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Effect of Students selected Context-Based Approach on Students' Performance in Genetics

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ABSTRACT

The quest to maximize students' learning in the sciences has been on high alert in the recent past. This has brought into focus how teachers enact the content prescribed by the curriculum. Various approaches have been suggested as probable solutions to cure students' weak learning attainment in the sciences. One approach gaining grounds in the literature as a means of effectively teaching science concepts leading to the maximization of students' learning is context-based teaching. This research sought to explore the effectiveness of student-selected context-based teaching approaches on students' achievement in genetics concepts in Ghanaian senior high schools. Using 107 biology students from three schools, pretest-posttest non-equivalent group design was used to identify which of the student-selected context-based teaching was effective in improving learning outcomes in genetics. Results indicate that the recent approach of students' selected context-based teaching was more effective in improving the performance of students in genetics as compared to the modern and traditional approaches with a large effect size. It is recommended that biology instructors who use students' selected context-based approach to teach genetics should use the recent approach to context-based teaching, which has been demonstrated to be more successful in increasing students' genetics performance.

KEYWORDS

students' selected context-based, recent approach, modern approach, traditional approach

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Introduction

Genetics concepts are found to be difficult for students because of the abstract nature of the concepts with many of the processes involved not physically evident (Abimbola, 1998; Locke & Mcdermid, 2005; Ruiyong, 2004). Due to the abstract nature of concepts in genetics, students at various levels of the educational system find it difficult to understand (Kılıç & Sağlam, 2014, Knippels, Waarlo, & Boersma, 2005; Thörne & Gericke, 2014; Tsui & Treagust, 2010). Bahar, Johnstone, and Sutcliffe (1999) argued that students find genetics concepts difficult because concepts are found at macro, micro and molecular levels leading to a lack of ability to link the concepts at various levels. Lack of understanding of genetics concepts ultimately leads to lower student attainment (West African Examinations Council (WAEC), 2016;2017;2018).

To help students overcome challenges in genetics, Marbach-Ad and Stavy (2000) proposed that students should be taught genetics concepts using phenomena they can relate to. At all levels of education, the primary goal of teaching is to produce change and transformation in the student (Oladipo & Ayeni, 2000, Tebabal & Kahssay, 2011). The quest to transform learners arises because teachers have a direct impact on the learning of students (Abell, Appleton, & Hanuscin, 2010). Teachers exert their impact on students through different teaching strategies that are expected to facilitate the transformation and learning attainment of students (Adufe, 2008). In this regard, teachers are supposed to employ the most effective instructional strategies that will aid students in improving their learning outcomes and holistic development.

Bhardwaj and Pal (2012) suggested that effective teaching approaches are those that are aligned with the needs of learners due to the uniqueness of how learners understand and respond to situations and experiences. Thus, different learners will react to the same stimulus differently. It is prudent, therefore, that teachers select techniques and activities that are diverse to meet the needs of different learners. Students' success in science has been linked to how scientific courses (such as biology and genetics) are taught (King, 2007; Onwu, 2009; Schwartz, 2006). Wilke (2003) found a connection between the difficulty of learning certain scientific subjects and inefficient teaching strategies. The evidence points to the fact that most genetics instructors use teacher-centered approaches which do not appear to improve students' conceptual understanding thereby impairing their achievement (King, 2007; Kyle, 2006; Van Aalsvoort, 2004). Cimer (2012) asserted that the difficulty students had with the teaching and learning of genetics could be traced to a multiplicity of factors namely the nature of the topic, teachers' style of teaching genetics, students' learning and studying habits, students' negative feelings and attitudes towards the topic, and a lack of resources.

One of the approaches to teaching that is effective in meeting the needs of diverse learners is the context-based teaching approach (Kazeni, 2012; Podschuweit & Bernholt, 2018). Context-based teaching is one of the ways of connecting content to students' daily real-life experiences and applications (Podschuweit & Bernholt, 2018). Beasley and Butler (2002) asserted that context-based teaching is a technique of instructing students in science in which the importance of the context or application of knowledge to a real-world scenario is stressed. Context-based teaching approaches are built on the "need-to-know" concept, in which the context validates students' acquisition of biological principles from their perspectives, making learning relevant on both an internal and extrinsic level (Beasley & Butler, 2002; Bulte, Westbroek, de Jong, & Pilot, 2006). When genetics is taught through real-life experiences and applications, however, students perform better (Bennett, 2003; Bennett & Holmann, 2002; Gilbert, 2006).

Agyei (2022) found out that context-based group's students seemed to like the teaching approaches adopted. Students attributed their likeness for the methods used due to the use of practical activities and stories relating to their real-life experiences. Kazeni and Onwu (2013) also asserted that students indicated that context-based approach made the study of genetics enjoyable and great fun and expressed confidence about their post-test performance in genetics.

Although context-based teaching is efficient elsewhere, the argument has been that teachers have been selecting contexts for students and therefore the voices of students are lost (Shiu-sing, 2005). This is unfortunate, given there is substantial proof that a context-based approach can improve students' conceptual understanding and overall achievement. Thus, in the face of poor performance in genetic concepts by Ghanaian students coupled with the desire to use student-centred and activity-based instructional strategies to teach biology as advocated by the Ghanaian elective biology syllabus for senior high school (Ministry of Education (MOE), 2010), it would not be out of place to explore the effectiveness of context-based approaches to determine the sustainability of the approach in the Ghanaian educational system. Thus, the research explored the effectiveness of student-selected context-based teaching approaches on students' achievement in genetics concepts in Ghanaian senior high schools..

