EFFECTS OF FLIPPED CLASSROOM, REFUTATIONAL AND EXPOSITORY TEXTS STRATEGIES ON UNIVERSITY OF BENIN PRESERVICE TEACHERS ACHIEVEMENT IN THE CONCEPT OF GENETICS

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Abstract
Misconceptions in the concept of Genetics among biology students have long been a problem in secondary schools as it creates poor performances in biology examinations. Several factors have been mentioned to have contributed to this problem among which are the misconceptions that arise from teachers. Hence, the need for this study to investigate the misconceptions that exists among 300 level and 400 level Preservice Biology and Integrated Science Student Teachers in the University of Benin and the possible strategies that can help improve understanding and achievement in the concept of Genetics. Three research questions were raised to guide this study. The quasi-experimental, pre-test post-test non-randomized design was employed. The population of the study was made up of 253 Preservice Biology and Integrated Student Teachers of the Department of Curriculum and Instructional Technology, from the Faculty of Education, University of Benin. The simple random sampling technique was used to select the sample size of one hundred and forty-eight (148) Biology and Integrated Sciences Preservice Student Teachers. The sample was also randomly selected into the three groups, namely Groups A and B (Experimental) and Group C (Control). Data was collected using Genetics Achievement Test (GAT) instrument, and two treatment packages made up of videos and texts structures. The treatment packages were validated by experts in the field and the reliability coefficient value of 0.721 was obtained using the Kuder –Richardson formula 20 for GAT. Findings showed that (74.49%) of the Preservice Teachers had misconceptions in genetics. The results also showed that there was also a significant difference in the effects of using the Flipped Classroom and Refutational Texts Strategies when compared to the use of Expository Text strategies in improving achievements in the concept of Genetics amongst Preservice Biology and Integrated Science Teachers.

Keywords: Preservice Teachers (PT), Flipped Classroom Strategy (FCS), Refutational Text Strategy (RTS) and Expository Texts Strategy (ETS). Let it be only 5 words

Introduction

Since the 1980s, various researchers have tried to uncover if education is preparing students well enough for their future with genetics. This inquiry becomes necessary because many researchers showed that students hold numerous misconceptions about the concept of Genetics,

and they often lack a deep understanding which is often reflected by their poor academic performances. Some common problems found were confusion of basic terms (like gene, chromosome, allele or meiosis and mitosis) and shallow understanding of their concepts as well as misconceptions about gene expression (how DNA influences cell functions) (Aldahmash & Alshaya 2012). Other common misconceptions when it comes to genetics, heredity, determinant traits, and genetic testing just to name a few include; Genes are the sole determinants of traits; Single genes code for most traits; Dominant traits are the most common traits in a population; The limiting factor to getting genetic information is the speed and/or cost of genome sequencing etc.

Haskel-Ittah & Yarden (2018) noted unfortunately that, recent findings suggest that this situation still has not changed. Meanwhile, genetics education has become increasingly important with the advent of recombinant DNA technologies and the subsequent emergence and availability of genetically modified food and organisms (GMOs). Scientific understanding of genetics and genome is important for the comprehension of all types of diseases (Spradling, *et al.* 2006), because it can lead to better diagnosis and treatment. Some of the main reasons for these misconceptions could be those students' misconceptions which can be influenced by the national curriculum; (Osman, BouJaoude, & Hamdan 2017); textbooks and teaching methods employed by teachers (Cisterna, Williams, & Merritt 2013).

Similarly, studies on Preservice science educators have found that both males and females students can have misconceptions about science topics. However, some studies have found that male PT have fewer misconceptions than female PT. These misconceptions can cause failure in understanding biological phenomena and may be difficult to discover and address. Gender differences in science are prevalent in academia (Holman, Sturt-fox & Hauser 2018). A fine-grained examination of gender difference in science is a pre-requisite for any deeper investigation. PT in secondary school biology Genetics are crucial because they provide a foundation for future educators to effectively teach complex Genetic concepts to students, ensuring accurate understanding of heredity while developing essential pedagogical skills to engage students in this critical biological field, ultimately impacting the quality of science education at the secondary level. This is especially important due to the often-challenging nature of Genetics for students, requiring teachers with strong conceptual knowledge and effective teaching strategies. A well-trained pool of Preservice Biology Teachers with a strong grasp of the concept of Genetics ensures that future generations of students receive quality science education, contributing to a scientifically literate society. Therefore, it is important to identify strategies that can help improve on the correct conceptions that PT have in the concept of Genetics. Teaching for the promotion of Genetics literacy using interactive instructional strategies would prepare and enable students to learn effectively and meaningfully thereby acquiring 21st-century skills. These skills are required for the adaptability and sustainability of individuals or groups in the modern work environment. A brief of some of the interactive instructional activities such as guided inquiry, problem-solving, constructivist

