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Effects of Constructive Controversy Strategy and Self-efficacy on Students' Attitude to Genetics

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Abstract: This study determined the effect of constructive controversy strategy (CCS) and the moderator effect of self-efficacy on students' attitude to genetics in Oyo State, Nigeria. The study was anchored to situated learning theory, while the pretest-posttest control group quasi-experimental design was adopted. The sample comprised senior secondary school II science students from six public-owned secondary schools purposively selected from two local government areas. An intact class of secondary school II science students from each school was randomly assigned to CCS (121) and conventional strategy (119). Data were analyzed using analysis of covariance at $p<0.05$. There was a significant main effects of treatment on student' attitude ($F_{(1;215)}=4.42$; partial $\eta^2=0.02$) to genetics concept. This implies that the observed difference in the attitude mean scores of students to genetics after they were exposed to CCS and control groups was significant. Students taught with CCS had improved attitude ($\bar{x}=65.00$) than those in the conventional strategy ($\bar{x}=56.63$). Hence, CCS enhanced students' attitude to genetics. In terms of interaction, treatment and genetics self-efficacy had significant interaction effect on students' attitude to genetics ($F_{(2;\ 213)}=3.04$; partial $\eta^2 = 0.05$), indicating that self-efficacy of the students influenced the effectiveness of the strategies employed in this study and this will favour medium self-efficacious students whenever these strategies are used. The implication of this is that biology teachers should always consider students' self-efficacy whenever they want to implement constructive controversy strategy in biology classroom.

Index Terms: Attitude To Genetics, Constructive Controversy Strategy, Self-Efficacy In Genetics, Situated Learning

1. Introduction

Genetics is an important topic in Nigerian senior secondary school biology curriculum, its studies genes, how genes are inherited and transfer, as well as the variation, functions and behaviours of genes. The application of genetics knowledge in the areas of bioengineering/biotechnology, gene therapy for curing of genetic diseases, crop and animal production, paternity testing and crime detention, among others has improved human life considerably [2]. Moreover, [3] emphasised that whatever knowledge or skills students are learning, they will have feelings about what they get from the outcomes of that learning. The feelings of like and dislike for a particular concept play a critical role in blocking or enhancing learning of such concept and they are major determinants of what will be learned in any class situation. In any learning situation, people tend to learn quicker that concept to which they possess a positive attitude. Any subject or concept towards which one has an unfavourable attitude would be difficult to learn or might not be learnt at all. Attitude to genetics concept can be described as a combination of feelings, beliefs and values to genetics that is a product or effect of genetics as well as genetics class [4].

In spite of the importance of attitude to students learning in genetics concept, [5] claimed that students have negative attitudes to genetics due to the perceived difficulty nature of the concept. [6] observed that students show negative attitude to some aspects of genetics such as cloning of human cell, sex determination and selective abortions. While [7] in a separate study reported that secondary school students have negative attitudes to genetics as a result of teachers' style of teaching biology. Furthermore, previous studies have attributed this negative attitude to skipping classes, low in-class participation, and placing a greater emphasis on examination scores than on learning of genetics content [8]. Also, a close examination of related literature also indicated that students' variables like gender, perceived interest, beliefs, religious affiliations/cultural background and instructional strategies used, influenced students' attitudes to genetics and related socioscientific issues [9].

The development of positive attitude to genetics concept is an important step in addressing the various issues related to genetics and the society at large. To address the aforementioned challenge in students' attitude to genetics

concept, a variety of innovative active learning strategies that can enhance students' cognitive, affective, and psychomotor domains in genetics concept and related issues have been proposed by several scholars in field of biology education, such as, computer simulation and game puzzle packages, problem-solving and discovery strategies, 5E learning strategy, problem-solving and discussion, among others. In spite of this, the negative attitude to genetics classroom still persists. The researcher attributed these to the fact that most of these strategies did not incorporate the socioscientific issues in genetics to the teaching and learning of genetics concept and the application of the gained knowledge in genetics concept. Among the strategies that allows the incorporation of socioscientific issues to genetics learning and provide an opportunity to apply the gained knowledge is constructive controversy.