Research questions

1. Which approach to context-based teaching is more effective in improving students' performance in genetics when the context is selected by the students?
2. What are the views of the students on the context-based teaching approaches used in the study?

Context-based approach to teaching

Numerous nations are experimenting with context-based teaching techniques in attempts to reinvigorate scientific education and foster the development of lively learning environments that meet the different demands of students, society, and science (Osbourn & Dillon, 2008). The fascination with context-based education arises from the fact that it addresses a multitude of issues afflicting global scientific education (Lyons, 2006). School science curricula are often filled with isolated facts, the majority of which are generated from a conceptual application of science that bears little or no connection to the learners' lives (Gilbert, 2006). Learners commonly express dissatisfaction with their science learning environment due to a lack of relevance and a high level of theoretical complexity. The complaints about science learning have resulted in many educators becoming interested in context-based science education (De Jong, 2015; Meijer, Bulte, & Pilot, 2013; Millar, 2007; Roehrig, Kruse, & Kern, 2007; Sevian & Bulte, 2015; Sevian & Talanquer, 2014; Sjöström & Talanquer, 2014; Tytler, 2007).

Numerous definitions exist for context-based instruction. “Context-based techniques are those employed in science education that begin with the contexts and applications of science" (Bennett, Lubben, & Hogarth, 2007, 348). The context-based approach is the application of science to increase students' scientific knowledge of their real-world contexts while also strengthening their ability to function as responsible members of society (King, 2012; Aikenhead, 2006; Bennett, 2005). Students are exposed to authentic assignments which contain real-world problems and can be used to integrate abilities in relevant settings (Baker, O'Neil, & Linn, 1994: 335). Thus, context-based teaching is seen as the development of science concepts and skills from situations of daily life experiences with which students themselves are familiar and perceive as relevant.

The use of the context-based approach in the teaching and learning process increases students’ interest, attitudes, and motivation towards the lessons (Bahtaji, 2015; Tariq & Saeed, 2021) and facilitates the transfer of newly learned information to daily life (John et al., 2018). For these reasons, the application of a context-based teaching approach has been emphasized in current science curricula and the subjects have been structured in a way that will facilitate the students’ understanding by making them more up-to-date and entertaining. Bennett, Hogarth, and Lubben (2003) synthesized 66 studies on the effects of context-based (and science-technology-society) methods and established that context-based techniques engage students in science courses and develop more favourable attitudes toward science in general, as well as having no adverse influence on students' knowledge of scientific ideas.

Students Selected Context-based Approach

Successful and effective teaching requires teachers to teach based on the aspirations and ideals of the learner (Kazeni, 2012). It appears teachers should teach what learners cherish but not what the teachers consider to be important, to teach effectively and maximise learners' learning. In students' selected context-based teaching, students are made to select their preferred context of teaching. In a study conducted by Kazeni (2012), the students' preferred context for teaching biology was context domains of societal issues, personal benefits, science and technological innovations, and environmental issues. These context domains were then used to design context-based instructions for the students. The real situations in which context-based materials are developed are essential to their effectiveness (Taasoobshirazi & Carr, 2008). De Jong (2008) elaborated that an insufficient connection between context and appropriate topics in the minds of students and teachers may hinder the achievement of desired learning outcomes. Contexts believed to be meaningful at one point in time may not be so at another due to alterations to conditions. Pilot and Bulte (2006) argued that contexts that are crucial in one part of the world may be insignificant in another, since individuals in these countries and cultures have distinct objectives and preferences.

Furthermore, from the learners' viewpoint, contexts employed in context-based teaching materials may not always be pertinent or readily available to learners. De Jong (2008) outlined four challenges that learners exposed to context-based resources may face. First, contexts may be irrelevant to learners and hence fail to inspire them. Second, contexts may be too complex for learners to properly connect concepts from science. Third, learners may be perplexed by context because everyday meanings of some concepts do not necessarily correlate to scientific interpretations. Fourth, contexts may be so engaging that learners are diverted from understanding the intended scientific principles. To suit the needs of various learner populations, it appears that contexts utilized to generate context-based resources must be carefully selected. Lubben and Campbell (2000) suggest that lessons with personal meaningful applications of science increase learners' attention and engagement with scientific discussions. Finding out what contexts learners believe would be beneficial in making a topic more relevant, meaningful, engaging, and accessible to them is one way to learn about their views, inclinations, and wants surrounding contexts. To that aim, Whitelegg and Parry (1999) argued that in context-based teaching, learners become encouraged to negotiate the process by choosing contexts that are accessible or meaningful to them, or by elaborating on contexts given by the learners themselves.

Some scholars (Basu & Barton, 2007; Sjberg & Schreiner, 2005) advocated for the inclusion of certain elements of science that students experience, value, and

use into curriculum materials. Osborne and Collins (2001) cautioned that excluding learners from curriculum development decisions may contribute to learners' dissatisfaction with scientific courses. Shiu-sing (2005) have expressed similar concerns about the exclusion of learners from curriculum content decisions. It was based on this concept that learners were made to select contexts they felt were important and interesting in learning.