strategies such as, audiovisual models, concept maps, blended classroom, Flipped classroom, etc have been found to promote scientific learning, conceptual understanding and achievement.

The Flipped Classroom Strategy (FCS) in particular has been found to be remarkable in creating critical thinking and helping students learning effectively. The FCS involves a transformation of the teacher's role. It moves away from this idea, placing the teacher in the role of the "guide on the side" who works with the students to guide them through their individual learning experiences (Bergmann, Overmyer, & Wilie, 2012). The "guide" role can be illustrated using Paulo Freire's idea that education "should not involve one person acting on another, but rather people working with each other," A common assumption in the FCS is that new technologies make it easy to convert instructor lectures through digital recordings and place these online for student access outside of face-to-face class time. As a result, students can review lectures in advance of class, then have class sessions for working together on the assignments that traditionally would have been done as homework. Not only are students seen as gaining through working together on "homework" problems in class, but instructors are able to more quickly see where students are struggling and provide remedial support which advocates that by using class time for student discussion, collaboration and problem-solving, the traditional lecture-based mode of instruction can be replaced by a more student-centered learning that is not only more effective but also achieves larger goals of 21st century skills (Bergmann & Sams, 2012).

Other than the FCS, text formats have also been used to facilitate conceptual change and learning more broadly. For instance, whereas expository texts are based on scientific facts, as one may often see in a textbook, conceptual change texts are slightly different, beginning with a question and following it with explanations of why common misconceptions are incorrect and providing the scientifically accepted explanation (Çalik *et al*., 2007; Roth, 1985). Similar to conceptual change text strategy is another promising text format known as the Refutation Text Strategy (RTS).

A Refutation Text states a common misconception about a subject, refutes it, and provides an explanation of the correct conception (Hynd, 2001; Mason *et al*., 2019; Tippett, 2010). The commonly held misconception is explicitly stated upfront and then refuted, after which the reader is introduced to the established, correct scientific explanation (Sinatra & Broughton, 2011; Tippett, 2010; Vosniadou & Mason, 2012). The rationale behind the advantage of RFS for knowledge revision processes is rooted in both conceptual change as well as reading comprehension theories, and has been summarized by Kendeou and O'Brien (2014) as follows: For knowledge revision to occur, the correct and incorrect knowledge components have to be co-activated in working memory. This supports their comparison and contrast. Readers are more likely to notice the discrepancy between their own intuitive understanding (as presented in the common misconception) and the scientific one, and to encode the newly presented information correctly. In contrast, readers with misconceptions make more invalid inferences while reading expository texts, as the newly presented information is assimilated

into the incorrect mental representations constructed in a person's working memory based on his/her pre-existing knowledge (Kendeou & van den Broek, 2007; Van den Broek & Kendeou, 2008). Explicit references and statements about the incorrectness of misconceptions (refutation cues) play an important role in RT.

Science textbooks traditionally contain Expository Texts in which scientific concepts are explained in detail, without directly referring to common misconceptions (Tippet, 2010) as observed in the Expository Text method. The Expository Text Strategy (ETS) typically is a pattern of teaching which involves giving students the task of reading from a textbook or notes developed by the teacher. This method is teacher-centered. The teacher presents a verbal discourse on a particular subject, theme or concept to the learners with little or no instructional aids. The teacher-centered mode of teaching relies heavily on chalk-and-talk method and students reading the textbook to follow it. The teacher responds to questions while students defer directly to the teacher for guidance and feedback. In an Expository Text classroom with a traditional style of instruction, individual lessons may be focused on an explanation of content utilizing a lecture-style.

