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COGNITIVE APPRENTICESHIP INSTRUCTIONAL STRATEGY AND STUDENTS' INTEREST IN PHYSICS; A COMPARATIVE APPROACH

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ABSTRACT

This paper compared the effect of the Cognitive Apprenticeship Instructional Strategy (CAIS) and Teacher Expository Strategy on the interest of secondary school students in Physics in Apa Local Government Area of Benue State, Nigeria. This study also compared the effect of CAIS on the interest of male and female students in Physics. The study

INTRODUCTION

Colleges of Education (COEs) are the third tier of institutions of higher learning in Nigeria that are encumbered with the tasks of training pre-service teachers in courses that best equip such individuals for pedagogical activities in primary and secondary schools. This is intended to make them share the knowledge gained with society towards sustainable development. These institutions no doubt played critical roles in producing teachers of high moral and ethical standards to teach subjects that range from technical, science, business, social sciences, languages, and humanities at the Primary and Junior Secondary Schools (Ezugoh *et al.*, 2020).

Such contributions towards national development cannot be overstated just like the Universities and Polytechnics for they have in the past produced competent manpower

adopted the pre-test, post-test, control group quasi-experimental, and survey research designs. The sample consisted of 90 Senior Secondary School One (SSS I) students selected using a multi-stage sampling procedure. The Physics Students' Interest Questionnaire (PSIQ) was used for data collection. The Cronbach's Alpha (α) statistics were adopted to determine the reliability of PSIQ which yielded 0.81. The results showed that CAIS is an effective teaching strategy for improving secondary school students' interest (Post-test: $\bar{x}$ = 40.8140, Pre-test: $\bar{x}$ = 16.6977) in Physics. The findings have also shown that the CAIS is gender-neutral in improving students' interest (Male: $\bar{x}$ = 40.27, Female: $\bar{x}$ = 41.11) in Physics. Based on the findings of the study, it was concluded that the CAIS is effective in enhancing male and female secondary school Physics students' interest and can lead to an increase in Physics students' enrolment at the higher institutions in Apa Local Government Area of Benue State. It was therefore recommended that teachers should receive training, workshops, and seminars on the use of CAIS to ensure effective implementation and to maximize its benefits.

Keywords: Cognitive Apprenticeship, Teacher Expository Teaching, Physics, Learning Outcomes, interest, higher institution.

for the education, economic, and social sustainability of the country. It is therefore a matter of serious concern noting that the (COEs) may no longer be meeting up to expectations, especially in rendering quality and efficient services that will lead to the achievement of educational goals due to myriads of challenges confronting the tier of Nigeria's education system. Owing to the foregoing, it is expected that COEs are meant to be functional and sustainable. Functionality and sustainability in this regard suggest that they have the required number of students in all the course combinations and an enabling environment for teaching, learning, and research.

It is a fact that Colleges of Education are faced with stark challenges in Nigeria. However, the case of the Federal College of Education, Odugbo seems to be different and in a dangerous trend due to low student enrolment. Aina and Ayodele (2018) submitted that there are many challenges confronting the Colleges of Education in Nigeria which include, teachers' inadequate pedagogical content

knowledge, off-content teaching, and low teaching staff self-efficacy. According to the report, there has been a serious decline in students' enrolment among the colleges which could be attributed to the proliferation of private Colleges of Education, students' loss of interest, and inadequate infrastructure among others. Aina and Ayodele (2018) affirmed that the core of challenges confronting the Nigerian Colleges of Education is diminishing students' enrolment.

This may be traced to the loss of interest in colleges of education by the students among others. Meanwhile, interest which precedes readiness is key in whatever anyone attempts to do especially learning. Apart from a general loss of interest in learning among students nowadays, there seems to be a special odium for Colleges of Education which may be due partly to the social and economic status of teachers who are products of these schools in society. This may also have to do with the perception of teaching among society as an undesirably worthless profession which may likely be based on criticisms concerning the absence of professional autonomy, low wages, and poor condition of service.

Within the available students seeking admission to COEs, Sciences most especially Physics seem to be the worst hit in terms of low enrolment. Science education is one of the academic programs of the College of Education in Nigeria alongside Social Sciences, Languages, Arts, and Vocational Education. The prime challenge of this program has been low enrolment. Aina and Ayodele (2018) examined the case of five-year enrolment at Federal College of Education Technical, Lafiaji where it was observed that between 2012 and 2016, the data indicated that the trend of enrolment decreased every year. Overall, within the years under review, 3174 students enrolled in sciences where 2187 (68.9%) for Biology, 712 (22.4%) for Chemistry, and Physics had 275 (8.7%). This is suspected to be the trend in all the Colleges of Education in Nigeria to date.