The constructive controversy strategy was introduced by Johnson and Johnson in 1979. It is a structured cooperative learning strategy that is facilitated in groups of four students with six students on rare occasions. Pairs are given perspectives to plan, present, and discuss within the context of a cooperative model aimed at reaching consensus on a decision or reasonable conclusion, or at the very least, agreeing on the best arguments on both sides [10]. The teacher's position in this strategy is to direct and inspire students to think by introducing them to controversial issues. Although there are a few observed limitations, the presence of personal qualities that want to stand out and it can be difficult to reach a conclusion at times. Constructive controversy fosters creativity, innovation, critical thinking, and empathy, all of which are skills that will not only improve discussion, but are of value outside the classroom [11]. In this study, the constructive controversy strategy is anchored to the situated learning theory by [12], which assumed that facts or ideas are linked to the specific contextual environments where it occurred or the applied domain of the knowledge being acquired, which is especially relevant where practical skills are very important. The theory also assumed that students would learn better if they actively participated in their learning through different activities, context, and culture based on the domains of learning rather than simply listening to teachers in classrooms.

It was also observed that the effectiveness of constructive controversy strategy has been determined on content knowledge, intellectual discussion and augmentation skills of students in science related subjects. The majority of the studies on this strategy conducted in and outside the shore of Nigeria found that the strategy enhances students critical thinking [14], and argumentative skills [13]. However, despite the efficacy of this strategy, there is a dearth of effort on students' attitude [15], more especially in genetics concept in biology. Also, most of these studies were carried out on undergraduates except for a few at secondary schools which were not in genetics. Therefore, the current study sought to fill this gap.

The teaching and learning of genetics concept involve planning, organising, and performing tasks in order to provide solutions to biological issues. Research indicates that self-efficacy can effectively predict students' future academic performance, and some studies also suggest that it has stronger predictive power than other non-cognitive variables [16). Self-efficacy is a term that implies the ability to plan, organise, investigate, and perform a given tasks in a specific science-related subject effectively. [17] reported that high self-efficacious students are more likely to accept more difficult activities, have better time management skills, are more persistent in the face of challenges, have lower anxiety, are more flexible in adopting different learning strategies. While, lower self-efficacious students have less confidence in themselves and their abilities to complete a given task or face an obstacle are easily discouraged. Based on the researcher's knowledge, the majority of studies carried on students' self-efficacy in science focused on chemistry [18] and physics [19], while the effectiveness of this variable on biology learning, especially in genetics is not yet explored as done on chemistry and physics especially at secondary school level. The researcher observed that none of the studies reviewed on constructive controversy strategy, focused on the moderating effect of self-efficacy of senior secondary school students in biology especially on genetics. Hence, this study, determined the effect of constructive controversy and self-efficacy in genetics on students' attitude to genetics. Therefore, the following hypotheses were formulated and tested at 0.05 level of significance:

Ho1: There is no significant main effect of treatment on students' attitude to genetics concept.

Ho2: There is no significant main effect of self-efficacy on students' attitude to genetics concept.

Ho3: There is no significant interaction effect of treatment and self-efficacy on students' attitude to genetics concept.

2. Literature Review

2.1 Constructive controversy strategy

The efficacy of constructive controversy as a strategy has been found to improve ingenuity, novelty, high-quality reasoned judgment, effective learning, and constructive social discourse in many other settings as well. Constructive controversy occurs when a learner's thoughts, facts, assumptions, inferences, philosophies, as well as views are contrary to that of other learners, this cognitive disagreement leads them to pursue an agreement that represents individuals' best-informed decision [17]. This strategy is similar to what philosophers called critical discussion, in which participants assume opposing viewpoints, use arguments, and conflicting arguments, as well as rebuffing in order to solve their disagreements, and "explanation," in which students create relationship among ideas and preceding knowledge [20].