Preservice Biology and Integrated Science Teachers undergo rigorous training to deeply understand biological concepts, particularly genetic principles, ensuring they can accurately explain complex concepts like DNA structure, gene expression, and inheritance patterns to their future students. Therefore, this study investigates the misconceptions that PT have in the concept of Genetic and compares the most effective strategy that can improve correct conception of the concept of Genetic among PT in the University of Benin.

Statement of the Problem

Over the years, researches have revealed that several misconceptions exist in the concept of Genetics. In addition to these conceptual and procedural difficulties in Genetics learning, PT attributed misconceptions in genetics to the challenges in genetics textbooks, instructional methods in teaching genetics, lecturers' English language skills, pre-service teachers' cultural beliefs and practices, nature of laboratories and abstractness of genetics (Etobro & Banjoko 2017). One of the ways that have been suggested to promote understanding and achievement in improving instruction is the FCS. This strategy is gaining support at all levels of education, including in primary, secondary and post-secondary classes as a tool for improving students understanding and achievement. By allowing students to use knowledge in class with feedback from peers and the instructor, the FCS helps student's correct misconceptions and organize new knowledge effectively. Another strategy for correcting misconceptions that have been found effective is the RTS by creating conceptual change among students. Specifically, "a refutation text is an expository text that acknowledges the misconceptions a reader may hold about a topic, explicitly refutes them, and presents the scientific explanations" as viable alternatives' (Tippett, 2010). In particular, three structural components of a refutation text have been defined; (1) "The statement of the misconceptions a reader may hold about the topic presented in the text, (2) a signal or cue that alerts the reader to the possibility of another explanation, followed by (3) the statement of the currently accepted

scientific explanation. As defined, the first two components could be properly referred to as the refutation statement. In contrast, a traditional text or Expository text (non-refutational text) only provides the new scientific information. A traditional form of learning science is through reading textbooks that expose student to new and unfamiliar scientific facts. Researchers have claimed that non-refutational texts such as expository texts typically do not invite students to critically think about the facts or concepts being presented and reconcile such facts to their prior knowledge and misconceptions" (Braten, Britt, Strømsø, & Rouet, 2011). This "problem may be amplified when students are learning science topics with contradictory or divergent viewpoints. Indeed, non-refutational science texts are replete with expository presentations of facts that may not trigger the cognitive conflicts needed to initiate conceptual change in the learner" (Braten, Britt, Strømsø, & Rouet, 2011).

This study therefore seeks to ascertain whether PT have misconceptions in the concept of genetics. Will the use of the FCS and the RTS be more effective in improving achievement when compared with the use of the ETS in the concept of Genetics among PT? Can the various teaching strategies be more effective with the female PT achievement than the male PT achievement in the concept of genetics?

Purpose of the Study

The purpose of the study is to investigate if;

1. Preservice Teachers have misconceptions on the concepts of Genetics

2. The achievement scores of Preservice Teachers will improve when taught the concept of Genetics using 3 different Instructional Strategies

3. The achievement scores between the of Male and Female Preservice Teachers will improve significantly when taught the concept of Genetics using 3 different Instructional Strategies

Research Questions

To guide this study, the following questions were raised.

1. What percentages of Preservice Teachers have correct conceptions of the concept of Genetics at pretest?
2. What is the difference in the mean achievement scores of Preservice Teachers taught Genetics using Flipped Classroom, Refutational and Expository Texts Strategies?
3. What is the mean achievement scores of male and female Preservice Teachers taught Genetics using Flipped Classroom, Refutational and Expository Text Strategies?

Null Hypotheses

The following null hypotheses were formulated to further guide this study and were tested at 0.05 level of significance

1. There is no significant difference in the mean achievement scores of Preservice Teachers taught Genetics using Flipped Classroom, Refutational and Expository Texts Strategies.

2. There is no significant difference in the mean achievement scores of male and female Preservice Teachers taught Genetics using Flipped Classroom, Refutational and Expository Text Strategies.