Implementation Strategies for Context-based Materials

Contexts and content are presented in changing amounts and at various points throughout a learning sequence in the course of instruction in a typical context-based lesson. Different models have different levels of context-based instruction. Contextualized education, accentuated by De Jong (2008), might suffer from inconsistencies in the presentation of contexts and related concepts because of differences in the stage at which they are offered (the position of the context). Thus, he proposed three methods for incorporating context-based resources that are based on how they are presented and used in the context. Thus, depending on when the context and concepts are presented, context-based teaching can be described as traditional context-based teaching, more modern context-based teaching, and recent context-based teaching.

The traditional context-based method begins with the teaching of scientific principles, followed by the application of those concepts. Contexts are used to exemplify previously taught concepts and to provide learners with opportunities to apply them (De Jong, 2008). For example, following teaching on blood group inheritance, the role of blood group inheritance in society is discussed. Contexts frequently serve two purposes in this approach of instruction. To begin the lesson contexts are used to illustrate previously taught concepts, particularly abstract concepts or to extend learning where scenarios are offered to allow students to apply their newly acquired knowledge of a taught idea. This might result in a change in the current meaning or the concept being assigned a new meaning (De Jong, 2008).

In the more modern context-based approach, a discussion of a particular context is made before the introduction of associated scientific topics. It is common to employ context to justify or commence the teaching of ideas, as well as to motivate students to acquire new scientific concepts (De Jong, 2008). For example, a talk on how a couple has always given birth to boys alone is followed by an examination of the central concept of human sex determination. Two additional functions of contexts are frequently emphasized in this approach. Contexts are presented as a jumping-off point or justification for teaching specific subjects and also serve a dual purpose of orienting students and motivating them to learn new concepts.

Recent approaches, on the other hand, begin with the introduction of contexts to learners before the presentation of content. Students are subjected to several diverse contexts after the introduction of scientific ideas. The contexts that come before the ideas are used to explain why the ideas are important and to encourage students to learn them. The contexts that come after the ideas are used to show how the ideas work in real life (De Jong, 2008).

In this study, the students' selected context was implemented through the lens of the three approaches to teaching with contexts. Thus, after the selection of contexts by students, the presentation of the instructional process followed the traditional, modern and recent approaches to the enactment of context-based teaching. Aside from exploring the effectiveness of students' selected context in general, the research also sought to identify which of the approaches of context presentation works best in the Ghanaian context. The approach being used is different from how teaching is done in Ghanaian schools in that in the typical classroom teachers select contextual issues to embed in the lesson whereas in this study students were instructed through their selected contexts.

Research Design

The pre-test posttest non-equivalent group was used in this study. In this, 3 intact classes of students were randomly selected and exposed to students' selected context-based teaching (traditional context-based teaching, modern context-based teaching and recent context-based teaching) after which their achievement in genetics concepts was compared. Although there was random selection of groups, there was no random assignment of subjects or participants. The design allowed for the comparison of the performance and outcomes across different groups of students taught with the recent, modern, and traditional approaches.

Students in each group took a pre-test which was meant to evaluate their knowledge of the measured learning objectives and also to determine if they were at par in terms of ability. After the pre-test, each group was instructed based on its assigned students' selected context approach. Here, the content learnt was the same for all the groups. The differing point was the mode of instructional delivery. Students were then assessed in a post-test after the interventions were completed. A focused group interview was also conducted to identify the views of the learners on the students' selected context-based teaching approach they experienced.

Participants

The participants in this research were third-year senior high school students pursuing a general science programme. The third-year students were used because, in the biology syllabus, it is at that grade that genetics is taught. Such students had been taken through prerequisite topics such as cell biology in the first year of their

course. In all, 107 learners participated in the study.

Sampling

Multi-staged sampling was employed for the study. There was the selection of a region, followed by the selection of schools and then the selection of classes to be used for the study. One region was selected from the 16 regions in Ghana using simple random sampling. In the selected region, schools that offer general science programme where genetics will be taught formed the sampling frame. This was done to eliminate the possibility of selecting a school that does not offer a science programme because it is in the General Science programme that students learn biology as one of the elective subjects which will cover the concepts of genetics. Three schools that offer science programme were then selected through simple random sampling. The schools selected were schools with more than one science class therefore one third-year science class was selected by simple random sampling from each of the participating schools. Thus, three classes from three different schools were selected using simple random sampling. Simple random sampling was used to select ten students from each of the three classes for the interview.

Data collection instrument

An achievement test covering genetics concepts was used to collect data for the study. The test was labelled Genetic Content Knowledge Test (GCKT) and was developed to determine students' achievement in genetics for both the pre-test and post-test. The test covered areas in genetics such as inheritance of characteristics, sex determination in humans, blood group inheritance and the use of genetics to identify offenders. Six (6) essay test items were adapted from past examination papers in biology from the West African Senior Secondary Certificate Examination (WASSCE) to constitute the GCKT. Thus, the GCKT was made up of essay test items.

To determine the GCKT instrument's content validity, a table of specifications encompassing the learning outcomes was developed for the development of the test items. Items selected reflected the learning outcomes as designated in Bloom's learning outcomes. Three biology university lecturers were requested to analyze the questions and define the learning goals assessed by each item. This ensured that the items covered the content areas taught and were assessing the aligned learning outcome as well.

