EFFECT OF TWO INSTRUCTIONAL (PROJECT AND INQUIRY) STRATEGIES ON STUDENTS' ACHIEVEMENT IN SELECTED BIOLOGICAL ABSTRACT CONCEPTS

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Abstract
The purpose of this study was to ascertain how two instructional strategies—project and inquiry—affect students' mastery of particular abstract biological concepts. The study used a quasi-experimental pretest-posttest control group design. 120 SS II Biology students were chosen at random from six coeducational schools located in two Local Government Areas (LGAs) in the state of Kwara. Treatment groups were assigned to participants at random. The Biology Student Achievement Test (r=0.88) and the Teachers' Instructional Guide on Project and Inquiry Strategies were the instruments utilised. Two theories were developed and put to the test at the significance level of 0.05. The intervention had a significant main effect on students' achievement on a subset of selected biological abstract concepts ($F(2, 107) = 12.061$; $p<0.05$, partial $\eta 2 = 0.184$), according to an analysis of covariance conducted on the gathered data. The students in the Conventional Strategy (CS) control group have the lowest adjusted mean achievement values ($\bar{x} = 17.20$), whereas the students in the Project Strategy (PS) treatment group 1 have the highest adjusted mean achievement values ($\bar{x} = 23.21$). It is indicated that PS > IS > CS is the order. The mean growth in accomplishment values for male students was higher at 21.94, compared to 17.13 for female students. Project and inquiry methodologies should be implemented in order to raise students' accomplishment in biology's abstract concepts, according to the findings.
Keywords: Project, Inquiry, Achievement, Biology, Gender and Abstract Concept
Diszcipline: pedagogy

Absztrakt
KÉT OKTATÁSI (A PROJEKTALAPÚ ÉS A KUTATÁSALAPÚ) STRATÉGIA HATÁSA A DIÁKOK TELJESÍTMÉNYÉRE A KIVÁLASZTOTT BIOLÓGIAI ABSZTRAKT FOGALMAK ESETÉBEN

A tanulmány célja annak feltárása, hogy két oktatási stratégia – a projektalapú és a kutatásalapú tanítás – miként befolyásolja a diákok teljesítményét bizonyos absztrakt biológiai fogalmak elsajátításában. A kutatás kvázi-kísérleti, előteszt–utóteszt kontrollcsoportos elrendezést alkalmazott. A vizsgálat során 120 középiskolás (SS II) biológia szakos diákot választottak ki véletlenszerűen hat, két helyi önkormányzati területen (LGA) található koedukált iskolából Kwara államban. A résztvevőket véletlenszerűen osztották be a csoportokba. Az alkalmazott eszközök közé tartozott a Biológiai Diák Teljesítményteszt (r=0,88) és a Tanári Útmutató a Projekt és Kutatásalapú Stratégiákhoz. Két kutatási hipotézist állítottak fel, amelyeket 0,05-ös szignifikanciaszinten teszteltek. Az összegyűjtött adatokon elvégzett kovarianciaelemzés (ANCOVA) eredményei szerint az oktatási beavatkozás szignifikáns főhatást gyakorolt a diákok teljesítményére az adott absztrakt biológiai fogalmak körében ($F(2, 107) = 12,061$; $p<0,05$, parciális $\eta^2 = 0,184$). Az átlagosan legmagasabb teljesítményértékeket a projektalapú stratégia (PS) szerinti oktatásban részt vevő diákok érték el ($\bar{x} = 23,21$), míg a hagyományos oktatási módszert (CS) alkalmazó kontrollcsoport diákjai mutatták a legalacsonyabb teljesítményt ($\bar{x} = 17,20$). Az eredmények szerint a stratégiák hatékonysága a következő sorrendet mutatta: PS > IS > CS.A nemek közötti különbségeket tekintve a fiúk átlagos teljesítménynövekedése ($\bar{x} = 21,94$) magasabb volt, mint a lányoké ($\bar{x} = 17,13$). A kutatás eredményei alapján javasolt a projektalapú és a kutatásalapú tanítási módszerek szélesebb körű alkalmazása a biológia absztrakt fogalmainak hatékonyabb elsajátítása érdekében.