Constructive controversy strategy, a type advocacy-based mode of instruction. It often starts with a crucial fact, that somewhat grabs the attention of the participants who are interested in inquiry, retains it and pushes them to explore

more, while the presentations serve as the inquiry's main point. In many settings, individuals may be confronted with contentious topics or problems (controversial issues) in their immediate environments. It must be noted that constructive controversy strategy and controversial issues are not similar, constructive controversy steps can help in addressing issues that are controversial in nature. A contentious problem is an issue, the society has not reached an agreement, which is deemed so important that each suggested solution has enthusiastic advocates and vehement opponents [17]. Review of available and relevant literature on constructive controversy strategy is worth exploring to provide a better comprehension of the effectiveness of constructive controversy strategy on students' attitude to genetics concept.

In online cooperative learning environments, [21] explored the impact of trust and constructive controversy on student achievement and attitude. After participating in a shared first workshop on basic cooperative learning abilities, students in one university course were randomly allocated to one of the two treatment groups. Following that, the ‘‘trust" and ‘‘constructive controversy" groups got skill training. Overall, the ‘‘trust" groups had significantly higher achievement than the constructive controversy" groups after each group received therapy during online cooperative group tasks. Furthermore, the ‘‘trust" groups held much more favourable views of online cooperative learning than the ‘‘constructive controversy" groups. For boosting the ‘openness and sharing' and ‘acceptance and support' components of student attitudes in online cooperative learning environments, utilizing ‘‘trust" building tactics was considerably more effective than using ‘‘constructive controversy" strategies.

In their own study, [22] determined the effectiveness of using of two learning strategies on students' achievement, ethical skills and moral development. The participants of the study consist fifty-six (56) 3rd to 5th grades students. Data were analysis by a repeated-measures MANOVA. Findings confirmed the efficacy of constructive controversy instruction over an individualistic instruction in enhancing participants' moral development, ethical skills and achievement. Based on the existing and available information at the researcher's disposal, the efficacy of this strategy has not been determined on any school level in Nigeria as all of these studies were conducted outside Nigeria, Also, evidence of influences of this strategy on attitude especially in biology concept are lacking, the gap which this study attempts to fill.

2.2 Students' Self-efficacy in Learning of Science

Self-efficacy was introduced by Bandura, to means the confidence a person has in one's ability to master a new task and to successfully manage a difficult construct in a demanding learning condition [23]. While self-efficacy in science means to individual's confidence in his/her capability to effectively execute science activity or achieve scientific outcomes [24]. Self-efficacy is believed to contributes to (i) an individual goals set for his or herself to achieve, (b) the effort an individual will put in to completing given tasks, (c) how determined and persevered an individual will be when he or she faces challenges in the course of executing given tasks, and (d) when such an individual fails how resilient will he or she be.

From the above, students' self-efficacy in genetics, as used in this study, can be described as student's confidence in their abilities or skills to complete a given task or activity in genetics concept and achieve the expected learning outcomes in genetics concept. That is, self-efficacy in genetics concept means the belief of a student in one's ability to successfully complete given activities in genetics concept that may include both cognitive and affective learning domains in genetics concept.

In Hong Kong higher education, [25] discovered a link between self-efficacy and attitudes about the use of technology in learning. A total of 300 questionnaires were issued, with 187 useable copies gathered. According to the findings, there is a positive association between self-efficacy and attitudes about the use of technology in learning in Hong Kong higher education. While [26] polled Higher Secondary school students about their views toward mathematics and self-efficacy in mathematics. The sample comprised of 784 male and female Class XI students drawn from 25 schools in West Bengal's southern regions. This correlational study found a strong relationship between Higher Secondary students' attitudes toward mathematics and their self-efficacy in mathematics.

[27] investigated the correlation that exist among secondary school chemistry students' attitude, motivation, and self-efficacy. 81 secondary school chemistry students took part in the study. Relationship students' attitude to chemistry was significantly related to their self-efficacy. Though literature has showed the efficacy of this factor on achievement of students, attitude as well as application of acquired knowledge. The effectiveness of these variables on biology learning, especially in genetics concept is not yet explored as done on mathematics and physics especially at secondary school level.

