hott et al. (2002) emphasized that the topic of genetics needs to receive more attention in the science curricula, given the growing significance of genetics in our daily lives, such as enhancing the biological literacy, equipping learners with informed decisions about personal and public health issues, including genetic testing and therapies (Veach et al., 2020). Furthermore, genetic principles enhance learners' critical thinking, problem-solving and understanding of genetic research and technology, crucial for careers in medicine, research and bioengineering (Dougherty et al., 2020; Howard Hughes Medical Institute, 2022) Ashelford (2008) added that the teaching of Senior High School genetics offers a significant opportunity for learners to examine contemporary ethical and social issues. Owing to this, students in Senior High Schools should comprehend what they read and hear about genetics and respond intelligently to personal or social concerns with scientific content (Lewis, et al., 2000). Relevant genetic education must be undertaken in schools if the general public is to comprehend such matters. However, there have been reports around the world over the years on the issue of poor biology performance among students (Alfiraida, 2018; Etobro & Fabinu, 2017; Gungor and Ozkan, 2017; Aivelo & Uitto, 2015; Agboghoroma & Oyovwi, 2015) and particularly in genetics (Fauzi et al. 2021; Solé-Llussà et al., 2019; Fauzi & Mitalistiani, 2018; Thörne & Gericke, 2014; Gericke & Wahlberg, 2013). In Ghanaian Senior High Schools, there are similar problems with genetic concepts among students (Amoah, Gyang et al., 2018; Gbore & Daramola, 2013; Adeyemi, 2006; WAEC Chief Examiners' Reports, 2020; 2019; 2017; 2016).

This indicates that the difficulty of students learning genetics in biology is not only peculiar to Ghanaian schools but it is a global challenge. Students' responses to questions on genetic concepts appear to be consistently poor, which eventually impacts how well they perform in biology. For instance, in the 2016 West African Senior School Certificate Examination (WASSCE), approximately 45% of candidates achieved grades A1 to C6, which according to the West African Examinations Council (WAEC) grading system, the grades represent various levels of passes, with A1 being the highest and C6 being the lowest acceptable grade for a pass. In the 2017 WASSCE, around 47% of the candidates scored between A1 and C6. In the 2018 WASSCE, approximately 49% of the candidates scored between A1 and C6 (WASSCE Performance Statistics, 2016, 2017, 2018). Similarly, in the 2019 WASSCE, about 47% of the candidates obtained A1 to C6 (West African Examinations Council, (2019)In light of this trend, stakeholders in education are keen to identify the best solutions for poor performance in genetic concepts and Biology in general.

Literature has highlighted the benefits of the Generative Learning Strategy, which is a step-by-step learning method that is based on the opinions and experiences of students who actively participate in their education across different learning domains. This method of teaching to a greater extent, could also help to improve the understanding of learners in genetics. Empirically, a study by Fiorella et al., (2020) found that Generative Learning Strategies like drawing and explanations significantly improved students' understanding and retention of complex information in video lessons. Similarly, a study by Appiah-Twumasi (2019) concluded that students perform better in physics concepts when instructed with the Generative Learning Strategy. Furthermore, a meta-analysis by Schneider, et al. (2018) confirmed that the Generative Learning Strategy led to better retention in mathematics, highlighting the effectiveness of these strategies in enhancing long-term memory. However, there seems to be a study gap in the use of the Generative Learning Strategy in the teaching and learning of biology, as there have not been extensive studies to examine how the Generative Learning Strategy could close the academic performance gap between low and high achievers. Therefore, this study adopted the use of the Generative Learning Strategy with the mind of helping Senior High School biology students from Sefwi-Wiawso Municipality in Ghana to bridge the performance gap between high and low achievers.

Related Literature and Studies

This section presents the theoretical framework and the empirical literature reviewed about the Generative Learning Strategy.