Kulcsszavak: projektmódszer, kutatásalapú tanulás, teljesítmény, biológia, nemi különbségek, absztrakt fogalmak
Diszciplína: neveléstudomány

Introduction

The significance of Science is appeared essentially in all field of instruction such as farming, medication, drug store. Adewumi (2014), Chukwuemeka (2011) declared that science may be a exceptionally imperative science subject that offer a essential necessity for advance learning of a number of sciences related proficient courses like pharmaceutical, farming, drug store, nursing among others.

Biology aids in the development of crop plant types with high yields and disease resistance. Biology aids in the reduction of human suffering and the treatment of inherited disorders such as Down syndrome and haemophilia. According to Muhammad-Jamiu and Muraina (2023). A solid theoretical and practical grasp of biology is necessary for the management of our natural resources, the public's access to high-quality healthcare, an adequate supply of food, and a healthy living environment (Chukwuemeka, 2011). Additionally, biologists make vital and dynamic contributions to a variety of fields, including factual sciences (such as biology, physics, and other disciplines), crime prevention, environmental pollution control, illnesses prevention, population control, and industries.

The purpose of the biology curriculum is to teach students the fundamentals of the subject, to increase their awareness of the world around them, and to help them develop transferable skills like communication, problem-solving, critical thinking, and objective reasoning in order to prepare them for the workforce and for being self-sufficient in the global economy (Khan & Muraina, 2023). According to the National Policy of Education, the biology curriculum's instructional goals are as follows (Muhammad-Jamiu & Muraina, 2023). Among them are. to be able to apply scientific information to daily life; to shed light on issues related to sex reproduction, growth, pollution, health, and other areas for the benefit of society; and to comprehend certain fundamental biological abstract required for effective living in a scientific and technology environment.

Despite the fact that the biology curriculum includes trustworthy objectives for the subject's teaching and learning, it seems that some of the topics are causing students' troubles. Secondary school pupils find it difficult to understand ideas related to genes, cells, chromosomes, genetics, and hormones, according to Josephine and Muraina (2023). Notwithstanding students' subpar performance in several biology concepts, the data from the West Africa Examinations Council (WAEC) Chief Examiner's Reports (2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017 & 2018) are readily available. For example, the WAEC Chief Examiner's findings from 2012 and 2013 revealed that a large number of examinees were unable to define genes, genotypes, gene mutations, and other terms. Additionally, the findings from the WAEC Chief Examiner in 2010 and 2017 and 2018 showed that candidates could not list transmittable characteristics; inability to draw genetics crosses properly and those candidates who attempted the genetic diagram perform it wrongly.

The majority of biology teachers' incorrect teaching strategies have been blamed for the low performance of their pupils in the subject (Adewumi and Adeoye, 2023; Babayemi, 2014; Awolere, 2015). Thus, scholars like Awolere (2015),

Babayemi (2014), and Ibitoye (2021) recommended using active learning techniques. Awolere (2015), Oloyede (2014), Adewumi (2014), Inquiry strategy by Muraina et al. (2021), and Puzzled Based Critical Thinking Motivation techniques by Ogundiwin (2013) are a few of the techniques that have been studied in earlier studies. Despite using various measures, a significant number of students continued to do poorly on the senior secondary school certificate exams.

The Project Strategy is one of the active teaching tactics that has drawn the attention of scholars. A deliberate process of problem diagnosis, experiment critique, alternative differentiation, planning, hypothesis research, information search, and coherent argument generation is known as project strategy (Aksela & Haatainen, 2019; Anette & Maija, 2022). Project strategies appear to include the elements that encourage educators and students to work together, with the primary goal being for students to recognise and comprehend each step that is necessary to reach a logical conclusion (Anette & Maija, 2022). According to Khan and Muraina (2023) and Olatoye & Project instruction, as defined by Adekoya (2010), is a methodical teaching technique that organises an extended inquiry process around difficult, real-world issues and carefully crafted assignments and deliverables to engage students in the acquisition of knowledge and skills.

Conversely, an inquiry-based approach is a teacher-centered and student-centered method of learning that involves having students research problems from the real world that they select from a wide range of themes. The inquiry style of teaching involves the student conducting a thorough search with minimal assistance from the teacher in order to find and generate solutions to a recognised problem (Muraina et al., 2023). Without making clear the links and differences, terms like "inquiry-based teaching" and "inquiry-based strategy" are frequently used interchangeably with "inquiry" (Josephine & Muraina, 2023; Muraina & Oladele, 2023). An investigation, search, problem definition, hypothesis formulation, data collection and interpretation, and conclusion formation are all components of an inquiry strategy. The teacher must adopt learner-centered teaching techniques by providing assignments and class activities' that will challenge the learner imagination.