3. Methodology

3.1 Research Design

*T*he pretest-posttest control group quasi-experimental design (this is due to the manipulation of the independent variable and its applicability in real-world settings where in-school students cannot be randomized into groups during school learning hours. Also, this design is valuable when true experimental designs and ethical issues are not feasible due the attitudinal nature of the participants being human being). However, this design's lack of randomization, selection bias, and limited control over extraneous variables posed significant challenges to establishing causal

relationships and ensuring internal validity. The researcher addressed these concerns, by carefully using appropriate sampling techniques to select the group of students, and potential moderator variable as well as carefully interpret the findings derived from the design). In case quasi-experiment is not feasible, the researcher will adopt the Regression discontinuity design (RDD).

3.2 Selection of participants

Senior Secondary School II students in Oyo state were the participants. In order to offer all of the local government areas in the three senatorial districts an equal chance to participate in the study, one local government area (LGA) was randomly selected from each of the three senatorial districts in Oyo State, for a total of three local government areas in order to be able to generalized the findings of the study across Oyo State. From the three local government areas, six senior secondary schools were chosen purposively. Two schools were purposively selected from each LGA based on the experimental (constructive controversy strategy) and control (conventional strategy) groups. The reasons for the use of purposive sampling technique in the selection of schools were due to the willingness of the school to engage in the study and the geographically distance of one school from the other in order to avoid research contamination. After the selection of the schools, one school from each LGA was randomly assigned to constructive controversy strategy while the second school was assigned to the conventional strategy. In total, three schools were assigned to the constructive controversy strategy from the three LGAs while three schools were also assigned to the conventional strategy from the three LGAs, making the total of the participated schools to be six. Since the design of the study is quasi-experimental, randomization is not possible, this prompt the researcher to use an intact class of senior secondary school II students in science that are offering biology (using this option, gave all the students in the selected senior secondary school II class to participate in the study). This means that in each school, an intact class of senior high school II students in science class offering biology was used. Making a total of six intact classes. Three intact classes were randomly assigned to constructive controversy strategy while the remaining three intact classes were assigned to the conventional strategy. The total number of the students that participated in the study from the six schools were 240.

3.3 Research Instruments

The following instruments were used.

Students' Attitude to Genetics Concept Questionnaire (SAGCQ): The SAGCQ is a 30-item instrument constructed by the researcher to assess students' attitude to genetics. This type of instrument was informed by the nature of the research design and 0.05 level of significance adopted by the researcher which recognized the attitudinal nature of man which cannot be 100.0% as in true experiment). The instrument measures students' feelings, beliefs, values and usefulness and impacts of genetics. The instrument was graded on a four-point Likert scale, from Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The participants were asked to tick one of four possible replies to indicate their level of agreement or disagreement with each statement. The positive statements were given a score of SA = 4, A = 3, D = 2, SD = 1, whereas the negatively worded statements were reversely scored.

The items from the instrument were presented to the researcher's supervisor and lecturers who are experts in measurement and evaluation in order to establish its validity in areas of language construction, precision of focus, clarity of purpose, and brevity of ideas for the target population. The views of the experts were incorporated into the instrument's final draft. The instrument was trial-tested on Senior Secondary School II science students that were not part of sample students that participated in the main study to ensure its reliability. Cronbach's Alpha formula was used to establish the instrument's internal consistency. This reliability technique is applicable for this instrument because each test item is supposed to measure the same latent feature on the scale, this reliability technique is applicable for this instrument. The reliability coefficient of 0.83 was obtained.