Theoretical Framework

The Generative Learning Strategy (GLS) is aligned with constructivist principles as it encourages students to generate connections between new information and their existing knowledge base. This strategy involves activities such as summarizing, questioning and mapping, which promote active engagement and deep processing of information (Wittrock, 1974). When applied to genetic concepts, being the problem under study, the constructivist approach facilitated by the Generative Learning Strategy can significantly enhance learning outcomes. Genetics involves abstract concepts, but through the use of the Generative Learning

Strategy, appropriate strategies help students build and organize knowledge. By using generative strategies, students can create meaningful links between new genetic information and their prior understanding, leading to better retention and comprehension (Fioorella, 2023). For instance, when students create concept maps or generate questions about genetic principles, they actively construct their understanding in a way that aligns with constructivist ideals.

Thus, the constructivist theory relates to the Generative Learning Strategy as both emphasize active learning and the construction of knowledge, which are crucial for understanding complex subjects like genetics. The active engagement promoted by GLS ensures that students are not merely passive recipients of information but active participants in their learning journey, leading to improved learning outcomes (Wittrock, 1990). Therefore, the study's conceptual foundation was the constructivist theory. This is not implausible given that the study focused on learners' thinking and academic development. It makes it clear that individuals construct their own knowledge of the world when they engage in experiences and think back on those experiences (Woolfolk, 2016). According to the constructivist view of learning, learners use a range of learning activities and interactions to generate knowledge and meaning from their experiences, whether working alone or in groups (Kazeni & Onwu, 2012).

According to Bhutto and Chhapra (2013), under constructivism, teachers assist students' growth by creating an inspiring and encouraging learning environment while taking into account their unique needs, past experiences and learner-oriented objectives through effective social communication. According to Husain (2018), learners' roles are to actively investigate new concepts and build them, as the instructional method effectively involves them all in the learning process. Basically, as students actively develop ideas on their own, the constructivist theory of learning serves as the most suitable basis for the formulation of the Generative Learning Strategy.

Generative Learning Strategy

The definition of "generative," which is derived from the Latin word "beget," is "having the power or function of generating, originating, producing or reproducing." Thus, the Generative Learning Strategy describes the mental operations involved in the creation of individual knowledge or meaning. Knowledge, according to generative learning theorists, is the intentional comprehension of information that results from the building of links between novel pieces of knowledge and between novel knowledge and memory. The core premise of the Generative Learning Strategy (GLS) is that students are not merely passive recipients of knowledge. Instead, they actively participate in the educational process and work to develop a deep comprehension of the knowledge they encounter in their environment (Wittrock, 1974).

The Generative Learning Strategy has been defined as a learner-centered instructional strategy with predetermined activities designed to promote active cognitive processing throughout the session. The internal processing of external stimuli is necessary for the generative learning processes (Wittrock, 1974). The learner, teacher or instructor should not assume a dominant role during any of the steps or activities in the Generative Learning Strategy; rather, they should be considered collaborators in the process. Awolere et al. (2019) claimed that one key method for teaching students to change their negative attitudes toward biology in particular and science in general, is through generative learning. According to Pappas (2014), the Generative Learning Strategy has the following four primary fundamental elements that teachers can incorporate based on the needs of the students and the materials used for teaching and learning:

Recall*:* Recall happens when a learner uses knowledge that has already been ingested to learn content that is fact-based by accessing knowledge that has been stored in his or her long-term memory. Asking the learner to repeat information or go over a concept again and again until he or she understands it completely is an illustration of the recall task.

Integration*:* Integration happens when a learner combines newly acquired knowledge with information that has already been gathered and stored in the brain. The goal is to change previously stored information into a format that makes it easier for the learner to remember and access it in the future. Making parallels to explain previously acquired knowledge that has been stored in the brain is an example of integration.

Organization*:* Organization requires students to effectively connect previously learned material to new concepts. Making lists or outlining the key ideas of a topic is an example of the organization in action.

Elaboration: Elaboration requires that, in evaluating concepts, the teacher encourages the students to draw connections between previously learned material and novel concepts. Extending ideas and visualizing mental images are two examples of elaboration.