The case of the Federal College of Education, Odugbo attests to this fact. In the 2022/2023 academic session which happened to be the maiden session, about 500 students applied for admission, it was a sad situation to see that no single student applied to study Physics and Chemistry. This implies that the school will not produce a single Physics teacher in its maiden convocation. Consequently, the society and most especially Apa Local Government Area Secondary School may have to contend with an acute shortage of Physics teachers shortly. This has been a source of concern for the researchers considering the impact of Physics on the individuals learning it, the society, and the world at large.

Agbaje and Alake (2014) in their study on the student variables as a predictor of secondary school students' academic achievement in science subjects established that students' interest is vital to learning. It was affirmed that there seem to be no more interest in the students learning which might be why the enrolment of students reduces on the yearly basis in the Colleges of Education. As a result of the loss of interest in the learning of Physics, students have developed a negative attitude towards the subject.

Studies in the past have attempted to find a lasting solution to this challenge with varying degrees of suggestions. Part of the suggested remedies was changing the teaching approaches employed by the teachers at the secondary schools. Meanwhile, what enhances students' interest in a subject could be the teacher's instructional strategies. When defining curricular priorities and pedagogical strategies, instructors should strive to promote discipline-based knowledge that ensures students move from novice to expert in a topic. The instructors teach domain-specific knowledge intending to assist students to skilfully organize the knowledge, and give chances for students to retrieve and use the knowledge in problem solving. Therefore, from a pedagogical standpoint, teachers understand what it means to be an expert in the topic and can identify the mechanisms that help students work toward acquiring competence and developing sustained interest.

It is no doubt that effective teaching strategies play a crucial role in enhancing students' academic achievement, raising interest in learning, and boosting confidence. Strategies like differentiated instruction, technology integration, and project-based learning can lead to better comprehension and retention of subject matter and the development of critical thinking. Efforts seem to be inclusive as to teaching strategies that could ultimately improve students' interest towards improved achievement in Physics to retain the students in the classroom.

One of such instructional strategy that is suspected to increase students' interest is the Cognitive Apprenticeship Instructional Strategy (CAIS). Cognitive apprenticeship was proposed by Brown *et al.,* (1989). It provides an opportunity for novices to observe how instructors or experts solve complex problems in an authentic context via the following steps:

1) **Modelling:** the experts demonstrate and explain their way of thinking for students to observe and understand;

2) **Coaching:** the students practice the methods, while the experts advise and correct;
3) **Scaffolding:** through increasing the complexity of problems and decreasing the level of assistance according to the student's progress, the experts progressively help the students successively approximate the objective of accomplishing a task independently;
4) **Articulation:** the students are given opportunities to articulate and clarify their way of thinking;
5) **Reflection:** the students compare their thoughts with those of experts and peers;
6) **Exploration:** the students manipulate and explore the learned skills or knowledge to promote their true understanding.

Based on this teaching strategy, students can compare their problem-solving processes with those of an expert, another student, and ultimately, an internal cognitive model of expertise through the process of reflection. Analyzing past performances by both experts and novices and pointing out parallels and contrasts would be a reflection method. Reflection is to help students examine their past performances to comprehend and enhance expert conduct.

The cognitive apprenticeship model is a constructivist approach to teaching and learning based on the idea that learners should be actively engaged in their learning process. It is based on the idea that learners should learn by doing, and be actively involved in the activity. The core concept of this model was that learning involves the integration of the learner's cognitive skills with the knowledge, skills, and values of a mentor or master. The cognitive apprenticeship model suggests that learners should be actively involved in the learning process and that the role of the instructor is to provide support and guidance. The instructor should provide guidance on how to think about and solve problems, as well as provide feedback on the progress and performance of the learners. Employing a cognitive apprenticeship model encompasses the following three activities: Making processes visible to students; situating processes in real-world contexts, and varying tasks and information to foster transfer of learning to new and different situations.