Methodology

The quasi-experimental, pre-test post-test non-randomized design was employed for this study. The population of the study was made up of 253 Preservice Teachers (PT) of the Department of Curriculum and Instructional Technology, from the Faculty of Education, University of Benin. The simple random sampling technique was used to select the sample size of one hundred and twenty-nine (148) students from two (2) subject areas in the Department (Biology and Integrated Sciences) taught genetics in their 300 and 400 levels. Data was collected using Genetics Achievement Test (GAT) instrument, and 3 Instructional Treatment Packages made up of videos and texts designed for the FCS Group and Text Structures for Group B and Group C. GAT is a multiple choice test instrument made up of sections A and B. Section A contains information on students' bio-data which indicates their gender (male or female), while section B consists of twenty (20) test items of misconceptions that exists in Genetics from several studies. These questions were carefully selected to identify right conceptions or misconceptions in limited but clearly defined content area using a table of specification for the validation of the instrument.

The first is the FCS Treatment Package that consisted of 4 animated videos and texts designed to address the 20 listed misconceptions for this study. The treatment provided explanations of the roles of Genes, Chromosome, Alleles, DNA, Mutations and Heredity through a period of 6 contacts of 45 minutes in classroom setups.

The second is the RTS Treatment Package which listed out the 20 misconceptions selected for this study (4 Misconceptions were treated through 5 classrooms contact of 45 minutes). A Refutation Cue for each of the misconceptions was stated and lastly the Correct Scientific View for each Refutation Cue were presented and correctly explained.

Lastly, ETS Treatment Package followed the same pattern as RTS. The difference was that Text materials (the 3 most popular biology textbooks prescribed and listed for use for the class) did not contain or identify likely misconceptions that exist in the concepts of Genetics.

Treatment Plan

The three groups had 6 contacts of 45minutes each in which the pretest was carried out on the first contact and posttest on the sixth contact. The Instructional Treatment Package was administered for 4 contacts each to the three groups. The students in group A were taught using FCS, group B was taught using RTS and Group C was taught using ETS.

Frequencies and percentages were used to determine misconceptions before and after treatment. Hypotheses one and two were tested using ANOVA and the mean scores of students in the different groups were compared using Oneway Analysis of Covariance (ANCOVA) for hypothesis two.

Results

Research Question 1: What Percentage of Preservice Teachers (PT) have Correct and wrong Conceptions of the Concept of Genetics Pretest

This was answered using frequencies, percentages, mean and standard deviation.

Percentage of Preservice Teachers (PT) on Correct and wrong Conceptions of the Concept of Genetics Pretest?

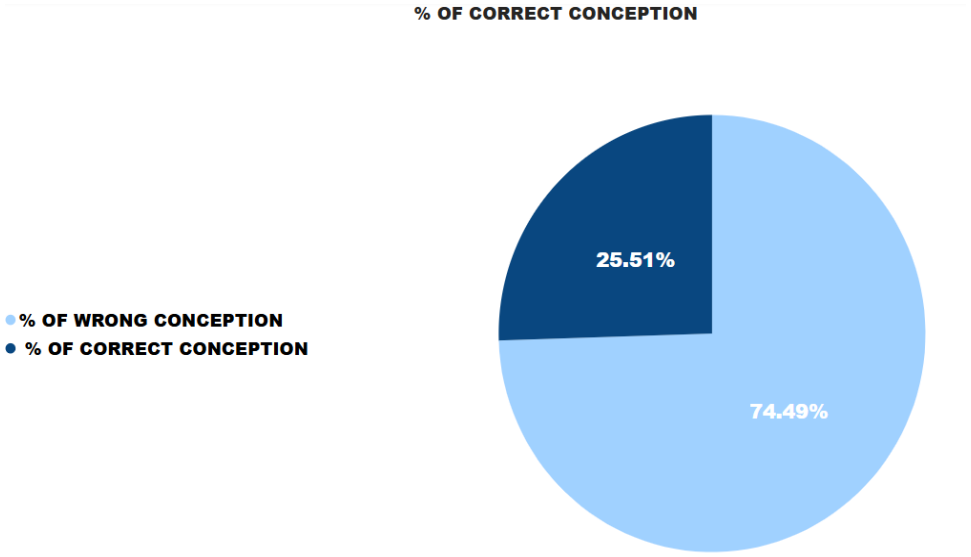

Figure 1: Percentage of PT with Misconceptions and Correct and wrong Conceptions of the Concept of Genetics at Pretest

An average of 74.49 percent of the PT had misconceptions of the concept of genetics at pretest before the treatment as illustrated in figure 1.

