Can Cognitive Apprenticeship tweak the Attitude and Entrepreneurial Skill Development of Pre-Service Integrated Science Teachers of different ability divides?

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Abstract

There are increasing clarion calls to give pre-service Science teachers an Education that will help them have a more positive attitude to science, and better entrepreneurial skill development; consequently, make them more resourceful to their students. This study therefore, investigated cognitive apprenticeship's effects on pre-service Integrated Science teachers' (PISTs) attitude and entrepreneurial skill development in anaerobic respiration. A 3 x 3 factorial non-randomized pre-test post-test quasi-experimental research design was adopted for this study. 115 PISTs from three Colleges of Education within Lagos and Ogun States, South-West, Nigeria participated in this study. Groups 1 and 2 taught with inside-school cognitive apprenticeship (ISCA) and outside-school apprenticeship (OSCA) respectively; and group 3 was taught with lecture method. Two research instruments used in this study were: Integrated Science Students' Attitude Questionnaire (ISAQ) and Integrated Science Students' Entrepreneurial Skill Practical Test (ISEPT). The reliability of the research instruments were established: Cronbach Alpha value of ISAQ was .813 and Richard Kuderson reliability index of ISEPT was .824. Higher attitude and entrepreneurial skill development means were noted among PISTs in OSCA and ISCA groups. The differences in the means were found significant for the PISTs' attitude: [$F_{(2, 94)}$= 86.936; $p < 0.05$] and entrepreneurial skill development [$F_{(2, 94)}$= 77.991; $p < 0.05$]. The Scheffe post-hoc test indicated PISTs in the ISCA did not perform significantly better than those in OSCA ($p > .05$). Also, ability group was not found to interact with the teaching strategies on the PISTs' attitude but did for entrepreneurial skill development. Based on these findings, this study suggests ISCA and OSCA as viable models for tweaking PISTs' attitude and entrepreneurial skill development in Science.

Key words: Inside-school cognitive apprenticeship, Outside-school cognitive apprenticeship, situated cognition theory, ability divides

1.0 Introduction

In Nigeria, there are high expectations from parents, guardians and the society of everyone that goes to school in order to receive formal education. These expectations include: achieving literacy, getting equipped with life skills and thereafter having automatic ticket to "becoming somebody in life". A popular interpretation of 'becoming somebody in life' is that such a fellow who has received formal education is expected to be able to take care of himself financially and consequently, be able to take care of others (at least his family members). The irony is that often times, these expectations gradually get shattered as white collar jobs become scarce to get and the rate of unemployment increases. National Bureau of Statistics (NBS, 2017) indicates that the unemployment rate in Nigeria increased to 18.80 % in the third quarter of 2017 from 16.20 % in the second quarter of 2017, where the youth unemployment and underemployed rate is 52.65%. Till date youth unemployment still chronically stares at us in Nigeria; and has risen to 22.8% in the first quarter of 2023 (NBS, 2023).

Furthermore, the Nigerian population is estimated to be one hundred and eighty-two million people based on the population of 140 million recorded in the last census a decade ago, using an annual growth rate of 3.5 percent weighed against other variables (National Population Commission, 2017). The Director-General of National Population Commission, NPC, Bello (2017) decries that having more than half the Nigerian people less than 30 years of age, puts a severe strain on a nation with its dwindling economy and declining revenue. This implies that the youths occupy a high proportion of the numerical strength of Nigeria and whatever affects the youths, needs to be given attention. Youths are naturally energetic but like the popular adage says that 'an idle hand is the devil's workshop', it is painful to note that formally educated Nigerian citizens make up a significant percentage of those that are crime suspects. Figures supplied by the Nigerian Prisons Service to the National Bureau of Statistics (2009) indicated that in 2006, the number of people aged 16-35years, in convict prisons was 49.8% and in 2008, the number almost doubled, increasing astronomically to 92.5% within a period of 3 years. Presently, cyber crime, kidnapping, violence, and terrorism make major criminal enterprise for the unemployed youths in the country (Longe, 2016; Alda *et al*., 2022). Unemployment is identified as a contributory factor to the increase in crime rate in Nigeria. Adekoya and Abdul-Razak (2016) found out that poverty has a significant positive relationship with crime. Kilishi *et al*. (2014) also revealed that unemployment was found to have significant impact on total crime and armed robbery. As a way of combating unemployment, Danmole *et al.* (2017) in a survey of three hundred and ten junior secondary school three students who had just finished their Basic Education Certificate Examination (BECE), found out that parents and guardians now enrol their children and wards in craft apprenticeship in addition to formal education. Although craft apprenticeship (also referred to as traditional or primitive apprenticeship) has been in practised for many centuries; it was a platform for learning tailoring, goldsmith, masonry, carpentry, animal husbandry, weaving and many other crafts but as the western education gained ground in Nigeria, many people found craft apprenticeship old-fashioned.