There are equally certain challenges in developing academic interests in students most especially in Physics. Such challenges may include; limited teaching resources

and opportunities, pressure to conform to expectations, the nature of the subject, inadequate exposure and awareness, competing interests and distractions, and self-doubt and uncertainties.

Research on students' interest in sciences is a broad and ongoing field of study. Numerous studies have been conducted to understand the factors that influence students' interest in mathematics and how it affects their learning outcomes. Peters-Burton *et al.*, (2015) examined how 19 secondary earth science and biology teachers' perceptions of inquiry, interest, motivation, and self-efficacy of teaching science were affected by a one-year professional development (PD) program based on a cognitive apprenticeship model of research experiences. A sample of 19 male and female in-service teachers were taught scientific thinking and inquiry skills using a cognitive apprenticeship paradigm. The findings showed that across every stage of the study, in-service male and female instructors maintained high levels of engagement and self-efficacy while also altering their views on inquiry. Teachers did not, however, alter their teaching of cognitive strategies in a long-term manner. Also, Olayanju et al., (2024) observed that the two models of cognitive apprenticeship (outside and inside school) had a significant impact on the interest of students in entrepreneurial skill development of PISTs in the two experimental groups.

Also, in a pre-test, and post-test quasi-experiment with a non-equivalent control group, Ogundola *et al.*, (2020) included students in intact classrooms in Ekiti State. All the 64 National Technical Certificate (NTC) II students pursuing fabrication and welding engineering craft practice made up the study's population and sample. There were 11 females and 15 males. The findings revealed that the mean achievement scores for males and females did not differ significantly. Conversely, Eze et al., (2020) where a pre-test, and post-test quasi-experimental method to investigate the effect of gender on students' academic achievement and retention in auto mechanic technology at technical colleges in Delta State, Nigeria. The study discovered that there was no significant difference in the interest and performance of male and female students taught auto mechanics technology using the cognitive apprenticeship teaching technique.

However, the study found that the gender-based differences in students' mean interest and retention scores were substantial.

In a related development, Okotubu (2023) conducted a study motivated by a goal to boost male and female students' interest in automotive technology. The study

sought to determine how the cognitive apprenticeship instructional technique affects students' interest in auto mechanics technology at Technical Colleges in Delta State. The study population consisted of 237 vocational II auto mechanic students from Delta State's six technical colleges. The study's sample size was 114 using a purposive sampling technique. The Auto Mechanic Interest Inventory (AMII) was utilized to collect data. The study found that students taught using the cognitive apprenticeship teaching approach were more interested in auto repair technology than students taught using the demonstration method. It also discovered that cognitive apprenticeship teaching does not differ by gender in terms of interest. Meanwhile, Collins (2005) has shown that the CAI model is carefully structured in the lesson, students will develop the capacity to apply the learned skills in new learning situations.

Cognitive apprenticeship teaching has been confirmed to increase students' interest in technical-related subjects, there may therefore be a need to examine its influence on students' learning outcomes such as interest in Physics. Meanwhile, changing the teaching narratives involves evolving teaching strategies that can impact directly student's interests. It is expected that when the students' interest is ensured, there will be a propensity for them to enroll in Physics not only at the colleges of education but other tertiary institutions. This study was therefore set out using a comparative approach to examine the cognitive apprenticeship and students' interest in Physics at the secondary school level to leverage their sustained interest up till tertiary institution. Specifically, the study observed the distribution scores of male and female students' interests in Physics before the application of the Cognitive Apprenticeship Instructional Package (CAIP), examined the effect of the CAIP on secondary school students' interest in Physics, and, determined the effect of the package on male and female secondary school students' interest in Physics.

Research Questions

The following research questions were raised to guide the study:

1. What is the distribution of male and female Physics students' interests before intervention?
2. How does CAIP influence students' interest in Physics?
3. How does CAIP influence male and female students' interests?

Hypotheses

Based on the research questions raised, the following hypotheses were formulated:

1. There is no significant difference in Physics students' interest when taught using CAIP.
2. There is no significant difference in the interest of male and female Physics students taught using CAIP.