Research Question 2: What is the percentage of correct conceptions held by the PT in each GAT items,

Table 1 shows the percentage of correct conceptions held by the PT in each GAT items.

Table 1: Percentage of Students with Correct Conceptions in Genetics

S/N	TEST ITEMS	% of CORRECT CONCEPTIONS
1.	Genes are the sole determinants of traits	10.3
2.	Only genetically modified food crops have genes etc.	37.8
3.	If a couple has a "one-in-four" risk of having a child with a disease, and their firstborn has the disease, the next three children will have a reduced risk.	32.4
4.	Only certain people have "disease genes"	14.2
5.	All genetic tests are equally reliable and precise	12.3
6.	Once a mutation is discovered, it can be "fixed"	37.3
7.	All mutations are harmful	53.2
8.	The limiting factor to getting genetic information is the speed and/or cost of genome sequencing	51.1
9.	Dominant traits are the most common traits in a population	57.0
1(	Single genes code for most traits	19.2
1:	Sex-linked traits are only expressed in males	45.5
1:	Traits from parents simply blend together to create offspring,	58.3
1:	Genetic information is different in different cell types	63.8
1⁴	mix up of terms like gene and chromosome	35.1
1!	Mix up of terms like allele and DNA	37.5
1(	Mix up terms like gene, chromosome, allele and DNA	16.6
1:	Wrong understanding of the basic terms	9.0
1!	Attributing wrong functions to DNA	32.8
1!	Wrong concept of heredity	37.4
2(	Mistook genetic information for genetics	24.0

It was observed in Table 1 that only in 4 test items (items7,8.12 and 13) did more than 50 percent of Preservice Teachers have correct conception of genetics at pretest. In seven of the items (items 2, 3, 6, 11, 14,15,18 and 19), the percentage of students with correct conception of genetics ranged between 30 to 45 percent. The table also showed that in 5 items, pre-services student teachers had correct conception of genetics which was less than 19 percent.

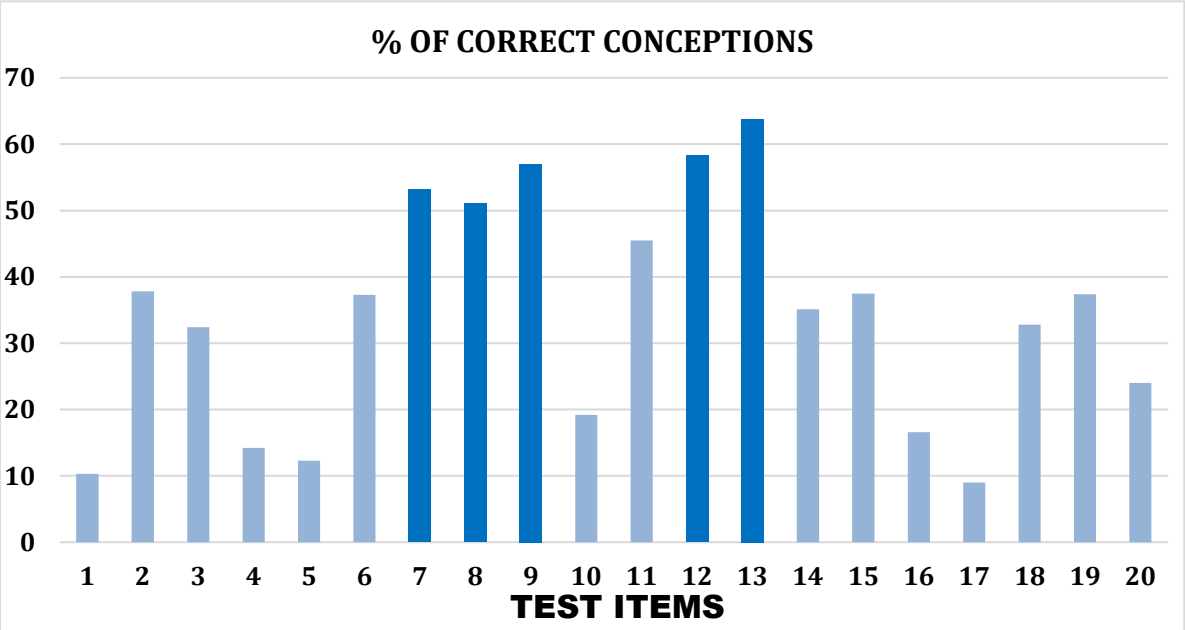

Figure 2 shows the pictorial distribution of the correct conceptions and misconceptions held by the PT.