In Nigeria, apprenticeship was used to communicate family profession to younger generations and, progenies from such families were distinct with peculiar skills. For instance, in Yoruba land, any family with the name "Ayan" was associated with drum production, drumming and dance; this was what they did to earn a living. Similarly, families with the name "Akin" were usually associated with warfare; and members of these families were skillful in using various war weapons and their production. There are families in Abeokuta (a city located in South-West, Nigeria) highly notable for locally made fabrics called "Adire". Similarly, the Ijaws are respected for their skillfulness in traditional orthopaedics while among the Hausa race, using horn for treatment is observed. All these and others pleasurably engage their children in apprenticeship. Jennifer *et al.* (2016) note that apprenticeship was employed in providing technical and artisan skills. They added that training professionals such as lawyers and doctors for hundreds of years also involved apprenticeship. For example; in the Middle Ages, doctors-to-be learnt medicine as apprentices, they were taught something about herbs and surgical skills by older peer (Gourevitch, 1999); up till the early 19th century when students who aspired to be physicians learned medicine by engaging in practical sessions and reading as offered by their preceptors. Apprenticeship later became a prototype for clinical training as still being practised today (Falvey, 2010). Collins *et al.* (1991) explained that apprenticeship is relevant in passing knowledge from one individual to another in order to improve efficiency and promote personal and professional growth. As a contribution to various research efforts on this discourse, this study therefore poses an inquiry on incorporation of apprenticeship into schooling as a tweak for pre-service Science teachers' attitude and entrepreneurial skill development.

1.1 Research Questions

The following questions were raised to guide this study:

1. What is the difference in the attitude and entrepreneurial skill development of Pre-service Integrated science teachers taught anaerobic respiration with inside-school cognitive apprenticeship, outside-school cognitive apprenticeship and lecture method?
2. What is the difference in the PISTs' attitude and entrepreneurial skill development in anaerobic respiration, across the high, average and low ability divides?
3. What is the interaction impact of teaching strategies and ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration?

1.2 Null Hypotheses

The following null hypotheses were tested in this study at 0.05 significance level:

H_{01}: There is no significant main impact of inside-school cognitive apprenticeship, outside-school cognitive apprenticeship, and lecture method on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration.

H_{02}: There is no significant main impact of ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration.

H_{03}: There is no significant interaction impact of teaching strategies and ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration.

2.0 Literature Review

Cognitive apprenticeship is an instructional model derived from the metaphor of the apprentice working under the master craftsperson in traditional societies (Norman & Jarvis, 2006). Cognitive apprenticeship although has its origin in traditional apprenticeship, shows variance from it, as the cognitive apprenticeship places focuses largely on guiding the learners to "think", this comes before or is part of solving an assigned task Norman and Jarvis (2006). Cognitive apprenticeship is a teaching strategy, which is an amalgamation of six teaching methods; these are: modelling, coaching, scaffolding, articulation, reflection and exploration. Stalmamijer *et al.,* (2009) posited that these six teaching methods foster autonomy of students' learning processes by encouraging students to formulate personal learning goals. These teaching methods are essential in equipping students towards the reality of the labour market because they help situate learning thereby familiarising the learners with the demands of the world-of-work and; assisting the learners to take responsibility of his learning.

In cognitive apprenticeship, the pre-service teacher systematically evolves to an expert from a novice. Cognitive apprenticeship is a pedagogic strategy at the core of situated learning. It extends situated learning to diverse settings so that students learn how to apply their skills in varied context with intrinsic motivation (Collins *et al*., 1989). Stein (1998) explained that situated learning is essentially a matter of creating meaning from the real activities of daily living. Also, Brown (1994) posited that schools are not islands, they exist in wider communities; and that situated cognition theory is a theory that posits that knowing is inseparable from doing (Brown *et al*., 1989). Stein (1998) explained that situated learning is essentially a matter of creating meaning from the real activities of daily living. Also, Brown (1994) posited that schools are not islands, they exist in wider communities; and that situated cognition theory is a theory that posits that knowing is inseparable from doing (Brown *et al*., 1989). Cognitive apprenticeship situates learning for the pre-service science teacher and creates a platform for him to make a meaningful contribution to the desired knowledge economy. In situating learning experiences in cognitive apprenticeship, this study explored two models of cognitive apprenticeship; these are: outside-school cognitive apprenticeship (OSCA) and inside-school cognitive apprenticeship (ISCA). In the outside-school model, pre-service Integrated Science teacher (PIST) went beyond the walls of the school to acquire knowledge; for instance, they went to relevant work sites, related with mavin in the workshop. On the alternative, the inside-school cognitive apprenticeship model brings cognitive apprenticeship to the students by engaging the expertise of a mavin in collaboration with the science teacher to facilitate learning within the school premise.