Methodology

The research designs adopted the non-equivalent pre-test, post-test, control group quasi-experimental, and survey. The population for the study comprised all the senior secondary school students (SSSI) taking Physics in Apa Local Government area of Benue State. The study sample consisted of all 90 SSS I students in intact Physics classes in the selected secondary schools in Apa Local Government Area (LGA) of Benue State. Two schools were purposively selected from the LGA. The basis for purposive selection was based on the availability of Physics teachers with a minimum of 5 years of teaching experience in Physics. One of the available arms of SSS I students was selected in each of the two schools using the random sampling technique. Each of the arms of students selected in their intact classes was randomly assigned to experimental groups A (Cognitive Apprenticeship) and control group B (Teacher Expository Teaching). Students in group A were taught using the Cognitive Apprenticeship Instructional Package (CAIP) developed by the researchers using the CAIS while students in their intact class using the Teacher Expository Teaching. One research instruments developed by the researchers were adopted for data collection for the study. An instrument titled Physics Students' Interest in Physics Questionnaire (PSIPQ). The PSIPQ consisted of carefully structured 4-point Likert items type that elicited the students' interest in Physics. The instruments were validated by science educators and tests and measurement experts from the Faculty of Education, Adekunle Ajasin University Akungba Akoko. The items in the instruments were thereafter modified based on the observations and comments of these experts. The instruments were pilot-tested by administering the instruments to a representative sample of 20 SSS II Physics students outside the population of the study. Crombach's Alpha (α) for PSIPQ was 0.81. There were three stages involved in this research: the administration of pre-test, the intervention stage and the

post-test stages. In the pre-test stage, PSIPQ was administered to the experimental and the control groups to ascertain homogeneity of the respondents in terms of interest in Physics. The intervention was carried out by the researchers. The first week was for the administration of pre-test. The treatment in all the groups covered three periods per week for a period of four weeks. In the sixth week, post-test which was PSIPQ was administered to the groups to determine the effect of the intervention on their interest in Physics. The research questions were answered using descriptive statistics of measures of frequency count, mean and standard deviation while the hypotheses were tested using the t-test statistics.

Results

Research Question 1: What is the distribution scores of male and female Physics students' interest prior to intervention?

To answer the research question, responses of male and female students on interest in Physics prior to intervention were subjected to descriptive analysis and the results are presented in Table 1.

Table 1

Distribution of male and female Physics students' interest prior to the intervention using CAIS

		Group Pre-test on Interest in Physics		
		Total N	Mean	Standard Deviation
Gender Group A	Male	28	16.89	4.05
	Female	15	16.33	3.92
Gender Group B	Male	26	16.08	4.11
	Female	21	17.71	4.50

According to Table 1, male and female students in both experimental group A, and the control group B in Physics had a similar interest in Physics (Group A; Male: $\bar{x}$ = 16.89, Female: $\bar{x}$ = 16.33), and (Group B: Male: $\bar{x}$ = 16.08, Female: $\bar{x}$ = 17.71). This revealed that Physics students' interest in Benue State is low and similar across the genders. This also infers that the students' entry characteristics into the experiment were homogenous and consistent across all groups.

Research Question 2: How does CAIP influence students' interest in Physics?
To address this research question, the pre-test and post-test students' interest in Physics in groups A and B were subjected to descriptive analysis and the results were presented in Table 2.

Table 2
Mean and standard deviation of Physics students' interest in group A and B when exposed to CAIS.

Descriptive Statistics					
	N	Minimum	Maximum	Mean ($\bar{x}$)	Std. Deviation
Group A Pre-test Interest	43	10.00	26.00	16.6977	3.96734
Group A Post-test Interest	43	32.00	48.00	40.8140	3.47272
Group B Pre-test Interest	47	8.00	26.00	16.8085	4.31700
Group B Post-test Interest	47	10.00	34.00	17.5745	4.62387

According to Table 2, the experimental group A students' post-test score ($\bar{x}$ = 40.8140) is higher than the pre-test score ($\bar{x}$ = 16.6977), whereas the control group B students' post-test score ($\bar{x}$ = 17.5745) is comparable to the pre-test score ($\bar{x}$ = 16.8085). This suggests that, when compared to students who were taught using the Teacher Demonstration Strategy, students who were taught using the Cognitive Apprenticeship Instructional Package showed an improved interest in Physics and an increase in interest scores.

Research Question 3: How does CAIP influence male and female students' interests?
To address this research question, the pre-test and post-test scores of male and female students' interests in Physics in groups A and B were subjected to descriptive analysis and the results were presented in Table 3.