While concentrating on the pupils' achievement, gender was generally discussed sufficient. Due to its correlation with academic success, gender has continued to be a significant topic in the field of education. The term "gender" describes how people are categorised based on their sex and the roles they play. The majority of research indicates that girls typically outperform boys in the classroom (Adewumi, 2014; Muraina et al., 2023). According to Yuniskurin, Noviyanti, Mukti, Mahana, and Zubidah's (2019), women outperform men in spelling as well as on literacy, writing, and general knowledge assessments in the classroom. However, studies by Okafor (2021) and Ekon and Eni (2015) demonstrated that not only were women underrepresented, but also levels of achievement in the fields of sciences and technology where low compared to the males.

Numerous research have looked into various teaching methods for biology training. For example, Muraina (2016) studied cooperative and inquiry-based methods; Muraina and Oladele (2023) studied scientific inquiry methods; Yan (2019) studied genetics exordium methods. But little work has been done utilising these two approaches to teach and learn biology's abstract notions. This research project aims to close this gap. The purpose of this research is to determine how two teaching strategies—project and inquiry—affect students' academic performance in abstract biological concepts. It also looked at how gender affected how well pupils understood biology's biological abstract concepts.

Statement of the Problem

The poor biology performance of pupils on the Senior School Certificate Examination each year raises the possibility that teachers' methods of instruction were insufficient. These tactics clearly did not teach the great level of independence that students need to locate resources and speak to them. It was shown that these shortcomings contributed to the low enrollment of students who were admitted to universities to study courses linked to biological science. Using instructional methodologies, several research studies have been conducted to address the low academic performance of the students in the field of biology. Nonetheless, a study must be conducted in which pupils will receive the teaching resources required to participate in scientific activities that would dispel misconceptions in biology and automatically lead to improvement of the students' performance in the subject.

Therefore, the purpose of this research is to ascertain the degree to which project-based learning and inquiry-based teaching methodologies might aid students in comprehending abstract biological concepts, thereby elevating their academic performance in the subject. It also looked at how gender affected how well pupils understood biology's biological abstract concepts.

Purpose of the Study

This study looked at how students' progress in biological abstract concepts in Kwara State was impacted by the combination of two teaching strategies—project and inquiry—and mental capacity.

1. Ascertain the variation in the average value of students in project and inquiry tactics about biological abstract concepts and contrast it with their counterparts who were taught using a conventional approach.

2. Determine the impact of gender and the type of instruction (project and inquiry) on students' mastery of biological abstract concepts.

Research Questions

Two research questions were formulated to guide the study:

1. How do the values of students in project and inquiry procedures in biology's biological abstract concepts differ from those of their counterparts who were taught using a traditional strategy?

2. Does the achievement value of students in project and inquiry tactics in abstract concepts of biology differ significantly by gender from that of their counterparts taught using the traditional strategy?

Research Hypotheses

Two null hypotheses were developed to direct the investigation and assessed at the 0.05 level of significance:

H01: The achievement value of students in project and inquiry tactics in biological abstract concepts of biology does not significantly differ from that of their counterparts taught using the conventional strategy.

H02: Students' achievement in biological abstract concepts, when taught using the traditional technique, is not significantly impacted by treatment (project and inquiry) and gender.

Methodology

The pretest-posttest control group quasi-experimental research design was used in this study. The target market was senior school students enrolled in SSS II Biology courses, while the population was all senior school students in Oke-ero and Irepodun Local Government Areas. By means of voting, a sample of 120 students was chosen at random. Data were collected using six instruments, which are The accomplishment test for biological abstract concepts is divided into two

components, A and B. While Section B comprises a 30-item accomplishment test with reliability coefficient of 0.86, Section A requests personal information about the pupils. Sixty of the original questions focused on biological abstract concepts. To determine the validity of the questionnaire, four high school biology teachers and one experience evaluator were given the questions.

These fifty questions were classified as having a discriminating power between 4 and 7, with questions below 4 being too simple and those over 7 being too difficult for the pupils. Project-specific teaching manuals for instructors, traditional and inquiry-based technique guides, and performance assessment forms for teachers to use while undergoing training. Five seasoned biology tutors from certain secondary schools were given a draft of the Teacher's Guide on (project, inquiry, and traditional) techniques along with an assessment form. This was done to guarantee that an evaluation sheet, together with the identical look, substance, and (project, inquiry, and traditional) procedures, would be given to five seasoned biology educators in a selected group of secondary schools.