Aside from the achievement test, an interview guide was also used to collect qualitative data from students. A focus group interview was conducted with the students to identify the views of the learners on the students' selected context-based teaching approach they experienced. The interview centred on students' perspectives on the teaching methods employed in teaching genetics, and students'

perceptions of the value of studying genetics. There were six interview questions. However, depending on the answer to a particular question led to a follow-up question.

Three senior high schools in a different region from the ones selected for the main research were chosen at random to participate in the piloting of the instrument. During the piloting, students were made aware of the research's goals, their involvement in it, how their data would be used, and their ability to withdraw participation if they so desired. A test was administered to the participants which consisted of the GCKT (achievement test). The result of the pilot testing was used to fine-tune the instruments. The reliability of the instrument was determined using inter-rater reliability with a kappa value of 0.9

Data Collection Procedures

Before administering the instruments, permission was sought from the three schools selected for the study after ethical clearance from University of Cape Coast's Institutional Review Board. The students were told of the study's goal, their involvement in it, the anonymity and confidentiality of the measurements and outcomes, as well as their opportunity to opt-out if they so desired.

Participants were pre-tested in genetics which they had not been taught. The pre-test results served as a diagnostic tool and also verified whether the students were performing at similar levels. After the pre-test, students were taught genetics in their preferred context with the three different approaches. The lessons were done during normal class hours. Each lesson lasted 60 minutes and 4 lessons were conducted.

Interventions used in the groups

In this study, students were made to select the context they see as relevant, accessible, interesting and relatable to them (societal issues, personal benefits, science and technological innovations, and environmental issues). These contexts were used as narratives to develop the context-based materials for the study. There are three approaches to the implementation of context-based teaching. The presentation of content based on the contexts selected by students was done through the three approaches (recent, modern and traditional) of enacting context-based teaching. Thus, there is a student-selected recent context-based approach, a student-selected modern context-based approach, student-selected traditional context-based approach.

In the recent approach, contexts are introduced to learners before the introduction of content. Following the introduction of scientific principles, students are exposed to a variety of different contexts. A sample lesson plan is attached in Appendix 1. The modern context-based approach entails a discussion of a specific situation before the introduction of associated scientific topics. A sample lesson

plan is attached in Appendix 2. In the traditional context-based approach, the teaching of scientific ideas is preceded by the teaching of appropriate contexts. Contexts are used to exemplify previously taught ideas and to provide learners with opportunities to apply them (De Jong, 2008). A Sample lesson plan is attached in Appendix 3.

Thus, one group was instructed with the recent approach to context-based teaching. The modern approach to context-based teaching was adopted in the second group and the traditional approach to context-based teaching was adopted in the third group. To avoid bias on the part of the researchers, lesson plans were prepared for the teaching. The teaching in all the groups lasted four weeks. The groups were given a posttest after the intervention period. The students in the groups were interviewed about their experiences after the post-intervention examinations had been administered. All interview sessions were audio-recorded

Results

The first research question sought to identify the approach to context-based teaching which is more effective in improving students' performance in genetics when the context is selected by the students. A pre-test was carried out to examine whether the students in the students' selected context groups (recent, modern, and traditional approaches) performed at the same level before the intervention.

A one-way analysis of variance was conducted to determine if there were statistically significant differences among the three groups. Table 1 shows the results of the one-way ANOVA conducted on the pre-test mean scores.

Table 1: One-way ANOVA of Pretest Results for Students' Selected Context in Genetics.

	Sum of squares	df	Mean Square	F	P
Between groups	166.945	2	83.472	1.176	0.313
Within groups	7167.584	104	70.966		
Total	7334.529	106			

* Significant at $p < 0.05$

There was no statistically significant difference among the three students' selected context-based approaches [$F(2, 104) = 1.176$, $p = .313$] in the pretest scores. This means that the students in the research were performing at the same level before the intervention was implemented. This situation gives a good justification for comparing the post-test scores of the students using the three approaches of students' selected context (recent, modern and traditional).

A one-way ANOVA was conducted to determine whether there were statistically significant differences among the three groups after the intervention. The result is presented in Table 2.

Table 2: Results of One-Way Analysis of Variance of the Post-Test Scores of Students in Students' Selected Context

	Sum of squares	df	Mean Square	F	p
Between groups	4756.113	2	2378.056	29.710	0.001*
Within groups	8404.406	104	80.042		
Total	13160.519	106			

* Significant at $p < 0.05$

Students' scores in the students' selected context-based approaches showed a statistically significant difference [F (2, 104) =29.95, p <0.001] among the three groups. The results imply that students' performance in the three groups differed. Since differences could be negligible and have no practical significance, the effect size of the difference was determined. Using the eta squared, the effect size was determined to be 0.60. Cohen (1988) considers an effect size of .01 to be of modest impact, .06 to be a medium effect, and .14 to be a big effect. According to Cohens' categorization, the effect size of this study is considerably large. This indicates that the practical difference between the groups was significant.

To determine where the differences lie among the groups, post-hoc comparisons using the Tukey HSD test were performed. Tukey HSD was chosen since the data satisfied the assumption of variance homogeneity. Table 5 shows the results of the Tukey HSD post-hoc test.