Studies on Generative Learning Strategy

Generative Learning Strategy is a method of instruction in which students actively create ideas on their own. It is an environment-based paradigm that suggests allowing learners to create their learning rather than having them solve a pre-defined problem by creating their issues or resolve the issues. Instead of just memorizing the information offered, students who engage in the generative learning must create meaning by fusing new knowledge with prior knowledge (Grabowski, 2004). The following are some of research findings highlighting the opportunity to use the Generative Learning Strategy to enhance learning outcomes:

Generative Learning Strategy allows learners to organize, generalize and simulate knowledge (Fiorella, 2023). Also, when employing video lectures, the Generative Learning Strategy results in better learning performance (greater) accuracy and quicker reaction time in students (Pi et al., 2023). Moreover, it can induce positive views toward the twenty-first-century educational technology like augmented reality (Buchner, 2022). Furthermore, it integrates previously learned material with recently acquired ideas, improving the student's academic performance (Boby et al., 2021). In addition, it allows teachers to empower their students or learners to take charge of their learning while also serving as a coach or facilitator for the learning process (Appiah-Twumasi, 2019). Furthermore, it encourages communication and cooperation for successful learning among the learners and it makes the teaching and learning process flexible (Awolere, 2015). To sum it up, it encourages learners to actively interpret the material they are learning and combine it with what they already know (Fiorella & Mayer, 2016; Wittrock, 1974).

The effectiveness of the Generative Learning Strategy has been examined across a wide range of curriculum areas, learning levels and learner ages, including what Fiorella (2023, Pi et al. (2023), Buchner (2022), George and Abumchukwu (2021), Olagbaju (2019), Appiah-Twumasi (2018), Bot (2018), Wittrock and Carter, cited by Wilhelm-Chapin and Koszalka (2016). These studies offer empirical evidence that students who use learning resources built on the principles of a Generative Learning Strategy have a higher average recall and retrieval than students who do not.

Methodology

Design

The study adopted an embedded design involving the quasi-experimental pretest/posttest groups, where two intact classes were randomly selected and treated as one group and exposed to the same treatment conditions. The use of the quasi-experimental groups was because participants were not randomly selected from the larger population.

Population and Sampling

The study involved 106 SHS 3 biology students. Among the 106 participants, 55 were selected from the science class while 51 were selected from the Home Economics class. The two were treated as one group. Among the 106 participants, 44 were low achievers, representing 41.50% and 26 were high achievers, representing 24.53%. The remaining 36 (33.96%) were average achievers of the total participants. The average achievers were removed from the study before the final testing.

Instruments

The research instruments used in this study were an achievement test, that is, the Genetics Concepts Test (GCT) and a semi-structured interview guide. The GCT assessed the performance of SHS 3 biology students after the intervention (post-test). Some selected students expressed their opinions regarding the employment of the Generative Learning Strategy in the semi-structured interview.

Validity and Reliability

In order to determine the validity of the research instruments, the GCT and the interview guide were given to six (6) experts in the field of biology and Science Education to proofread, make their inputs and determine the appropriateness of each item on the instruments. Further analysis, using the Cronbach's Alpha value yielded the score of 0.958.

Stages of Generative Learning Strategy

The GLS stages used in this study were recall, integration, organization and elaboration. Table 1 shows a detailed description of these stages.

Introduction

This stage introduced the lesson and the subject matter to the students. The generative learning activity employed at this stage is recall.

Recall: Using an advanced organizer, the instructor evaluated the students' previously stored knowledge about the current subject. The main goal was to motivate students to develop an idea based on facts and details they were already familiar with.