Null Hypothesis One: There is no significant difference in the mean achievement scores of Preservice Teachers taught Genetics using Flipped Classroom, Refutational and Expository Texts Strategies.

Table 2: Summary of Descriptive Statistics of Students' Post Mean Achievement Scores

Groups	N	Pretest		Posttest		Mean Gain
		Mean (x)	SD	Mean	SD	
A FCS	54	9.74	1.67	11.82	4.58	2.08
B RTS	48	9.84	2.18	12.84	3.02	3.00
S ETS	46	5.52	2.02	6.74	2.04	1.22

Results from Table 2 shows that students taught Genetics concepts using FCS had a mean score of 9.74 and a standard deviation of 1.67 in the pretest and a mean score of 11.82 and a standard deviation of 4.58 in the posttest and pretest-posttest mean gain of 2.08. While the students taught with the RTS obtained a mean score of 9.84, a standard deviation of 2.18 at pretest while at posttest, the PT obtained 12.84, 3.02 and 3 as mean, standard deviation and mean gain respectively. The group taught with ETS obtained 5.52 and 2.02 Mean and Standard Deviation at pretest respectively and 6.74, 2.04 and 1.22 mean, standard deviation and mean gains at posttest. The results revealed that the group that was taught with the RTS treatment had highest mean score gained, while those who used the FCT had 3.00 mean gain and the group taught with ETS had the lowest mean gain of 1.22.

To test for the significant difference between the three groups, analysis of variance ANOVA was employed (since there was no significant difference in the group's mean achievement score at pretest). The result is as presented on the Table 3.

Null Hypothesis 2: There is no significant difference in the mean achievement scores of Preservice Teachers taught Genetics using Flipped Classroom, Refutational and Expository Texts Strategies.

Table 3: Scores on Genetics One-Way Analysis of Variance (ANOVA) of Posttests Students' Achievement

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1225.754	2	612.5	115.431	.004
Within Groups	770.922	142	5.430		
Total	1996.676	146			

Table 3 shows the ANOVA analysis of posttest students' achievement scores taught the concept of Genetics using FCS, RTS and ETS. The result indicates that F=.115, p=.004 is significant at 0.05 alpha level. Therefore, the null hypothesis of no significant difference in mean posttest achievement scores of PT taught the concept of Genetic using FCS, RTS and ETS is rejected. To further determine where the significance lies, a Scheffe's post-hoc analysis was carried out and the results are presented in Table 4.

Table 4: Scheffe's Post-Hoc Test on Mean Scores for Preservice Teachers Achievement Score of the C0ncept of Genetics by Treatment

Groups	Groups	Mean Difference (I-J)	Std. Error	Sig.
Group A and B	Group A (RTS)	-3.166*	.338	.000
	Group C (ETS)	5.276*	.532	.000
Control Group C (ETS)	Group A (RTS)	-7.363*	.572	.000

***The mean difference is significant at 0.05 level**

Results from Table 4 show that at 0.05 level of significance, there were significant differences in the mean achievement scores in the three groups. There was significant difference of 0.000 between Groups A and B, there was also a significant difference of 0.000 between Group A and Group C and a significant difference of 0.000 between Group B and Group C in favour of Groups A and B. It therefore means that, the treatment had significant effects on Preservice Teachers achievement scores in the concept of Genetics. The null hypothesis was therefore rejected.

Null Hypothesis Two: There is no significant the mean achievement scores of male and female Preservice Teachers taught the concept of Genetics using the Flipped classroom, Refutational Text and Expository Text strategies.

Table 5: Summary of Mean and Standard Deviation of Male and Female Student's after Treatment.