Self-efficacy in Genetics Concept Scale (SeGCS): The SeGCS was adapted to access the self-efficacy of students in genetics. This type of instrument was informed by the nature of the research design and 0.05 level of significance adopted by the researcher which recognized the attitudinal nature of man which cannot be 100.0%% as in true experiment). The SeGCS consists of 28 items adapted from [24] General Self Efficacy Scale and Biology Self-Efficacy developed by [28]. [27] instrument contains 10 items on a four-point scale of Exactly true-4, Moderately true-3, Hardly true-2 and Not at all true-1. Cronbach alpha was used to establish the internal consistency of GSES by the authors which gave alpha coefficients between 0.76 and 0.90. [28] instruments of 23 items was made on a 5-point rating scale from Totally confident, Very confident, Fairly confident, Only a little confident and Not at all confident. The internal consistency reliability for the instrument yielded Cronbach's alpha coefficients of 0.89. The instrument was modified to a four-point Likert response scale of Strongly Agree, Agree, Disagree and Strongly Disagree. To read genetics, some items were recreated. These changes were made to fit the study's objectives and the participants' skill levels. In scoring, Strongly Agree = 4, Agree = 3, Disagree = 2 and Strongly Disagree = 1, were assigned to statements that are positively stated, while negatively worded statements were reversely scored.

The validity of the SeGCS was ascertained by the researcher's supervisor and lecturers who are experts in measurement and evaluation to establish the suitability of the items in term of language construction, precision of focus, clarity of purpose and suitability for the target population. Their comments were taken into account when designing final draft of the instrument. The 34 items instrument was pilot-tested on a Senior Secondary School II science students that were not among the sample students select to participate in the main study to ensure its reliability. The Cronbach's alpha formula was used to establish the instrument's internal consistency. This reliability technique is applicable for this instrument, because

each test item is supposed to measure the same latent feature on the scale. The reliability coefficient of 0.88 was obtained. After which, only 28 items were found to be good enough for the study.

3.4 Treatment Procedure for Constructive controversy strategy

The following adapted steps from [17] processes of constructive controversy were employed.

Step 1: Grouping and assigning responsibilities

i. Students were divided into groups of four members,

ii. Students were separated into two pairs after being randomly assigned to four-person teams. Each pair was assigned one of the two sides of the debate established in Step 2 at random.

Step 2: Definition of problem and researching positions

i. Teacher provided background information on the topic and related controversial issue either using lecture or text materials.

ii. Students evaluated their assigned positions by providing a brief description of the topic and at least have five explanations for their positions

Step 3: Research and prepare a position

Students reassemble again in their 4-member teams, with each pair presenting the best probable argument for their given position, while the second pair do the same for their own given position.

Step 4: Open discussion

Students continued to provide support for their assigned viewpoints, by critically analysing the opposing argument and pointing out the flaws and weakness, as well as defending their own assigned roles against the opposing pair's attack.

Step 5: Reverse Perspectives

i. Students made the strongest case feasible for other side of the argument.

ii. Students referred to their notes and provide new information to check whether the provided information is accurate. Here, students tried to perceive the problem from both sides.

Step 6: Reconceptualisation, synthesis, integration

i. Students dropped their assigned roles.

ii. Summarised and used the best reasoned ideas of the four group members, and integrate it into a joint accepted position on the problem's solution by learning, reflecting and understanding other's perspectives.

iii. Students wrote a group report (by making use of given handout procedure) outlining their decision with supporting rationale and evidence,

iv. Teacher clarified any misconceptions.

Step 7: Assessment

i. Each student took a test on the topic and the given positions to see how well the group worked together.

ii. The group celebrated their accomplishments and each member's hard work.

3.5 Methods of Data Analysis

Data collected were analysed by analysis of covariance at $p<0.05$. The magnitude of the mean scores of the different groups and which group has the highest mean score were determined using the Estimated Marginal Mean (EMM). Descriptive statistics and content analysis were used to examine the study lone research question.

4. Results

Ho1a: There is no significant main effect of treatment on students' attitude to genetics concept

Table 1. Main and interaction effects of treatment and self-efficacy in genetics concept on post-attitude to genetics concept

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7162.547	6	1193.758	3.627	0.002	0.095
Intercept	60871.071	1	60871.071	184.937	0.000	0.471
Pre-Attitude	890.280	1	890.280	2.705	0.102	0.013
Treatment	1453.667	1	1453.667	4.416	0.037*	0.021
Self-efficacy	2055.530	2	1027.765	3.123	0.046*	0.029
Treatment x Self-efficacy	2003.822	2	1001.911	3.044	0.050*	0.028
Error	68462.262	208	329.145			
Total	805745.000	215				
Corrected Total	75624.809	214				