Table 1: Generative Learning Strategies Adopted for this Study

Stage	Generative Learning Strategy	Activity
Introduction	Recall	Elicitation of students' previous knowledge. For example, using multimedia resources, diagrams, and interactive simulations to introduce basic genetics concepts.
Development	Integration	Addition and modification of previous knowledge on genetics concepts using cooperative brainstorming activities in which students explore and illustrate the connections between these concepts and ideas.
	Organization	Connecting previous knowledge with new knowledge on genetics concepts through hands-on experiments or simulations that allow students to observe genetic principles in action. For example, using Punnett squares with physical representations of alleles (like beads or colored counters) to model genetic crosses.
	Elaboration	Application of new knowledge on genetics concepts to other areas or real-life situations. For example, introducing case studies that highlight the application of genetics in diverse fields, such as medicine, agriculture, or forensics.
Closure		Summary of the main concepts of the lesson using reflective activities where students articulate their understanding of genetics concepts and connect them to their own lives.
Evaluation		Assessment of attainment of lesson objectives through oral presentations, class tests and assignments.

Lesson Development

This stage is also characterized by connecting the prior knowledge of students to the new knowledge to be learned in the lesson as well as expanding the new knowledge learned. The generative learning activities employed at this stage include integration, organization and elaboration.

Integration: Supplement what they already know with new information. The primary goal was to alter the content to make it more readable and memorable. Asking students to paraphrase the material or creating analogies to explain concepts are two examples of this type of learning activity.

Organization: Students efficiently make connections between new concepts and their prior knowledge, which aids with memory. A few examples of organization techniques are making lists, assigning grades to specific items, or analyzing a concept's essential components.

Elaboration: Students were expected to make original connections between new ideas and what they previously knew. Thinking about how the new information fits with prior knowledge or everyday tasks is an example of an elaboration technique. The students gave themselves an explanation of the lesson's specifics. In this phase, students identified the most pertinent information, provided an in-depth explanation of each aspect, arranged the information using deductions, and integrated new information with what they already knew.

Closure

In the closure session, students were allowed to appraise the weaknesses of the old concepts they had already conceived. Students were also encouraged to recall the material and concepts they learned during the lesson.

Evaluation

In the evaluation, the teacher gave end-of-lesson assignments and quizzes to assess the attainment of lesson objectives.

Statistical Treatment of Data

The analysis of data involved descriptive statistics, inferential statistics and thematic analysis.

Ethical Considerations

An official permission was sought from relevant authorities prior to data collection. The purpose, importance and uses of the results were explained to the authorities and participants while assuring them of the confidentiality of the results and information provided. Pseudo names were used for students who participated during the interview.

Results and Discussion

Research Question 1: Is there a difference between the genetics test scores of high achievers and low achievers instructed with the Generative Learning Strategy?

This research question sought to determine the difference in academic performances in pretest and posttest scores between the high-achievers and low-achievers before and after the introduction of the intervention. To categorize students into high achievers and low achievers, students' scores in the pretest were used. Specifically, students' pretest scores were ranked according to their percentiles and divided into three: 100th percentile, 66th percentile and 33rd percentile. Students whose pretest scores were ranked from 1st to 33rd percentile were considered low achievers, those from 34th to 66th percentiles were considered average achievers and those from 67th to 100th percentiles were considered high achievers. The average achieving students were removed from participation since they were not the focus in this study.

The performance differences between high- and low-achieving students who were taught utilizing the Generative Learning Strategy were ascertained by the computation of descriptive statistics. The mean and standard deviation of the GCT pretest and posttest results obtained before and after the implementation of the Generative Learning Strategy are displayed in Table 2.

From Table 2, the low-achievers obtained a pretest mean score of 6.26 (SD = 0.806) and a post-test mean score of 22.63 (SD = 1.770) while the high-achievers obtained a pre-test mean score of 10.73 (SD = 0.799) and a post-test mean score of 23.73 (SD = 2.567).