Table 5: Tukey HSD post-hoc Analysis for Students Selected Context Posttest Results

(I)Context based approach	(J) Context-based approach	Mean Difference (I-J)	Std. Error	Sig.
Recent	Modern	8.107*	2.133	.001
	Traditional	15.987*	2.101	.001
modern	Recent	-8.107*	2.133	.001
	Traditional	7.881*	2.147	.001
traditional	Recent	-15.987*	2.101	.001
	Modern	-7.881*	2.147	.001

The results from the post-hoc analysis show that students' selected context-based approach mean scores using the recent approach (M=40.58, SD=10.83) were statistically significant from the modern approach (M=32.43, SD=15.58) and the traditional approach (M=24.43, SD=19.73). This means that the recent approach of students selected context-based teaching was more effective in improving students' performance in genetics, followed by the modern approach and then the traditional

approach. A mean graph for the three approaches to students' selected contexts is presented in Figure 1.

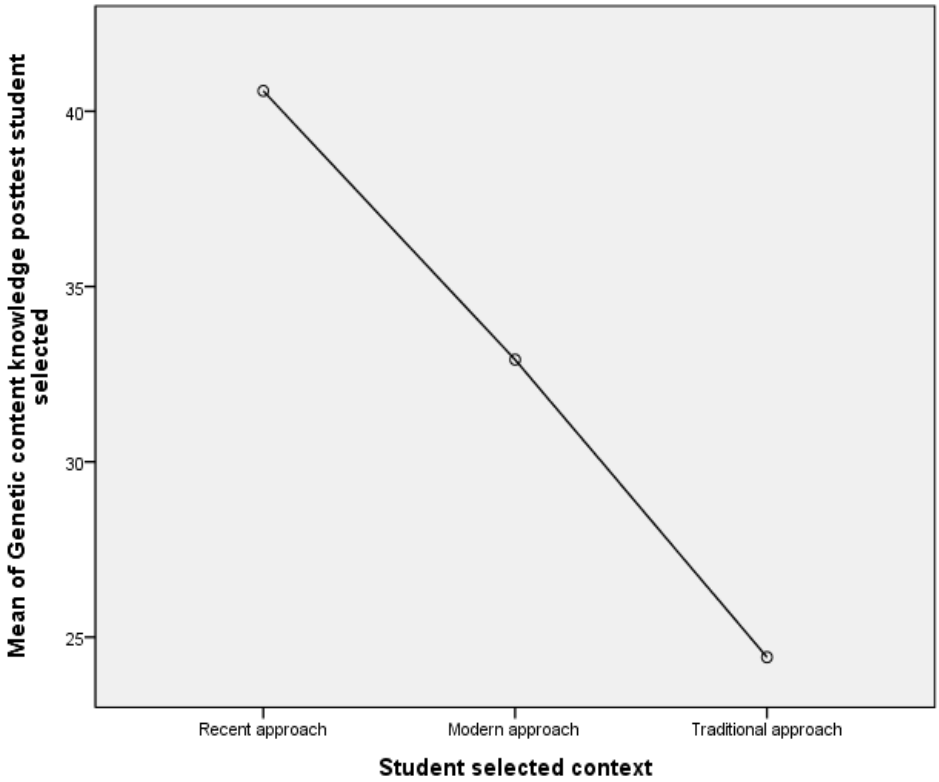

Figure 1: Means plot for the three approaches to students selected context

From the results, it is evident that the recent approach of students selected context-based teaching is more effective in improving the performance of students in genetics as compared to the modern and traditional approaches with a statistically significant degree of effectiveness and large effect size. In comparison to the traditional approach, the modern approach to students' selected context-based teaching was proven to be more successful in improving students' performance in genetics. Thus, the effectiveness of the approaches within the students' selected context-based approaches in improving students' achievement in genetics is in the order of recent, modern and traditional.

The second research question sought to solicit the views of the learners on the specific students' selected context-based teaching approach they experienced. Focus group discussions were used to gather qualitative data on this research question. The interview centred on students' perspectives on the teaching methods employed in teaching genetics. Students from the three context-based approaches

used in this study were interacted with separately.

Concerning the recent approach, students expressed their satisfaction with the teaching approach they encountered. They attributed their likeness for the method used due to the use of practical activities and stories relating to their real-life experiences. Students believed that the use of stories at not only the beginning of the lesson but also at the concluding part of the lessons was very interesting which helped to improve their understanding of concepts discussed during the lesson. For instance, Felix noted that "the teacher began with stories relating to our everyday life. This made us more interested in what he was teaching us. After the teaching, he gave us more stories relating to our lives on what he taught us and this made us understand the lesson very well". Yidara corroborated what Felix said by indicating that "when sir started with the story, I enjoyed the lesson so much. Sir also gave us more stories after teaching us and that made us understand the topic very well". Another discussant, Kofi, agreed with his colleagues by noting that how the teacher began the class with stories relating to their everyday life and concluded by using more stories relating to their lives made them interested in what the teacher was teaching as well as improved their understanding. John supported the views of his colleagues by expressing that "the story sustained our interest and we wanted to know more". In providing an overarching reaction to the approach used Stephen asserted that "some teachers are too sluggish to explain what is occurring to students. They hand you a few pages of notes or assign page 56 to read at home, then demand an explanation from you in class. This was complicated and hard to follow. However, the teaching strategy used was not like that at all. We were able to grasp the material".