As the essentiality of the heart is to any living organism's functionality, so is attitude essential to the human's output in all his areas of endeavours, which is inclusive of formal education. Attitude and education are interdependently interwoven. This means that attitude may determine how well an individual goes while receiving education; and as a complement, education thereafter may influence attitudinal dispositions of an individual. Danmole *et al*. (2021) conceptualised attitude to science as a person's positive or negative response to doing science and; like or dislike doing science. There are various research works on improving students' attitude to Science. Danmole *et al.* (2021) conducted a quasi-experimental research on the potency of problem solving skill in boosting one hundred and six S.S.S. 3 students' attitude to learning genetics, which was a dreaded topic in Science. A major finding of their study was that, problem solving significantly boosted the S.S.S. 3 students' attitude to learning genetics. Also, Blazar and Kraft (2017) argued that students' attitude to Science can be predicted by teaching practices. Furthermore, based on the findings of their study, Nja *et al* (2022) argued that classroom instruction plays a significant role in helping students

have a positive attitude to science. Rebekah (2020) also found out that cognitive apprenticeship model can influence attitude of pre-service teachers in the use of instructional technology. Mustafa *et al*. 2012 advocated that attitudes of teachers towards science teaching are also of great importance in achieving the intended success level and assisting students in developing more positive attitudes towards science. Pre-service Integrated Science teachers have a significant role to play in order to assist their own students gain positive attitude towards entrepreneurial skill development.

Without mincing words, Sousa (2014) identified schools and universities as germane actors that have the responsibilities to create entrepreneurial culture and develop entrepreneurial skills; and that, school and universities have responsibilities to produce programmes, implement learning methodologies and partner with companies and other business owners to develop entrepreneurial skills. Saibu *et al*., (2022) expressed that entrepreneurship in schools is a need that should be given attention. Very importantly, cognitive apprenticeship is not a single teaching method, it amalgamates six teaching methods. These are: modelling, coaching, scaffolding, articulation, reflection and exploration. This makes it very relevant in enhancing students' attitude and entrepreneurial skill development. This buttresses the position of Sugano and Mamolo (2021) from their meta-analysis, that the use of different teaching methods can influence students' attitude to learning of Science. This is essential to take care of students' attitudinal differences in the Science class. In addition to these, Stalmeijer *et al*. (2009) that found cognitive apprenticeship model very impactful in improving students' skill during clinical training. The study was conducted in the academic year 2006–2007 among 24 medical students in the 6-year undergraduate curriculum of Maastricht Medical School, the Netherlands. Similarly, Kuo *et al.,* (2012) explored effectiveness of cognitive styles of students as a human factor in the effectiveness of cognitive apprenticeship model; the study found that cognitive apprenticeship plays significant role in the development of web-based collaborative problem solving skills.

Without doubt, just like the similitude of the society, there are ability divides among pre-service Science teachers. These pre-service Science teachers will be fed into Education industry after completion of the teacher education programme, it then becomes to assist them become better versions of themselves. Based on this, this study therefore examined cognitive apprenticeship as a tweak for pre-service Integrated Science teachers' attitude and entrepreneurial skill development.

3.0 Methodology

3.1 Design

This study explored the effects of two cognitive apprenticeship models: Inside-School Cognitive Apprenticeship (ISCA), Outside-School Cognitive Apprenticeship (OSCA) and lecture method on Pre-service Integrated Science Teachers' (PISTs') attitude and entrepreneurial skill development in anaerobic respiration. The research design adopted was a 3 x 3 factorial non-randomized pre-test and post-test, control non-equivalent quasi-experimental design. The sample was 115 Nigeria Pre-service Integrated Science Teachers from three Colleges of Education within Lagos and Ogun states, of the South-West geo-political zone of Nigeria. These three Colleges were purposively selected from five public Colleges of Education offering Integrated Science Education, the selection was premised on the following criteria: the schools were Colleges of Education offering Integrated Science Education at NCE level; the PISTs in such schools were in the second semester or almost starting second semester as at the time of this study (this was to ensure that the experiment went on almost concurrently in the selected schools).

There were three intact groups of the PISTs: 42 were in the lecture group, 38 were in ISCA group and 35 were in OSCA group. Before the commencement of the treatments, a pre-test was conducted on the PISTs' attitude and entrepreneurial skill development skill using ISAQ and ISEPT. A test was also conducted to determine the pre-achievement score of the PISTs. These scores were used for placement of the PISTs into three ability divides. PISTs with scores within 0 and 5 were grouped into low ability group, those who scored between 6 and 9 were grouped into average ability group, and PISTs with 10 and 14 were grouped into high ability group. However, the ability divides were given nominal identifiers which did not directly inform the students the essence of the scoring and placement, while taking cognizance of the PISTs' self esteem and helping them to freely solve tasks with peers without any inferiority or superiority complex.

3.2 Research Instruments

Two instruments were used to collect data from the PISTs: Integrated Science Students' Attitude Questionnaire (ISAQ) and The Integrated Science Students' Entrepreneurial Skill Practical Test (ISEPT) designed by the researchers. ISAQ had two sections: A and B. Section A contained items that requested students' demographic data. The data were: name, gender and name of school. Section B had ten items with Likert scale, the items measured Integrated science students' attitude to anaerobic respiration. The items were rated on a 5-point Likert scale of; 5: excellently well, 4: moderately well, 3: well, 2: fairly well, 1: not well. The (ISAQ) items were structured to measure students' attitude like: pleasure, confidence, interest, willingness and eagerness.