Groups	Gender	N	Mean	Std. Deviation
A (FCS)	Male	30	13.10	1.910
	Female	13	4.11	1.761
	Total	43	12.32	1.873
B (RTS)	Male	38	9.43	2.121
	Female	20	8.87	2.431
	Total	58	9.43	2.440
C (ETS)	Male	20	2.51	1.938
	Female	27	2.41	1.131
	Total	47	2.81	1.111

***Significant at P≤0.05**

Results in Table 5, shows differences in the mean scores for male and female students' achievement in the three groups in test on Genetics. The means scores for group A males and females were 13.10 and 4.11 respectively, 9.43 and 8.87 for males and females respectively in group B and 2.51 and 2.41 for the males and females in the group C respectively. ANCOVA was employed to determine the significant difference and result is presented in Table 6.

Null Hypothesis Two: There is no significant the mean achievement scores of male and female Preservice Teachers taught the concept of Genetics using the Flipped classroom, Refutational Text and Expository Text strategies.

Table 6: ANCOVA Results for Male and Female Students Achievement After Treatment.

Groups		Type III Sum of Squares	df	Mean Square	F	Sig.
Group A	Corrected Model	11.721[a]	2	5.345	1.561	.316
	Intercept	1006.342	1	1122.032	327.515	.000
	Achievement Pretest	8.414	1	6.432	2.130	.123
	Sex	4.422	1	3.491	1.342	.423
	Error	141.765	40	3.542		
	Total	7643.000	43			
	Corrected Total	162.809	42			
Group B	Corrected Model	43.721[b]	2	23.765	3.762	.010
	Intercept	543.650	1	342.781	112.953	.000
	Achievement at Pretest	40.620	1	60.276	9.216	.007
	Sex	7.097	1	7.123	1.242	.342

	Error	300.199	57	6.432		
	Total	4945.000	58			
	Corrected Total	350,360	59			
Group C	Corrected Model	2.361[c]	2	1.230	.352	.735
	Intercept	74.432	1	67.421	16.361	.000
	Achievement at Pretest	1.754	1	1.343	.282	.473
	Sex	1.866	1	.645	1.154	.363
	Error	76.345	45	3.330		
	Total	332.001	47			
	Corrected Total	89.455	46			

The ANCOVA results displayed on Table 6, show that, there was no significant difference in the mean achievement scores between male and females in group one {F (df;1, 40) =1.1342}, not significant at 0.423, group two {F (df;1,57) = 1.242} not significant at 0.342 and group C {F (df;1,45) =1.154} not significant at 0.363 after teaching. Hence, there was no significant difference in the achievement scores between male and female students' and the treatment they were exposed to. Conclusively, the hypothesis of no significant difference in the mean achievement scores of male and female PT taught the concept of Genetics using FCS, RTS and ETS was retained.

Discussion of Findings

Percentages of Preservice Teachers have Correct Conceptions of the Concept of Genetics at Pretest

The results of this study showed that majority of the students had misconceptions in all the test items of the concept of Genetics. Results showed that only in four test items that 25.51 percent of the students had correct conceptions of the concept of Genetics. Invariably over 75 percent of PT had misconceptions in the concept of Genetics. These findings are consistent with those of many researchers who showed that students hold numerous misconceptions about the concept, and they often lack a deeper understanding of Genetics (Kinnear 1983; Stewart 1982). The misconceptions held by these PT are glaring in the "mixup of terms such as genes, chromosomes and DNA as seen in texts items 9 and 16 of Table 1. Other notable areas of misconceptions are the roles that genes play in the concept of genetics as seen in texts items 1, 12, 14 and 20 where students had less that 20 percent correct conception. Aldahmash and Alshaya 2012; Lewis and Wood-Robinson 1998; Saka et al. 2006), also opined that common problems found were confusion of basic terms (like gene, chromosome, allele or meiosis and mitosis) and shallow understanding of their concepts as well as misconceptions about gene expression (how DNA influences cell functions). The findings also corroborates those of (Haskel-Ittah and Yarden 2018; Kiliç and Sağlam 2014; Vlčková, Kubiatko, and Usak 2016), who noted that findings suggest that this situation still has not changed.