R Squared = 0.10 (Adjusted R Squared = 0.07) * denotes significant $p<0.05$

Table 1 depicted that the main effect of treatment on students' post-attitude scores to genetics concept in biology ($F_{(2;\ 214)} = 4.42$; $p<0.05(0.04)$; partial $\eta^2 = 0.02$) was significant. Hence the null hypothesis 1a was rejected at the 0.05

level of significance. Table 1 also revealed an effect size of 2.0%, which indicated that the treatment group accounted for 2.0% (0.02) of the variance out of the 7.0% (Adjusted R Squared = 0.07) total variation observed in the model in respect of student's adjusted post-attitude scores to genetics concept in biology. The differences in the post-attitude mean scores of the students exposed to different treatment and control conditions are established by the estimated marginal mean analysis and the result presented in Table 2.

Table 2. Adjusted post-attitude to genetics concept mean performance by treatment and control groups

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Constructive Controversy Strategy (CCS)	60.85	2.01	56.89	64.80
Conventional Strategy (CS)	55.15	1.74	51.72	58.58

Table 2 revealed that students taught with the constructive controversy strategy recorded the higher adjusted post-attitude mean score of 60.85 with confidence interval ranging from 56.89 to 64.80, while students exposed to the conventional strategy had the lowest adjusted post-attitude mean score of 55.15 with confidence interval ranging from 51.72 to 58.58. This order is presented as CCS > CS.

Ho2: There is no significant main effect of self-efficacy in genetics concept on students' attitude to genetics concept

Table 1 depicted that self-efficacy in genetics concept main effect on students' attitude to genetics concept in biology ($F_{(2, 213)} = 3.12$ $p<0.05$, partial $\eta^2 = 0.03$) was significant after controlling for pre-attitude at $p<0.05$. This means that the null hypothesis 2a was rejected. This depicts that there was a significant difference in the post-attitude mean scores of students to genetics concept in biology in respect to their self-efficacy. Table 1 revealed an effect size of 3.0%, which means that the moderator effect of self-efficacy in genetics concept alone accounted for 3.0% of the variation observed in student's adjusted post-attitude scores to genetics concept. In order to determine the differences among the post-attitude mean scores of the students across self-efficacy in n genetics concept levels, the estimated marginal means analysis was carried out and the result is presented in Table 3.

Table 3. Adjusted post-attitude to genetics concept mean performance by self-efficacy in genetics concept

Self-Efficacy in genetics concept	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low	61.54	2.08	57.44	65.64
Medium	59.22	2.01	55.26	63.19
High	53.22	2.62	48.06	58.39

Table 3 indicated that low self-efficacy students in genetics concept had the highest adjusted post-attitude mean score of 61.54, followed by moderate genetics concept self-efficacious students with adjusted post-attitude mean score of 59.22, while high genetics concept self-efficacious students had the lowest adjusted post-attitude mean score of 53.22. This order is showed as Low > Medium > High.

Table 4. Multiple comparisons of self-efficacy in genetics concept groups mean by post-attitude to genetics concept

(i)Self-Efficacy in genetics concept	(J) Self-Efficacy in genetics concept	Mean Difference (I-J)	Sig.
Low	Medium	2.315	1.000
	High	8.315*	0.042
Medium	Low	-2.315	1.000
	High	6.000	0.213
High	Low	-8.315*	0.042
	Medium	-6.000	0.213

* denotes significant $p<0.05$

Table 4 showed that the difference in the adjusted post-attitude mean score of low and high self-efficacy students in genetics concept in biology was statistically significant. But there was no statistically significant difference between medium and low self-efficacy students' post-attitude mean score to secondary school biology genetics concept. Table 4 further revealed that the difference in the adjusted post-attitude mean score to genetics concept in biology between medium and high self-efficacy students in genetics concept was not statistically significant. This means that low self-efficacy in genetics concept was the main source of the significant differences observed across self-efficacy in genetics concept levels to attitude.