In the modern approach group, students expressed their satisfaction with the contexts used to teach them. Philip argued that "our teacher taught us using practical activities that engaged all of us". This assertion was corroborated by Peekay who said that "we were more engaged in the lesson because of the practical activities". Samuel agreed that "our teacher used practical activities to teach us". There was a feeling among the students that the teacher could have used more stories to facilitate learning. This idea emanated from John who argued that "the stories the teacher used were good but we expected him to tell us more stories". This view was supported by Alicia who expressed that "we wanted our teacher to tell us more stories because the stories were good".

The students in the traditional approach of students' selected context-based learning were indifferent about the approach. They argued that there was no difference in the approach used during the study and that of their regular class teacher. Kray asserted that "there was nothing new in the method used". Jingles corroborated the point made by his colleague by explaining that "the stories that

were told by the teacher could not explain the concept well for us. After all, our class teacher has been doing something similar". Joyce was of the view that "understanding the topic was a bit of a challenge because there was nothing new in the method used". This was supported by Kad who said that "I found it very difficult to understand the topic".

Discussion and Conclusion

The results from the study showed that learners in the recent approach of the students' selected context-based group performed better on genetic concepts than the modern and traditional approaches. The evidence shows that learners in the traditional group got the lowest mean score among the three groups. A statistical difference does not allude to much if the difference is of no practical essence. The results however show that the differences seen among the three approaches of context-based learning had a large effect size signifying that the difference that existed was not by chance but as a result of the effectiveness of the intervention. The students in the recent group outperformed their counterparts in the other groups due to the nature of the approach. As can be seen from the focus group discussions, the students in the recent group alluded to the diverse contexts of the approach as a source of their conceptual understanding which ultimately resulted in their improved academic performance.

The findings of this study corroborate that of Kazeni (2012) who compared the recent approach to context-based teaching with the conventional approach and found that the effectiveness of the recent approach superseded the conventional approach. De Jong (2008) argued the various contexts provide unique experiences to students which facilitate their understanding of concepts. For instance, contexts that come before the presentation of the scientific ideas to be learnt are used to explain why the ideas are important and to encourage students to learn them whereas contexts provided after the explanation of scientific principles are used to show how the ideas work in real life. Such presentation of contexts related to students serves as a springboard for teaching scientific topics and provides the incentive for students to acquire new concepts (De Jong, 2008). This implies that learners who are taught using the recent approach can demonstrate and apply their knowledge in new contexts. In doing so, the performance of the learners would be improved.

Aside the academic performance, students' affective reactions to any instructional approach are paramount if that approach is to be used for instruction. This is critical in the sciences where students' interests and attitudes are dwindling (Rani, 2000). It is therefore pertinent that students' reaction to approaches of teaching used in the research is identified to inform practice. This is true in the

sense that as De Jong (2008) puts it, the familiar context that was used as a jumping-off point to the introduction of the content serves as a rationale for learning and motivation as well as the context that was introduced after the content was meant to help learners apply what they have learnt to new situation. The findings from the study lend credence to the fact that when students select their context, the recent approach to context-based teaching seems more successful in improving students' performance in genetics than the modern approach and the traditional approach respectively. Moreover, students seem to appreciate the nature and approach of the recent approach to context-based learning.

Implications for science education

The quest to make learners the centre of learning should not just be limited to the use of social and collaborative teaching strategies alone. Learners should be involved in the selection and application of teaching strategies. The evidence from this study supports the use of students' selected context-based approach to teach genetics. This implies that science teachers especially biology teachers should involve students in the selection of teaching approaches. Here, learners' aspirations, motivations and educational desires should influence the selection and use of teaching strategies and techniques.

Again, science teachers should consciously relate the scientific concepts and principles being taught to students' real-life experiences. There should be a paradigm shift from teaching concepts in isolation with the hope that learners will transform such knowledge when they encounter issues in life to integrating contexts students are likely to meet in real life into the teaching and learning process. When such integration is done, learners will not struggle to apply the scientific principles learnt in the classroom to solve real-life problems when they encounter them.

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Appendix 1

Lesson Plan: Recent approach to context-based teaching

Topic: How characteristics are inherited

Objectives:

At the end of this lesson, students should be able to:

1. Explain how traits are passed down from parent to children.
2. Differentiate between genes that are dominant and those that are recessive.
3. Make a distinction between genotype and phenotype.
4. Give an account of Mendel's experiment with monohybrid inheritance.

Context Introduction

Capture of the mind

Compare the characteristics of children with those of their parents, grandparents, cousins and other family members in a table format (colour; height; weight; eye colour and size; and any other traits. Assign students the task of determining who in the family has the most resemblance to whom, and for what traits**.**

Narrative

For twenty years, Beatrice has been married to Kofi Attah. They are the parents of four children: Joyce, Gifty, Francis, and Charles. Joyce and Gifty have a striking resemblance to one another, and they share other characteristics with their mother Beatrice. Francis is an exact duplicate of his father, Kofi Attah. Charles, on the other hand, is albino, like his uncle Alex, Kofi Attah's brother. Kofi Attah is perplexed as to how his baby may have inherited his brother Alex's characteristics since neither he nor his wife Beatrice are albinos. He is concerned that his wife may have had an extramarital affair with his brother, Alex.