Difference in the Mean Achievement Scores of Preservice Teachers Taught Genetics using Flipped Classroom, Refutational and Expository Texts Strategies

The null hypothesis one was rejected because a significant difference was observed in the PT achievement scores in the concept of Genetics taught using FCS, RTS over those taught with the ETS. This finding suggested that the PT in groups A and B performed better and as they had to align with scientific views. In comparing the achievement scores between groups, A and B, Group B PT who were taught with RTS performed significantly better in their achievement score more than the Group B PT who were taught with FCS in the concept of Genetics. Therefore, the use of RTS was more effective in clearing misconceptions and improving conception in the concept of Genetics. This result supports the findings from the researches carried out by Guzzetti et al, (1997), who noted that RTS have the capability to improve conceptual understanding and achievement probably because of their ability to create cognitive conflict in the readers. Diakidoy *et al*, (2003), posited that students' who read RTs performed better than students who read Non-Refutational Texts. As hypothesized, the findings show the superiority of the Refutation Text structure in learning new scientific concepts. This outcome is in line with most previous studies that have investigated offline products of learning from Refutation Text with students of different grade levels (Diakidoy *et al*., 2003; Hynd, McWhorter, Phares, & Suttles, 2004; Mason et al., 2008). The PT who were taught with the FCS also performed better in the GAT scores as the strategy was able to improve the correct conception of the concept of Genetics and the PT achievement scores. Little wonder why the study by (Strayer 2008), noted that students in a Flipped Classroom environment preferred the method and displayed a higher level of innovation (being able to solve problems in creative and unique ways) and cooperation (familiarity with working with others to solve problems and discuss ideas), than students in a traditional classroom setting. His results also indicated that students in a Flipped Classroom experienced a lower level of task orientation than students in a traditional classroom (Strayer, 2008). In a study at Virginia State University, an introductory course on psychology consisting primarily of African American students found that students in a flipped classroom environment scored 8.6% better in the class on average over the traditionally taught course (Talley 2013).

The results on the Null hypothesis two established that there was no significant difference in the achievement scores of male and female students who were taught genetics using FCS, RTs and ETS. Therefore, the difference in sex did not play a role on PT achievement of the concept of Genetics. Though sex difference can be one of the key factors affecting science achievement, however, the data from this current study showed that sex had no effect on the PT achievement scores in the concept of Genetics. This findings also supports those of (Nelson-Ebimie, Adolphus, Omeodu & Naade 2023) shows that gender had no effect or difference in terms of misconceptions held by biology students in Genetics, which implies that gender does not play much role in students' misconception but rather the existence of these misconceptions is basically related to their cognitive ability and understanding of the concept. This assertion supports the research of (Hamdan, Osman and BouJaoude 2016) on identifying

misconceptions and difficulties to design a learning progression in Genetics, the study opined that students' misconceptions in Genetics was highly influenced by their grade level as well as their inadequate understanding of major Genetic concepts, which was highlighted by a low level of progression in their conceptual understanding of major Genetic concepts that cut across all grade level. This shows that gender has nothing to do with the PT academic achievement but rather their performance was because of their cognitive ability to understand and change their prior conception in Genetics.

Conclusion

Misconceptions of the concept of Genetics did exist significantly among PT before treatment. It can therefore be concluded that instructions on FCS and RTS are effective in restructuring misconceptions compared to the ETS. The students taught using FCS and RTS had significantly higher achievement scores in Genetics when compared to students' taught with the ETS. This finding suggested that the students in Groups A and B were taught with FCS and RTS were able to reconstruct the misconceptions they had to agree with scientific views and performed better in the achievements in the test on the concept of Genetics. It was also established that there was no difference in the achievements of male and female PT who were taught the concept of genetics with FCS and RTS. Therefore, it can be inferred that the sex of students does not influence their achievement scores in the concept of Genetics.

Recommendations

The following recommendations were proffered;

1. Education Biology Teachers should spend sufficient time to explore the likely misconceptions that students may have prior to teaching any new concepts in biology and other science subjects generally. They can consider the students' existing conceptions or misconceptions in biology/science in order to select and organize students' intended learning outcomes in biology/science.

2. Preservice Teacher education programs should therefore equip Preservice Teachers with appropriate teaching strategies to effectively convey genetics concepts, including utilizing engaging activities, visual aids, and real-world applications to enhance student learning, by thoroughly understanding common misconceptions related to genetics and probably proactively address them in their classrooms, while promoting accurate scientific knowledge.

3. The power of Refutational Text as a conceptual change agent must be recognized by publishers, editors, and authors, so that the refutation text structure will appear more frequently in children's science information books.

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