Ho3: There is no significant interaction effect of treatment and self-efficacy on students' attitude to genetics concept

Table 3 indicated that the interaction effect of treatment and self-efficacy on students' post-attitude to genetics concept in biology whilst adjusting for pre-attitude ($F_{(2; 213)} = 3.04$; $p<0.05$, partial $\eta^2 = 0.05$) was significant. This indicates that students' post-attitude score to genetics concept in biology vary significantly among low, medium and high self-efficacy students after they were exposed to the treatment and control conditions. Therefore, null hypothesis

2a was rejected. Table 3 also revealed an effect size of 3.0%, which implies that the interaction effect of treatment and self-efficacy alone accounted for 5.0% of the variance in student's adjusted post-attitude scores to genetics concept.

In order to explore the nature of the interaction effect, the line graph is presented in Fig. 1.

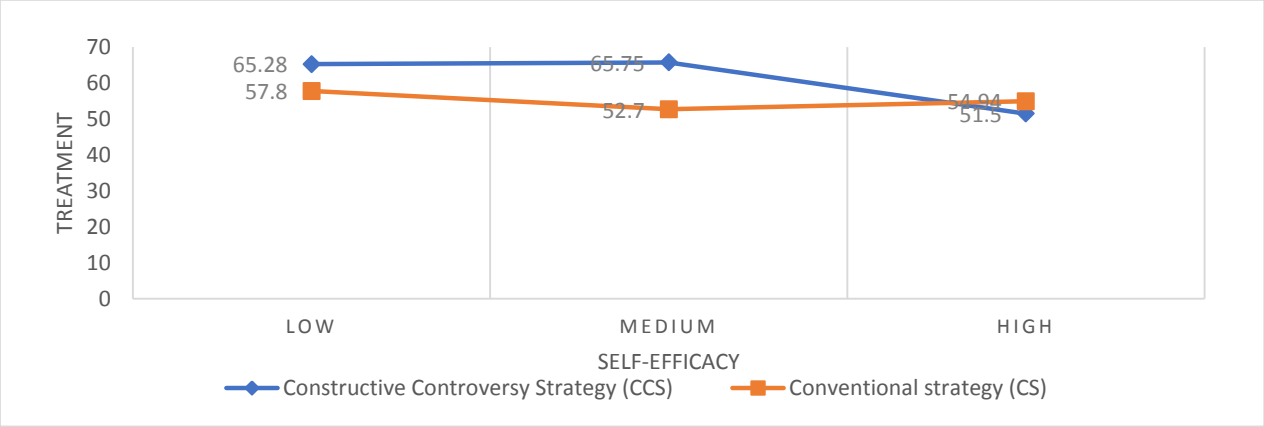

Fig. 1. Treatment and self-efficacy in genetics concept on students' attitude to genetics concept

Figure 1 indicated that medium self-efficacy students in constructive controversy strategy recorded the highest adjusted post-attitude mean score to genetics concept in biology (65.75) as compared with other combinations of students. Fig 1 also indicated that the nature of the interaction is disordinal since the lines crossed each other. This means that based self-efficacy of students in genetics concept, it was not the same group of students across treatment group that have better performance in post-attitude mean score to genetics concept in biology.

5 Discussion

5.1 Main effect of treatment on secondary school students' attitude to genetics concept

The main effect of treatment on genetics concept post-attitude of students in biology was significant. The result further indicated that students in constructive controversy treatment group had better post-attitude than those in the conventional strategy to genetics concept in biology. This outcome implies that constructive controversy was effective in developing positive attitude in students towards genetics concept and related social issues.