The researchers gave out the pre-test instruments, and the students' results were noted. Following that, the researchers used project and inquiry methodologies to teach the abstract concepts to experimental groups 1 and 2, whereas the control group received instruction using a traditional method.

The biological abstract concepts that were chosen for this investigation have to do with genetics, molecular biology, and evolution. Six weeks were spent on the treatment. Descriptive statistics, analysis of covariance, and the Scheffe Post hoc test were used to analyse the data at the 0.05 level of significance.

Results

Research Question one: What is the difference between students in project and inquiry tactics for biological abstract concepts and those who were taught using standard strategies in terms of achievement mean values?

Table 1: Characteristic Statistics of Treatment-Associated Achievement. Source: Authors.

Parameter	Achievement Values		
	Project Strategy	**Inquiry Strategy**	**Conventional Strategy**
No of cases	34	46	40
Pre-test mean	13.09	9.63	9.98
Pre-test SD	3.11	2.67	3.08
Post-test mean	23.21	17.80	17.20
Post-test SD	3.01	5.01	5.81
Mean Gain	+9.12	+8.17	+7.22

The descriptive statistics of the students' achievement values are displayed in Table 1. The project approach had a gain value of 9.12, while the inquiry strategy had a gain value of 8.17 compared to the conventional strategy's 7.22. Project strategy outperformed inquiry strategy in terms of gain, whereas inquiry strategy outperformed conventional strategy in terms of gain.

Research Question two: Does the achievement mean value of students in project and inquiry tactics in abstract concepts of biology differ significantly by gender from that of their counterparts taught using the standard strategy?

Table 2: Characteristic Statistics of Gender-Related Achievement. Source: Authors.

Parameter	Achievement Values	
	Male	Female
No of cases	50	70
Pre test mean	11.20	10.39
Post test mean	21.94	17.13
Post test SD	4.13	5.42
Pre test SD	3.52	3.07
Mean Gain	+10.74	+6.74

The descriptive statistics of the students' accomplishment values together with their gender are shown in Table 2. Male students' gain achievement values (10.74) improved more than those of female students (6.74).

H_{01}: The achievement mean value of students in project and inquiry tactics in biological abstract concepts of biology does not significantly differ from that of their counterparts taught using the traditional approach.

Table 3: ANCOVA of students' post-test performance results by gender, mental capacity, and therapy. Source: Authors.

Source	SS	df	MS	F	Sig.	Eta Squared
Corrected Model	1749.922	12	145.827	87.27	.000	.495
PREACH	31.183	1	31.183	1.866	.175	.017
Main Effect: Treatment Group	403.061	2	201.530	12.061	.000*	.184
Mental Ability	75.354	1	75.354	4.510	.036*	.040
Gender	26.390	1	26.390	1.579	.212	.015
2-ways Interactions Treatment x Mental Ability	100.449	2	50.225	3.006	.050*	.053
Treatment x Gender	49.557	2	24.778	1.483	.232	.027
Mental Ability x Gender	60.473	1	60.473	3.635	.059	.033
3-way Interaction Treatment x Mental Ability x Gender	192.386	2	96.193	5.757	.004*	.097
Error	1787.945	107	16.710			
Total	47468.000	120				
Corrected Total	3537.867	119				

*Significant at $p<0.05$

Table 3 demonstrates that the students' academic achievement was significantly impacted by the treatment (F2, 107) = 12.061 P <.05, $\eta 2 = 0.184$). 18.49% effect size was a fair value. Consequently, the null hypothesis is disproved. Based on these results, hypothesis 1 was rejected because there was a significant difference in the achievement values of the subjects who received treatment.

Table 4: Post-hoc Test Scheffe Examination of the Post-Test Achievement Value by Treatment Group. Source: Authors.

Treatment	N	Mean	Project strategy	Inquiry strategy	Conventional strategy
Project strategy	34	23.21		*	*
Inquiry strategy	46	17.81	*		*
Conventional strategy	40	17.26	*	*	

Pairs of groups significantly different at $p < 0.05$

Furthermore, the Scheffe post-hoc test was used to identify the cause of the significant difference seen in Table 4. Table 4 showed that, in terms of accomplishment values, group 1 (project approach) differed considerably from inquiry and conventional procedures. In terms of accomplishment values, the inquiry technique differed significantly from the project and traditional approaches. These imply that neither conventional strategy nor inquiry strategy outperformed project strategy when it comes to the increasing impact of instructional method (treatment) on the completion of biological abstract concepts.