Examining contexts

Students should debate and try to answer the following questions, as well as any others that may emerge. They should jot down their responses for future reference.

1. Why do some members of the same family have similar characteristics while others do not?
2. Why do some children exhibit traits of both parents?
3. Do you believe Charles might have become an albino if not for his mother Beatrice's romance with her brother-in-law Alex?
4. Is there a genetic reason why some children look like their relatives but not their parents?
5. Why is it so difficult for individuals who are related to one another to be married?

Content introduction

What is the origin of a person's chromosomes?

1. Gamete creation - meiosis; segregation, egg and sperm composition
2. Fertilization – inheritance
3. Homologous chromosomes - DNA replication and mitosis (growth)

How are characteristics passed down from one generation to the next?

1. Experiments conducted by Mendel
2. Monohybrid inheritance
3. Dihybrid inheritance
4. Phenotypes and genotypes
5. Pairs that are allelomorphic (alleles)
6. The laws of Mendel
7. Alleles that are dominant and recessive
8. Complete dominance, co-dominance and incomplete dominance
9. Inheritance patterns

Connection between content and context

Students should be encouraged to revisit the questions the context examination stage and re-evaluate them in light of the new information they have gained. Each question should be re-examined and students should determine the following:

1. What do you think of your first responses and viewpoints?
2. If you believe they are incorrect, what would be the proper responses and why?
3. Does the information supplied relate to or explain the previous situations?
4. Are there any other questions you would want to ask that the information supplied does not address?

Evaluation of learning

1. Grace and Phililp got married 15 years ago. They gave birth to three children namely Kwaku, Abena and Yaa. Both parents are very tall. Abena and Yaa are also tall. However, Kwaku is very short just like his grandfather Opanyin Kofi. Philip, Kwaku's father is worried why Kwaku is short and he is suspecting his wife had an extramarital affair with her father-in-law, Opanyin Kofi.
    i. Can Grace and Philip give birth to Kwaku? Explain with a genetic diagram.
2. Dark hair (H) predominates over grey hair (h) - a recessive trait. A male with a mixture of dark and grey hair marries a female who is homozygous grey hair.
    i. What are the genotypes of the male and female partners in this

pair?

ii. How likely is it that their child will be born with dark hair?

3. In Mr. Kofi Bronya's nuclear family dark skin colour (D), dominates fair (f) skin colour.
    i. If one parent has pure dark skin and the other has pure fair skin, what are the various genotypes of the offspring?
    ii. What would the genotypic and phenotypic ratios of these parents' children be if they are allowed to marry?
    iii. What are the genotypes of the parents if both parents have dark skin and their offspring have fair skin?
4. A certain species of bird has three colour types: yellow; blue and green. These colours are determined by a pair of genes: yellow (Y) and (B) blue.
    i. What are the phenotypes of:

(a) a yellow bird? (b) a blue bird? (c) and a green bird?

    ii. If a yellow bird is mated with a green bird, what colours can their offspring be?
    iii. If two green birds are mated;
        a. What colours can their offspring be?
        b. What percentage of the offspring would you expect to be green? Explain.
5. If the birds produced four offspring, is it possible that all four could be green? Explain.

Appendix 2

Lesson Plan: Modern approach to context-based teaching

Topic: How characteristics are inherited

Objectives: It is expected that at the end of this lesson, students will be able to:

1. Explain how traits are passed down from parent to children.
2. Differentiate between genes that are dominant and those that are recessive.
3. Make a distinction between genotype and phenotype.
4. Give an account of Mendel's experiment with monohybrid inheritance.

Capture of the mind

Compare the characteristics of children with those of their parents, grandparents, cousins and other family members in a table format (colour; height; weight; eye colour and size; and any other traits. Assign students the task of determining who in the family has the most resemblance to whom, and for what traits**.**

Content introduction

What is the origin of a person's chromosomes?

1. Gamete creation - meiosis; segregation, egg and sperm composition
2. Fertilization – inheritance
3. Homologous chromosomes - DNA replication and mitosis (growth)

How are characteristics passed down from one generation to the next?

1. Experiments conducted by Mendel
2. Monohybrid inheritance
3. Dihybrid inheritance
4. Phenotypes and genotypes
5. Pairs that are allelomorphic (alleles)
6. The laws of Mendel
7. Alleles that are dominant and recessive
8. Complete dominance, co-dominance and incomplete dominance
9. Inheritance patterns

Context introduction

Narrative

For twenty years, Beatrice has been married to Kofi Attah. They are the parents of four children: Joyce, Gifty, Francis, and Charles. Joyce and Gifty have a striking resemblance to one another, and they share other characteristics with their mother Beatrice. Francis is an exact duplicate of his father, Kofi Attah. Charles, on the other hand, is albino, like his uncle Alex, Kofi Attah's brother. Kofi Attah is perplexed as to how his baby may have inherited his brother Alex's characteristics since neither he nor his wife Beatrice are albinos. He is concerned that his wife may have had an extramarital affair with his brother, Alex.