ISEPT was designed by the researchers to measure students' entrepreneurial practical skills in anaerobic respiration. ISEPT has three sections: A, B and C. Section A contained items that requested demographic data from Pre-service Integrated Science teachers; these are: Name, school and gender. Section A also reflected the duration for the administration of ISEPT which is three weeks. Section B had test items that measured the Pre-service Integrated science teachers' entrepreneurial practical skills achievement in anaerobic respiration. The development of table of specification for (ISEPT) was guided by the skills-based goals identified by Bloom *et al.* (1956) and the two highest levels of knowledge–based taxonomy of Anderson and Krathwohl (2001).

The two instruments were given to two seasoned experts in Integrated Science for validation and suggestions. A pilot test was conducted from a sample different from that of the actual study. During this pilot test, items identified as vague and ambiguous by the PISTs were re-structured. Initially, there were eighteen items, but after running the first reliability test, four items with low contribution to the scale were deleted, and fourteen items were retained. The Cronbach Alpha gave a value of .813 for ISAQ. Using Kuder Richardson-21 (K-21) formula, the reliability index for ISEPT was established as .824. These values imply good internal consistency of the ISAQ and ISEPT.

3.3 Procedure for data collection

Permission to carry out this research was sought from the departments and respective course lecturers. Permission was also obtained from the College management where students needed to be taken out of the school premises (i.e. PISTs in the outside-school cognitive apprenticeship treatment). The researcher also obtained permission from the Lagos state Ministry of veterinary services; to visit the Ikorodu abattoir, where Lagos state has a biogas production site.

Activities in the ISCA were similar to OSCA, but differed in the kind of environment that the PISTs were exposed to. In the Inside-School Cognitive Apprenticeship treatment (ISCA), the PISTs were exposed to cognitive apprenticeship within the school premises, various activities were carried out taken in the laboratory. In the OSCA, the PISTs were exposed to cognitive apprenticeship outside the school premises, with some lessons taken in the class and others at the biogas production site. In OSCA, the mavin took the PISTs round the biogas production site for familiarization and gives precautionary measures for safety.

In both ISCA and OSCA, the PISTs were introduced to the topic with the objectives of each of the lessons with. After this, the PISTs go into their assigned groups, after they were given tasks in the general class, these tasks (varying from week to week) included: "what is anaerobic respiration, what are the ecological and economic benefits of anaerobic respiration, what is the science behind bio-digester and how can bio-digester be constructed"? The PISTs were also given puzzles: they were asked to watch related videos and proffer solutions to given puzzles. The essence of watching the videos were to prompt the PISTS to think, discuss, to create a quest in the PISTs to get the puzzle solved in their groups. For instance, after watching videos of dump site at Olusosun, Ojota, Lagos, Nigeria; before and after the fire outbreak in 2018, the teacher asked the PISTs to think of possible reasons that the fire was not easily quenched. All the PISTs' answers were noted on the board for an evaluation later in the class. An example of how scaffolding was done was through lightning of candles and observing the combustion of the candles, when there was supply and deficiency of oxygen. The teacher coaches them (week by week) by demonstrating and explaining several concepts like

respiration, anaerobic respiration, methanogens, methanogens and biotechnology, ecological and economic benefits of anaerobic respiration and protocol for constructing bio-digesters; for learners to understand.

The teacher gave room for articulation by presenting PISTs with opportunities to explain and articulate their own way of thinking. This was then enhanced by reflection where PISTs compared their own thoughts and ways with those of the teacher, mavin and their peers. At the exploration phase, the teacher re-assigned the same task which was given initially to the PISTs at the beginning of the class. This time, hints and supports were withdrawn from the PISTs, while they were encouraged to solve tasks alone and with their peers. The teacher then asked the PISTs to identify their mistakes in the initial answers noted on the board for corrections. Tasks such were assessed and mistakes corrected.

In the lecture group, the PISTs were taught using lecture method. The facilitator introduced the topics to the PISTs. He presented the lesson objectives for the day to the Pre-service Integrated science teachers (PISTs). The facilitator introduced the lesson by asking the PISTs question related to the topic. He corrected wrong answers, and built on the responses of the PISTs to explain the concept of the day. The teacher assigned tasks to the PISTs and distribute them to their groups. The teacher listened to the PISTs' answers. The teacher spoke on the concepts. He distinguished between concepts where necessary and then evaluated the lesson. The facilitator summarises the lesson, emphasises salient points and re-assigns tasks to the PISTs.

3.4 Method of Data Analysis

Mean and standard deviation were used to answer the questions, while the null hypothesis was tested using Multivariate Analysis of Variance (MANCOVA) at 0.05 level of significance. A test of normality was conducted using SPSS, and (the Shapiro-Wilki values were not significant for the three dependent variables; the F-values were: [$F_{(2,94)}$=.992; p > .05] for attitude and for entrepreneurial skill development, it was: [$F_{(2.94)}$=959: p > .05]. The non-significance of these F-values indicates that the distribution of the study population was a normal distribution. Also, Wilks' Lamda associated with the effect of the teaching strategy was statistically significant [$F_{(2,94)}$=34.082; p<.05], implying the significance of the teaching strategy in enhancing a difference in the group means.