Table 2: Descriptive Statistics of Pretest and Posttest Scores

Ability Group		Pre-test		Post-test		MD*
	N	M	SD	M	SD	
Low Achievers	44	6.26	0.806	22.63	1.770	16.37
High Achievers	26	10.73	0.799	23.73	2.576	13.00

MD* - Mean Difference

Table 3: Results for Test of Homogeneity of Variances of Posttest Scores

		Levene's Test Statistic F	**Sig.**
Posttest	Equal Variances Assumed	2.814	.103

The results in research question 1 were further tested as hypothesis 1 using a one-way analysis of covariance (one-way ANCOVA) to determine whether the difference in the posttest scores of the two groups (high-achievers and low achievers) was significant at an alpha level 0.05, using the pretest scores as covariate. Major assumptions of ANCOVA were tested to detect non-violations.

As revealed in Table 3, Levene's test statistic F, which tests for the assumption of equal variances in the posttest scores between high achievers and low achievers was not significant ($F = 2.814$, $p = 0.103 > 0.05$). Therefore, the null hypothesis was accepted. Hence, the variances in post-test scores between high achievers and low achievers were equal. The results for the assumption of homogeneity of regression slopes are also presented in Table 4.

The results as presented in Table 4 show no significant interaction ($p = 0.439$) between the covariate and the treatment. Therefore, from Table 4, the assumption of homogeneity of the regression slopes was not violated. Also, the assumption of linearity between the covariate and the dependent variable was tested and the results are presented in Figure 1. As observed in Figure 1, there is a linear (straight line) relationship between the post-test scores and pre-test scores for high achievers and low achievers in experimental and control groups. As a result, this assumption was not violated. Since all the assumptions were not violated, the one-way analysis of covariance was therefore conducted and the results are presented in Table 4.

Table 4: Results of Test of Assumption of Homogeneity of Regression Slopes

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13.415[a]	3	4.472	.918	.444
Intercept	127.032	1	127.032	26.082	.000
Teaching Method	1.644	1	1.644	.337	.566
Pretest	.065	1	.065	.013	.909
Teaching Method * Pretest	3.000	1	3.000	.616	.439
Error	146.114	30	4.870		
Total	18330.000	34			
Corrected Total	159.529	33			

a. R Squared = .084 (Adjusted R Squared = .007)