Examining contexts

Students should debate and try to answer the following questions, as well as any others that may emerge. They should jot down their responses for future reference.

1. Why do some members of the same family have similar characteristics while others do not?
2. Why do some children exhibit traits of both parents?
3. Do you believe Charles might have become an albino if not for his mother Beatrice's romance with her brother-in-law Alex?
4. Is there a genetic reason why some children look like their relatives but not their parents?
5. Why is it so difficult for individuals who are related to one another to be married?

Evaluation of learning

1. Dark hair (H) predominates over grey hair (h) - a recessive trait. A male

with a mixture of dark and grey hair marries a female who is homozygous grey hair.

i. What are the genotypes of the male and female partners in this pair?
ii. How likely is it that their child will be born with dark hair?

2. In Mr. Kofi Bronya's nuclear family dark skin colour (D), dominates fair (f) skin colour.
   i. If one parent has pure dark skin and the other has pure fair skin, what are the various genotypes of the offspring?
   ii. What would the genotypic and phenotypic ratios of these parents' children be if they are allowed to marry?
   iii. What are the genotypes of the parents if both parents have dark skin and their offspring have fair skin?
3. A certain species of bird has three colour types: yellow; blue and green. These colours are determined by a pair of genes: yellow (Y) and (B) blue.
   i. What are the phenotypes of:

(a) a yellow bird? (b) a blue bird? (c) and a green bird?

   ii. If a yellow bird is mated with a green bird, what colours can their offspring be?
   iii. If two green birds are mated;
      a. What colours can their offspring be?
      b. What percentage of the offspring would you expect to be green? Explain.
   iv. If the birds produced four offspring, is it possible that all four could be green? Explain.

Appendix 3

Lesson Plan: Traditional approach to context-based teaching

Topic: How characteristics are inherited

Objectives: At the end of this lesson, students should be able to:

1. Explain how traits are passed down from parent to children.
2. Differentiate between genes that are dominant and those that are recessive.
3. Make a distinction between genotype and phenotype.
4. Give an account of Mendel's experiment with monohybrid inheritance.

Context Introduction

Capture of the mind

Compare the characteristics of children with those of their parents, grandparents, cousins and other family members in a table format (colour; height; weight; eye colour and size; and any other traits. Assign students the task of

determining who in the family has the most resemblance to whom, and for what traits**.**

Narrative

For twenty years, Beatrice has been married to Kofi Attah. They are the parents of four children: Joyce, Gifty, Francis, and Charles. Joyce and Gifty have a striking resemblance to one another, and they share other characteristics with their mother Beatrice. Francis is an exact duplicate of his father, Kofi Attah. Charles, on the other hand, is albino, like his uncle Alex, Kofi Attah's brother. Kofi Attah is perplexed as to how his baby may have inherited his brother Alex's characteristics since neither he nor his wife Beatrice are albinos. He is concerned that his wife may have had an extramarital affair with his brother, Alex.

Examining contexts

Students should debate and try to answer the following questions, as well as any others that may emerge. They should jot down their responses for future reference.

1. Why do some members of the same family have similar characteristics while others do not?
2. Why do some children exhibit traits of both parents?
3. Do you believe Charles might have become an albino if not for his mother Beatrice's romance with her brother-in-law Alex?
4. Is there a genetic reason why some children look like their relatives but not their parents?
5. Why is it so difficult for individuals who are related to one another to be married?

Content introduction

What is the origin of a person's chromosomes?

1. Gamete creation - meiosis; segregation, egg and sperm composition
2. Fertilization – inheritance
3. Homologous chromosomes - DNA replication and mitosis (growth)

How are characteristics passed down from one generation to the next?

1. Experiments conducted by Mendel
2. Monohybrid inheritance
3. Dihybrid inheritance
4. Phenotypes and genotypes
5. Pairs that are allelomorphic (alleles)
6. The laws of Mendel
7. Alleles that are dominant and recessive
8. Complete dominance, co-dominance and incomplete dominance

9. Inheritance patterns

Connection between content and context

Students should be encouraged to revisit the questions the context examination stage and re-evaluate them in light of the new information they have gained. Each question should be re-examined and students should determine the following:

1. What do you think of your first responses and viewpoints?
2. If you believe they are incorrect, what would be the proper responses and why?
3. Does the information supplied relate to or explain the previous situations?
4. Are there any other questions you would want to ask that the information supplied does not address?

Evaluation of learning

1. Dark hair (H) predominates over grey hair (h) - a recessive trait. A male with a mixture of dark and grey hair marries a female who is homozygous grey hair.
    i. What are the genotypes of the male and female partners in this pair?
    ii. How likely is it that their child will be born with dark hair?
    iii. What are the genotypes of the parents if both parents have dark skin and their offspring have fair skin?
2. A certain species of bird has three colour types: yellow; blue and green. These colours are determined by a pair of genes: yellow (Y) and (B) blue.
    i. What are the phenotypes of:

(a) a yellow bird? (b) a blue bird? (c) and a green bird?

    ii. If a yellow bird is mated with a green bird, what colours can their offspring be?
    iii. If two green birds are mated;
        a. What colours can their offspring be?
        b. What percentage of the offspring would you expect to be green? Explain.
    iv. If the birds produced four offspring, is it possible that all four could be green? Explain.