4.0 Results

Distribution of the PISTs by teaching strategies is indicated below.

Table 1: Demographic data of the Pre-service Integrated Science Teachers (PIST)

Variables		Subject Factor	**N**	%
Treatment Groups	1.00	Lecture method	42	36.5
	2.00	Inside-school cognitive apprenticeship	38	33.0
	3.00	Outside-school cognitive apprenticeship	35	30.4
	Total		115	100.0

Table 1 presents the distribution of the PISTs who participated in this study into three treatment groups. A total of 115 PISTs participated in this study.

Research Question 1

What is the difference in the attitude and entrepreneurial skill development of pre-service Integrated science teachers taught anaerobic respiration with outside-school cognitive apprenticeship, inside-school cognitive apprenticeship and lecture method?

Research question 1 was answered using table 2 below

Table 2: Mean and standard deviation of PISTs' attitude and entrepreneurial skill development in ISCA, OSCA and lecture method

Dependent variable	Treatment group	N	Mean		Mean Diff	SD		SD Diff
			Post-test	Pre-test		Post-test	Pre-test	
Attitude	ISCA	38	4.75	2.94	1.81	0.49	0.17	0.32
	OSCA	35	4.83	3.49	1.34	0.49	0.12	0.37
	Lecture method	42	3.66	3.36	0.30	0.58	0.57	0.01
Entrepreneurial skill development	ISCA	38	54.68	3.29	51.39	8.69	1.59	7.10
	OSCA	35	59.57	1.66	57.91	11.04	1.63	9.41
	Lecture method	42	35.05	3.00	32.05	10.56	1.89	8.67

Table 2 shows that there is a difference in the attitude mean scores of PISTs taught with anaerobic respiration using lecture method, Inside-School Cognitive Apprenticeship (OSCA) and Outside-School Cognitive Apprenticeship (OSCA). The post-test mean score of the PISTs in the lecture group was 3.66, those in ISCA group was 4.75 and their colleagues in OSCA group was 4.83. The mean pre-test score of the PISTs lecture group was 3.36, those in the ISCA group was 2.94 and those in the OSCA was 3.49. Also, the low standard deviation for the three groups indicates that there is a high cluster of PISTs' individual change in attitude around the attitude mean scores for their groups; hence, there is improvement to "excellently well" in attitude of majority of the PISTs to anaerobic respiration in the ISCA and OSCA groups; while majority of the PISTs in the lecture group still had a "well" attitude to anaerobic respiration after the lecture interactions.

For entrepreneurial skill development, the highest mean difference was recorded in the OSCA group (57.91), followed by PISTs in the ISCA group (51.39); while, the least mean difference was recorded among the PISTs in the lecture group (32.05). This interprets that the PISTs in the OSCA group did best in entrepreneurial skill development followed by those in the ISCA group; while their colleagues in the lecture group did not perform interestingly well as the other two groups. With the differences in the pre-test and post-test standard deviation of the groups indicating that the three groups are moderately homogeneous with respect to their entrepreneurial skill development, i.e. the PISTs' entrepreneurial skill development scores are moderately clustered around the mean.

The differences in the means were tested with MANCOVA to find out if they were significant or not, this is presented below.

Null Hypothesis 1

H_{01}: There is no significant impact of outside-school cognitive apprenticeship, Inside-school cognitive apprenticeship and lecture method on pre-service integrated science teachers' attitude and entrepreneurial skill development in anaerobic respiration.

Table 3: Test of between-subject effects of ISCA, OSCA and lecture method on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Attitudepost	35.742[a]	20	1.787	12.324	.000	.724
	Entre. Skill dev. Post-test	20830.699[b]	20	1041.535	24.529	.000	.839
Intercept	Attitudepost	25.762	1	25.762	177.651	.000	.654
	Entre. Skill dev. Post-test	4296.310	1	4296.310	101.183	.000	.518
Attitudepre	Attitudepost	.210	1	.210	1.449	.232	.015
	Entre. Skill dev. Post-test	53.570	1	53.570	1.262	.264	.013
Entre. Skill Dev. Post-Test	Attitudepost	.074	1	.074	.513	.475	.005
	Entre. Skill dev. Post-test	.180	1	.180	.004	.948	.000
Teaching Strategies	Attitudepost	22.619	2	11.310	77.991	.000	.624
	Entre. Skill dev. Post-test	7382.692	2	3691.346	86.936	.000	.649
Error	Attitudepost	13.631	94	.145			
	Entre. Skill dev. Post-test	3991.301	94	42.461			

a. R Squared = .724 (Adjusted R Squared = .665)
b. R Squared = .839 (Adjusted R Squared = .805)