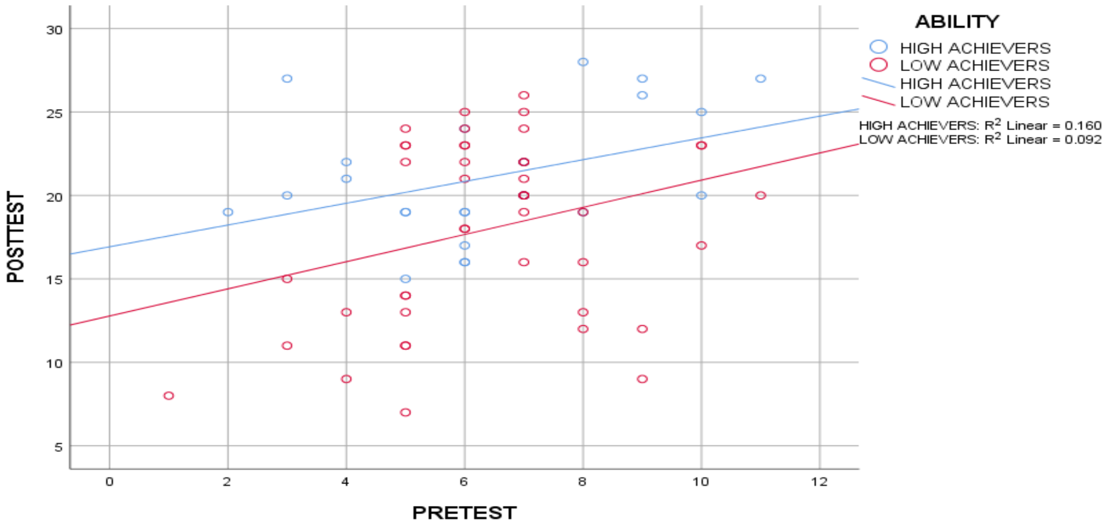

Figure 1: Linear Relationship between the Posttest scores and Pretest scores

As observed in Table 5, after adjusting for the pre-test scores for high achievers (Mean=10.73, SD=0.799) and low achievers (Mean=6.26, SD=0.806), there was no significant difference in the adjusted post-test mean scores between high-achievers (adjusted mean = 24.003, std. error= 1.33) and low achievers (adjusted mean = 22.419, std. error = 1.077) taught using the Generative Learning Strategy ($F_{(1, 67)}$ = 0.479, p = 0.494 > 0.05), with a small effect size (partial eta squared = 0.015). The adjustment in the pretest scores of the high and low achievers using ANCOVA is essential to control for any baseline differences between both groups. The adjustment also ensures a fair comparison of post-test scores of the high and low achievers and focuses on the true effect of the independent variable. This ultimately, increases the statistical power of the test.

Research question 1 sought to determine the difference in academic performances between high-achievers and low-achievers after the use of the Generative Learning Strategy in teaching genetics. It was found that after introducing the Generative Learning Strategy there was no significant difference between high and low-achievers taught using the Generative Learning Strategy.

This finding agrees with Appiah-Twumasi (2018) who also found no significant difference in performance between high achievers and low achievers instructed with Generative Learning

Strategy. The relative equivalent levels of performance by high-achieving and low-achieving SHS 3 biology students instructed with the Generative Learning Strategy may be explained, at least in part, by the fact that using the Generative Learning Strategy puts all students at the center of the learning process. It also provides equal opportunities for all learners to understand and grasp the meaning of the content as reported by Fiorella and Mayer (2016).

Table 5: One-Way Analysis of Covariance of Posttest Scores between High Achievers and Low Achievers

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10.415[a]	2	5.208	1.083	.351	.065
Intercept	164.402	1	164.402	34.178	.000	.524
Pretest	.240	1	.240	.050	.825	.002
Group	2.305	1	2.305	.479	.494	.015
Error	149.114	67	4.810			
Total	18330.000	70				
Corrected Total	159.529	69				

a. R Squared = .065 (Adjusted R Squared = .005)

Table 6: Thematic Presentation of Students' Perceptions on Generative Learning Strategy

Theme	Topic
Theme 1	Better understanding of genetic concepts
Theme 2	Increased motivation to learn genetics
Theme 3	Retention of genetic concepts
Theme 4	Self-directed learning and more time on learning task

Additionally, the use of the Generative Learning Strategy connected new knowledge to prior understanding, ensuring that the classroom environment was no longer competitive but rather cooperative, where students and the teacher supported and encouraged one another to learn, which confirms the finding of Yaduvanshi and Singh (2019) who reported that Generative Learning Strategy fosters knowledge, comprehension and application in biology across different levels. As a result, there was an abundance of empathy, cooperation and harmony in the classroom, which minimizes the likelihood of unpleasant situations and maximizes the learning and happiness of all learners with a variety of abilities. The students were also given autonomy as well as personal responsibility for finishing the task. Hence, each student developed an awareness of their learning and performance, which helped to raise performance levels.

Research Question 2: What are the perceptions of students about the relevance of the Generative Learning Strategy in teaching genetic concepts?

This research question sought to determine how low-achieving and high-achieving students taught using the Generative Learning Strategy perceived the effectiveness of the Generative Learning Strategy. To answer this research question, a face-to-face, semi-structured interview was conducted with eight students from both high and low achieving groups. Students' views were recorded with their permission and transcribed for thematic analysis. It was discovered that students had positive perceptions about the integration of the Generative Learning Strategy in teaching genetic concepts. The various themes generated from the interview are presented in Table 6 with explanations and representative statements from students (pseudo names used).

For instance, Ibrahim, a SHS biology student who was a high achiever, reported:

> Sir, I am a very good student. I know myself looking at my performances in Biology. But all this while, how we were being taught, especially for genetics, which you came to teach us again, was different

> from this time how you taught us. When we were taught genetics at first, I felt like I learned on my own, even though our teacher taught us. That is why my scores on the first test were far lower than in the second test.