The constructive controversy strategy is more effective at improving students' post-attitude to genetics concept in biology than the conventional strategy. This may be attributed to the one of the features of constructive controversy strategy which allow team members to re-evaluate their attitudes about genetics concept and the related problems as well as incorporating opposing accepted opinions [29]. This may also be because this strategy gives team partners the opportunity to interact positively and strengthen cordial relationships among them by encouraging high worth problem-solving tasks, motivation to study the topic under debate, therefore, enhancing their disposition, belief and value of that topic [30]. The efficacy of the experimental strategy is supported by the assumptions of the situated learning theory which stated that science lessons should be held in settings that encourage students to engage in active and socially responsible civic living through the participation of each member in the group [31], in authentic activities where they explored and finding solutions [32]. The engagement of students in intellectual conflict within a real-world context, which could lead to the comprehension of genetics and the application of their knowledge in a meaningful and constructive ways [33].

This result of effectiveness of constructive controversy on students' attitude to genetics concept over the conventional strategy is in agreement with the study of [25] in which the results revealed that constructive controversy was significantly effective than conventional strategy in improving different components of students' attitude to online collaborative learning settings. This result is consistent with [26], who found that constructive controversy significantly resulted in development of positive attitudes in 3rd, 4th, and 5th-grade students toward social interdependence.

5.2 Main effect of self-efficacy on secondary school students' attitude to genetics concept

The main effect of students' self-efficacy in genetics concept in this current study on their attitude to genetics concept in secondary school biology was found to be significant. The result also revealed that low self-efficacious students had better post-attitude to genetics concept mean score, as against medium and high self-efficacious students, respectively. The reason for this outcome could be that students were encourages raising genetics issues, reflecting on them and relating them to real life situations. In such conditions, they perceive difficult tasks as something to cater to, reflect on, and evaluate rather than to move away from. And as a result, low self-efficacy students become more persistent, resilient and self-assured in learning of genetics concept and related issues. This might have led to the improved achievement recorded by them than their medium and high self-efficacious students. This finding gives credence to the situated learning that emphazied ownership of learning, engagement in real-life scenarios, opportunities

to apply knowledge gained to real-world problems, peers' collaboration and interaction, real-world tasks engagement, which provided students the opportunities to experience mastery and success, which could have resulted in the performance of the low self-efficacy students in genetics over the others groups [34].

This result is affirmed by the finding of [25] that positive correlation existed between self-efficacy and students' attitude to technology usage in Hong Kong higher education. This is also reinforced by the result of [26], that relationship existed between higher secondary students' attitude to mathematics. But this current study is in variance with [26] that high self-efficacy students had the highest mean score in mathematics at higher secondary level.

5.3 Interaction effect of treatment and self-efficacy in genetics concept on secondary school students' attitude to genetics concept

Treatment and self-efficacy interaction on students' attitudes to genetics concept in biology had significant effect. This indicates that being low, medium or high efficacious has different effect on the treatment applied. It was also observed from the result that students with medium self-efficacy in CCS had better post-attitude to genetics concept in biology.

This finding is confirmed by the research report of [35] which indicates that higher level of self-efficacy directly associated with the learning strategies adopted in biology learning environment. This finding of the current study lent credence to by the research works of [36], that self-efficacy of students is a potent factor that strongly mediate the relationship that existed between teacher use of instructional strategies and students' attitude. This finding is corroborated by the finding of [37], who found a correlation between strategies used and self-efficacy of students. This present finding is corroborated by the assertion of [38] that the mode of cooperative learning instructions used can be determined by self-efficacy of students.

6. Conclusion

The study concluded that constructive controversy strategy was more efficient in improving students' attitude to genetics concept and related socioscientific issues in secondary school biology when compared to conventional strategy. Students' genetics self-efficacy in genetics concept influenced their attitude to genetics concept. Treatment and students' self-efficacy in genetics concept interaction on their attitudes to genetics concept in secondary school biology had significant effect. While, medium self-efficacious students in constructive controversy strategy had better attitude to genetics concept when compared to others.

Recommendations

For biology teachers to have inclusive genetics classroom when implementing this strategy, they should consider the self-efficacy status of their students as it goes along way in influencing its effectiveness during the teaching and learning of genetics in favour of a particular group of students.

There is need to explore socioscientific issues that are related to the needs of genetics learning in biology, especially those that are local and national to our everyday life, needs to be done to support the implementation of constructive controversy strategy in biology learning.

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