The result in Table 3 depicts that there is a statistically significant difference in the attitude [$F_{(2,94)} = 77.99$; $p < .05$] and entrepreneurial skill development [$F_{(2,94)} = 86.94$; $p < .05$] of PISTs taught with ISCA, ISCA and those taught with lecture method. The R Squared values were .724 and .805; these values imply that, the contribution of the teaching strategies to the three learning variables tested in this study is very high. That is, across the three treatment groups; teaching strategy contributed 72.4% to the improvement in the PISTs' attitude and 80.5% to their entrepreneurial skill development. Furthermore, the Partial Eta Squared values are quite humongous: .624 and .649. This means that teaching strategy accounts for 62.4% and 64.9% of the variation noted in the mean scores of the PISTs' attitude and entrepreneurial skill development. To this end, the first null hypothesis which states that there is no significant difference in the attitude and entrepreneurial skill development of pre-service teachers taught anaerobic respiration with inside-school cognitive apprenticeship, outside-school cognitive apprenticeship and lecture method is hereby rejected.

A Scheffe post-hoc analysis was conducted to further examine the differences across the ISCA, OSCA and lecture method, the result is presented below.

Table 4: Scheffe post-hoc comparison on effect of ISCA, OSCA and lecture method on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration

Dependent Variable	(I)TEACHING STRATEGY	(J)TEACHING STRATEGY	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Attitude post-test	Lecture method	ISCA	-1.0942*	.08240	.000	-1.2986	-.8898
		OSCA	-1.1707*	.08424	.000	-1.3797	-.9617
	ISCA	Lecture method	1.0942*	.08240	.000	.8898	1.2986
		OSCA	-.0765	.08623	.676	-.2904	.1374
	OSCA	Lecture method	1.1707*	.08424	.000	.9617	1.3797
		ISCA	.0765	.08623	.676	-.1374	.2904
Entre. skill devt post-test	Lecture method	ISCA	-19.64*	2.269	.000	-25.27	-14.01
		OSCA	-24.52*	2.320	.000	-30.28	-18.77
	ISCA	Lecture method	19.64*	2.269	.000	14.01	25.27
		OSCA	-4.89	2.375	.125	-10.78	1.00
	OSCA	Lecture Method	24.52*	2.320	.000	18.77	30.28
		ISCA	4.89	2.375	.125	-1.00	10.78

The Scheffe pair-wise comparison test result in Table 4 shows that the difference between attitude post-test mean score of PISTs in the lecture method group and attitude post-test mean scores of PISTs in the ISCA group is significant ($p < .05$). A significant difference was also observed between attitude post-test mean score of PISTs in the OSCA and their colleagues in the lecture method ($p < .05$). No significant difference was observed between the attitude post-test mean scores of PISTs in ISCA and OSCA ($p > .05$). The result also shows that the mean difference in entrepreneurial skill development post-test scores of PISTs in ISCA and OSCA is not significant ($p > .05$). However, a significant difference was observed between entrepreneurial skill development post-test scores of PISTs in ISCA and lecture method ($p < .05$); and, entrepreneurial skill development post-test scores of PISTs in OSCA and lecture method ($p< .05$). This implies that the attitude and entrepreneurial skill development of PISTs in both ISCA and OSCA were not significantly different than other; but were significantly different from those in lecture method.

Research Question 2

What is the difference in the PISTs' attitude and entrepreneurial skill development in anaerobic respiration, across the high, average and low ability divides?

Table 5: Mean and Standard deviation of PISTs' attitude and entrepreneurial skill development across the high, average and low ability divides

Dependent Variable	ABILITY GROUP	Mean	Std. Deviation
Attitude post-test	Low	4.336[a]	.64
	Average	4.402[a]	.61
	High	4.517[a]	.73
Entre. skill devt post-test	Low	38.873[a]	11.43
	Average	50.686[a]	13.54
	High	60.621[a]	13.62

From the Table 5, it is evident that all the three ability divides had close attitude mean scores; but PISTs in the high ability group had relatively the highest mean score (4.34), this was followed by those in the average ability group (4.40), the least means score was recorded among the PISTs in the low ability group (4.52). Improvement was also observed in the entrepreneurial skill development post-test mean scores across the three ability divides of the PISTs: the high ability group had the highest mean score (60.62), this was followed by the average ability group (50.69); and, the least mean score was recorded in the low ability group (38.87). However, these differences were further investigated, to determine if they were significant or not.

Null Hypothesis 2

H_{02}: There is no significant main impact of ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration.