Motivation is associated with academic performance (Amrai et al., 2011) and being motivated to learn a particular task helps an individual create an environment to understand every bit of detail regarding that task (Brophy, 2010). Motivation is associated with academic performance (Amrai et al., 2011) and being motivated to learn a particular task helps an individual create an environment to understand every bit of detail regarding that task (Brophy, 2010). Students thus perceived the use of the Generative Learning Strategy as a better approach in the teaching and learning of genetics since it helped them to develop a deeper intrinsic motivation to learn genetics.

In her own words, Elizabeth who was a low-achieving Biology student expressed:

> Sir, to be frank with you, had it not been you, I said to myself I would not answer genetics questions during my WASSCE. Because I did not understand genetics previously, I had no desire or motivation to study it or how to find ways to understand it. That topic seemed boring to me, but your new teaching strategies have ignited my passion and desire for the study of genetics, leading to a constant effort to answer genetics questions.

Students, moreover, considered the use of the Generative Learning Strategy in teaching genetics as a method which helps them to retain concepts better. During the interview session, Diana, a low-achieving Biology student remarked:

> Oh Sir, honestly, I used to struggle to remember the things we learned previously in genetics but as you taught us differently, it made me see genetics as a topic easy to understand and remember. It has been three weeks since you taught us that what we can observe about a person called phenotype, is the result of some internal, unique arrangements of his or her genes which is also called genotype. Before that, I had learned and read about phenotype and genotype but did not answer questions correctly in exercises and tests.

Students perceived the Generative Learning Strategy as helpful in seeking relevant genetic information by themselves. For instance, Lydia, a high-achieving Biology student said:

> This is my first time visiting the school library. Formerly, our biology teacher would only explain notes to us, and then if we had questions, we would ask. But how you taught us always pushed me to look for more information which is very helpful in my studies. For example, anytime you taught, you wanted us to explain what we learned by ourselves and use examples in the explanation. So, I always wanted to learn more by myself so that I could explain things better.

The interview results revealed that being exposed to the Generative Learning Strategy in the teaching and learning of genetics helped the SHS 3 biology students to understand concepts much better, increase their motivation to learn genetics and retain genetics concepts. It also assisted them in self-directed learning. These views are in agreement with Fiorella and Mayer (2016), who found that students who engaged in Generative Learning activities showed significant improvements in their learning outcomes compared to those who did not use these strategies.

The findings are in harmony with those by Wena (2009), who reported that the Generative Learning Strategy required students to study independently, explore their knowledge from multiple learning sources, concentrate on the issue at hand, execute the experiment to build concepts they had learned and then apply those concepts to situations they encountered daily. Similarly, Purwo (2016) reported that learners' opportunities to generate ideas and sharpen their analytical thinking skills are increased by interchanging their viewpoints, which in turn increases their understanding of concepts.

Conclusions and Recommendation

Conclusions

Based on the results of this study, it can be concluded that the use of the Generative Learning Strategy helps bridge the gap in academic performance between high-achieving and low-achieving biology students. This is because, the use of the Generative Learning Strategy placed the biology students at the center of the teaching and learning process, where their prior knowledge was linked to current knowledge, which consequently resulted in a deeper understanding of genetic concepts. This trend is confirmed by the interview results where the use of the Generative Learning Strategy helped the learners to understand genetic concepts better, increasing their motivation to learn genetics, helping them retain genetic concepts and assisting them through the self-directed learning.

Recommendation

The study recommends that teachers use the Generative Learning Strategy in the teaching of genetics to close the achievement gap between high and low achievers. Additionally, teachers should orient their teaching strategies with such modern learner-centered methodologies as the Generative Learning Strategy in order to equip themselves with current skills that will enable their learners to understand and retain concepts, increasing their motivation to learn.

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