H_{02}: When it comes to students' mastery of biological abstract concepts, there is no discernible connection between gender and treatment (project and inquiry) and their counterparts taught using the traditional method.

Table 3 showed that the pupils' academic achievement was not significantly impacted by their gender. $P<0.05$, partial eta square ($\eta 2$) = 0.015, and (F (1,107)) = 1.579. It was a fair effect size of 1.5%. Consequently, hypothesis two was not disproved.

Discussion of Finding

The study looked at how well students understood biological abstract concepts when they were taught using two different instructional strategies: projects and inquiries. Based on biological abstract concepts, the questions were designed to assess the academic achievement of biology students in the control and experimental groups at the pre- and post-tests. According to Table 1's results, the experimental group's post-test value was higher than the control group's, and Table 2's results showed that the value of the male respondents in the experimental group was greater than that of the female respondents.

Table 3 presents findings, which indicate a noteworthy interaction impact of therapy on students' academic progress in biological abstract concepts related to biology. The results demonstrate that, in addition to the traditional technique, both the project and inquiry strategies improved students' achievement. This finding implies that learners in the project strategy were more likely to share their accomplishments than those in the inquiry method and traditional tactics. These could be attributed to the project's methodical and structured structure as well as the inquiry techniques created and used during the research, which gave students the freedom to participate in a variety of learning activities that helped them discover and expand their own understanding of the abstract concepts on their own.

Additionally, by participating in activities with the experimental group, the students were able to clear up misconceptions and get a deeper comprehension of biology's biological abstract concepts. This outcome is consistent with the work of Olatoye and Adekoya (2010), who worked on three different teaching methodologies projects: lectures,

demonstrations, and projects. It was discovered that the kids that were in project strategies saw the most gains in their accomplishment ratings. Muraina (2016), who confirmed that the project method is more effective than other strategies since it allows the students to study independently, also supports these findings. The results corroborate the findings of the Buck Institute for Education (2002), which proposed that the project model promoted student collaboration.

Akinwumi's (2009) investigation revealed that the inquiry strategy outperformed the traditional technique in terms of effectiveness. The results also demonstrated that pupils using inquiry technique understood biological abstract concepts considerably better than those using traditional strategy. This research validates the findings of Nwagbo (2001) and Muraina et al. (2021), who discovered that the guided inquiry approach to biology instruction improved student achievement more than the traditional approach. When compared to the other treatment groups, the conventional strategy performed poorly on the post-test achievement value. This suggests that the group's exposure to the teacher-centered conventional strategy, which only permits students to listen passively, may have had some bearing on the results.

Analysis conducted by Akinwumi (2009) revealed that the inquiry strategy outperformed the traditional strategy. The results also demonstrated that students who were taught inquiry technique had a considerably greater comprehension of biological abstract concepts than those who were taught conventional strategy. The findings of Nwagbo (2001) and Muraina et al. (2021) that the guided inquiry approach to teaching biology improved achievement more than the traditional approach are corroborated by the results of this research work. The group's exposure to the teacher-centered conventional strategy of merely allowing students to listen passively may have contributed to the conventional strategy's poor performance in the post-test achievement value when compared to the other treatment groups.

Conclusion

The results of this study have demonstrated that inquiry-based learning and projects are more beneficial than traditional or conventional teaching methods for raising students' academic progress in biological abstract concepts. The rationale behind this was that by allowing students to actively engage in learning activities and fostering an environment that fosters productive interaction, the two instructional methodologies improved the development of critical thinking in the students. It is interesting that when these tactics were used in the classroom, students demonstrated a better level of dedication and involvement to addressing abstract concepts and related problems in biology.

Recommendations

In light of the findings and the conversation, the following suggestions are consequently made.

1. As useful and practical teaching methods for understanding biological abstract concepts, project-based and inquiry-based learning approaches ought to be implemented.
2. Teachers of biology should provide exercises that allow students to actively engage in the process of teaching and learning.
3. Rather than sticking to a single mode of instruction, in-service biology teachers should experiment and employ instructional strategies that are compatible with students' cognitive abilities.

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