Table 6: MANCOVA of the impact of ability group on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Attitude post-test	35.742[a]	20	1.787	12.324	.000	.724
	Entrepre skill post-test	20830.699[b]	20	1041.535	24.529	.000	.839
Intercept	Attitude post-test	25.762	1	25.762	177.651	.000	.654
	Entrepre skill post-test	4296.310	1	4296.310	101.183	.000	.518
Attitude pre-test	Attitude post-test	.210	1	.210	1.449	.232	.015
	Entrepre skill post-test	53.570	1	53.570	1.262	.264	.013
Entrepre skill pre-test	Attitude post-test	.074	1	.074	.513	.475	.005
	Entrepre skill post-test	.180	1	.180	.004	.948	.000
Ability group	Attitude post-test	.171	2	.086	.591	.556	.012
	Entrepre skill post-test	967.067	2	483.533	11.388	.000	.195
Error	Attitude post-test	13.631	94	.145			
	Entrepre skill post-test	3991.301	94	42.461			

a. R Squared = .724 (Adjusted R Squared = .665)
b. R Squared = .839 (Adjusted R Squared = .805)

From table 6, ability group does not have a statistically significant impact on the PISTs' attitude to anaerobic respiration [$F_{(2,94)}$=.60; $p > 0.05$] but has a statistically significant impact on the PISTs' entrepreneurial skill development [$F_{(2,94)}$=11.39; $p < 0.05$]. The Partial Eta Squared are comparatively low (.012 and .195); this means that, ability group accounts for the variation in the PISTs' attitude by 12% and 19.5% in the entrepreneurial skill development of the PISTs.

Therefore, the first tier of the second null hypothesis which states that there is no significant main impact of ability divides on pre-service Integrated Science teachers' attitude to anaerobic respiration is hereby rejected. The second tier of the second null hypothesis which states that there is no significant main impact of ability divides on pre-service Integrated Science teachers' entrepreneurial skill development in anaerobic respiration is not rejected.

Research Question three

What is the interaction impact of teaching strategies and ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration?

Table 7: Mean and Standard deviation of PISTs' interaction impact of teaching strategies and ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration

Dependent Variable	Group type	Ability Group	Mean	Std. Deviation
Attitude post-test	ISCA	Low	4.638a	.18
		Average	4.727a	.25
		High	4.984a	.14
	OSCA	Low	4.707a	.08
		Average	4.870a	.06
		High	4.991a	.17
	Lecture method	Low	3.577a	.73
		Average	3.575a	.26
		High	3.645a	.60
Entrepreneurial skill post-test	ISCA	Low	47.706[a]	3.34
		Average	56.368[a]	3.50
		High	60.346[a]	13.31
	OSCA	Low	45.444[a]	3.05
		Average	63.151[a]	4.70
		High	72.347[a]	3.56
	Lecture method	Low	24.434[a]	6.79
		Average	33.997[a]	5.72
		High	45.909[a]	2.56

From table 7, a general trend of very good post-test mean scores were noted in the attitude and entrepreneurial skill development of the PISTs in the OSCA and ISCA across the high, average and low ability divides; when compared to the post-test mean scores of PISTs across the three ability divides in the lecture group.

Null Hypothesis 3

H_{03}: There is no significant interaction impact of teaching strategies and ability divides on pre-service Integrated Science teachers' attitude and entrepreneurial skill development in anaerobic respiration.

Table 8: MANCOVA of interaction impact of teaching strategies and ability divides on PISTs' attitude and entrepreneurial skill development in anaerobic respiration

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Attitudepost	35.742[a]	20	1.787	12.324	.000	.724
	Entrepre skill post-test	20830.699[b]	20	1041.535	24.529	.000	.839
Intercept	Attitudepost	25.762	1	25.762	177.651	.000	.654
	Entrepre skill post-test	4296.310	1	4296.310	101.183	.000	.518
Attitudepre	Attitudepost	.210	1	.210	1.449	.232	.015
	Entrepre skill post-test	53.570	1	53.570	1.262	.264	.013
Entrepreskill_pre_test	Attitudepost	.074	1	.074	.513	.475	.005
	Entrepre skill post-test	.180	1	.180	.004	.948	.000
Group_type *Ability_type	Attitudepost	.341	4	.085	.587	.673	.024
	Entrepre skill post-test	580.762	4	145.191	3.419	.012	.127
Error	Attitudepost	13.631	94	.145			
	Entrepre skill post-test	3991.301	94	42.461			

a. R Squared = .724 (Adjusted R Squared = .665)
b. R Squared = .839 (Adjusted R Squared = .805)

The MANCOVA result presented in table 8, reflects a non-significant interaction impact of teaching strategy and ability group on PISTs' attitude to anaerobic respiration [$F_{(4,94)}$=.59; p >.05]; with the Partial Eta Squared calculated as .024, which indicates a 2.4% contribution of the interaction impact of teaching strategy and ability group on PISTs' attitude post-test mean scores, this is quite low. But, the result indicates that there is a significant interaction impact [$F_{(4,94)}$=3.419; p<.05] of teaching strategy and ability group on PISTs' entrepreneurial skill development. Although, the Partial Eta Squared is low .127; which depicts a low

contribution of the interaction impact of teaching strategy and ability group to the variance in PISTs' entrepreneurial skill development post-test mean scores is 12%.

5.0 Discussion

Since the past decades, and till now; research efforts have indicated how stakeholders in Education seek to improve students' attitude to science. The findings of this study shows that the attitude of the PISTs in the OSCA group improved from "well" (3.66) to "excellently well" (4.83). The attitude of PISTs in the ISCA group also improved from "fairly well" (2.94) to "excellently well" (4.75). On the other hand, although there was a mean gain in the attitude of the PISTs in the lecture group, it remained in the "well" range i.e. 3.36 and 3.66. The impact of the ISCA and OSCA were found to be significant. The findings of this study is not at variance with the quasi-experimental research of Danmole *et al.* (2021) that the teaching strategy employed by teacher contributes significantly to students' attitude to learning and doing science. This study agrees with Blazar and Kraft (2017) that students' attitudes and behaviours are predicted by teaching practices and very importantly, teachers' emotional support and classroom organization. This study also aligns with Nja *et al* (2022) that classroom instruction plays a significant role in helping students have positive attitude to science. Also, the finding of this study is in congruence with Rebekah (2020) that cognitive apprenticeship model can influence attitude of pre-service teachers in the use of instructional technology. This study therefore submits that the two cognitive apprenticeship models can assist Science students of any ability group to boost their attitude.

With the present need to equip students with entrepreneurial skills, this study found the two cognitive apprenticeship models (OSCA and ISCA) very useful in tweaking PISTs' entrepreneurial skill development in anaerobic respiration. This is in consonance with Stalmeijer *et al*., (2009) who found cognitive apprenticeship model very impactful in improving students' skill during clinical training. The study was conducted in the academic year 2006–2007 among 24 medical students in the 6-year undergraduate curriculum of Maastricht Medical School, the Netherlands. The findings of this study are not at variance the research of Kuo *et al.*, (2012) on the potency of cognitive apprenticeship in fostering the development of web-based collaborative problem solving skills. It explored effectiveness of cognitive styles of students as a human factor in the effectiveness of cognitive apprenticeship model. The results point out that cognitive apprenticeship plays significant role in the development of web-based collaborative problem solving skills.

Every Science student can excel without limit, no matter the range of individual differences in the science class, as against some ill opinions that some students are not educable. Over the years, efforts have been made by Science teachers and researchers to address the issue of individual differences especially ability divides in the science class. At the end of this research, the post-test mean scores of the PISTs in the low, average and high ability divides of ISCA and OSCA were found to be higher than their colleagues in the lecture group. The MANCOVA results also indicated that ability level did not significantly interact with teaching strategies in the PISTs' attitude and entrepreneurial skill development. This suggests that the impact of the teaching strategies on the PISTs' attitude did not differ significantly based on their ability divides. This study also found that the interaction effect of teaching strategies and ability divides was statistically significant, this suggests that the combined impact of teaching strategies and ability divides on the PISTs' entrepreneurial skill development was significant, even after accounting for the covariates. The findings of this study is at not par with the findings of Adeyemo (2010) that found that there was relationship between students' ability divides and problem-solving task in physics among 200 senior secondary school students in Kosofe Local Government, Nigeria; using multiple regression. This study adds that although there was improvement in the entrepreneurial skill development of PISTs across the three ability divides in both ISCA and OSCA groups, PISTs in the high ability divides still had the highest mean score in entrepreneurial skill development. This may suggest that the place of innate and natural ability in entrepreneurship may not be trashed. There is still need to further examine predictor variables around ability divide, natural ability and entrepreneurial skill development in Science.

6.0 Conclusion and Recommendations

This study lends empirical evidence to literature, that cognitive apprenticeship is very relevant in helping pre-service Integrated Science teachers improve their attitude and entrepreneurial skill development in Science. Also, this study queues behind the situated cognition theory: that advocates for creating meaning from the real activities of daily living; and that, knowing is inseparable from doing, since schools are not islands, but exist in wider communities. No student should be a write-off. Putting into bare that learners are uniquely

different, learn differently, think differently, answer questions differently, solve questions differently and apply knowledge to situations differently. It is important to note that as, cognitive apprenticeship is not a single teaching method, but being an amalgamation of six teaching methods makes it very relevant in enhancing students' attitude and entrepreneurial skill development. This is essential to take care of students' attitudinal differences in the science class. Beyond desiring that pre-service teachers have good grades in examinations, it is imperative to help them develop good attitude to learning and doing science. This transcends the walls of the school, as it helps them to contribute their quota meaningfully to national development, especially now when the anthem is high on the need for to produce more teachers that can facilitate entrepreneurial skill development especially among youths.

Premised on the empirical findings of this study, the following recommendations were made:
1. Both outside-school cognitive apprenticeship and inside-school cognitive apprenticeship as viable models of cognitive apprenticeship for tweaking pre-service Integrated Science teachers' attitude and entrepreneurial skill development in Science.
2. No Pre-service teacher should be treated with disdain because of his ability level, but could be taught with cognitive apprenticeship for better entrepreneurial skill development in Science.
3. Pre-service Integrated Science teachers should be exposed to more Science-based entrepreneurial activities, so that they can be more resourceful to their students.
4. A collective effort from curriculum planners, textbook authors, lecturers, relevant industries and school administrators could be harnessed into how cognitive apprenticeship and Science-based entrepreneurial activities can be incorporated into the Science classroom.

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