Table 3

Students' post-test mean and standard deviation for the interest of males and female in Physics

		Group A Post-test Interest		
		N	Mean ($\bar{x}$)	Standard Deviation
Gender Group A	Male	28	41.11	3.41
	Female	15	40.27	3.63

According to Table 2, the post-test interest scores of the male ($\bar{x}$ = 40.27) and female ($\bar{x}$ =41.11) students in experimental group A are comparable. This implies that there was no difference in the interest of male and female students who received instruction utilizing the Cognitive Apprenticeship Instructional Package, indicating that there is no gender bias in the Cognitive Apprenticeship Instructional Package at improving students' interest in Physics.

Hypothesis 1: There is no significant difference in Physics students' interest when taught using CAIP.

To test this hypothesis, the pre-test and post-test mean interest scores of students in the experimental group were subjected to t-test analysis and the results are presented in Table 3.

Table 4

The t-test analysis of students' interest scores in Physics using CAIP

Students' Interest	N	Mean	Std. Deviation	t	Df	Sig. (2-tailed)
Group A Pre-test	43	16.6977	3.96734	27.599	42	.000
Group A Post-test	43	40.8140	3.47272			

$p<0.05$

Table 3 showed the t-value is 27.599, which is extremely high. This indicates a significant difference between the pre-test and post-test interest scores being compared. The p-value of .000 also means that the probability of observing the difference (or more extreme) between the two groups by chance is extremely low (less than 0.1%). The extremely high t-value and very low p-value indicate a highly significant difference between the groups. In other words, the difference is

statistically significant. Based on the t-test results, the null hypothesis stating that there is no significant difference between the pre and post-test interest scores is hereby rejected.

Hypothesis 2: There is no significant difference in interest of male and female Physics students taught using CAIP.

To test this hypothesis, the post-test mean interest scores of male and female students in the experimental group were subjected to t-test analysis and the results are presented in Table 4.

Table 5

The t-test analysis of male and female students' interest scores using CAIP

Gender	N	Mean	Std. Deviation	t	Df	Sig. (2-tailed)
Male	28	41.11	3.41	.738	27.210	.467
Female	15	40.27	3.63			

p<0.05

The t-test results from table 5 indicate no statistically significant difference between male and female scores: t-value of .738, df: 27.210, Sig.: .046 greater than 0.05. This indicated no significant difference in the interest of male and female students in Physics when taught using CATS. In summary, the difference between male and female scores is not statistically significant. As such, the null hypothesis stating that there is no significant difference between the male and female students' interest is hereby accepted.

Discussion

The findings of the study which was set out to examine how CAIP influenced students' interest in Physics suggested that the when compared to students who were taught using the Teacher Demonstration Strategy, students who were taught using the Cognitive Apprenticeship Instructional Package showed an improvement in their interest in Physics and an increase in interest scores. The finding corroborated Collins (2005) which shown that the CAI model carefully structured in the lesson, students will develop the capacity to apply the learned skills in new learning situations. This may tend to increase the interest of the students in studying Physics. It is therefore thoughtful that through cognitive

modelling, students are exposed to higher-level thought processes while working with instructors and experts in cognitive apprenticeship methods. Students genuinely investigate novel concepts and come to conclusions by employing sophisticated reasoning techniques following the initial phases of assistance from teachers and specialists. Okotubu (2023) conducted a study motivated by a goal to boost male and female students' interest in automotive technology. The study sought to determine how the cognitive apprenticeship instructional technique affects students' interest in auto mechanics technology at technical colleges in Delta State. The study population consisted of 237 vocational II auto mechanic students from Delta State's six technical colleges. The study's sample size was 114. The purposive sampling technique was used to select two colleges among the six technical colleges. The Auto Mechanic Interest Inventory (AMII) was utilized to gather data. Three research experts validated the instrument. Cronbach Alpha was used to establish the reliability coefficient of the instrument, and a reliability coefficient of 0.81 was achieved. The study found that students taught using the cognitive apprenticeship teaching approach were more interested in auto repair technology than students taught using the demonstration method. It also discovered that cognitive apprenticeship teaching does not differ by gender in terms of interest. These findings were also in conformity with Olayanju *et al.,* (2024) where it was observed that the two models of cognitive apprenticeship (outside and inside school) had a significant impact on the interest in entrepreneurial skill development of PISTs in the two experimental groups.

The findings of the study seeking to examine how CAIP influences male and female students' interest in Physics showed that there was no difference in the interest of male and female students who received instruction utilizing the Cognitive Apprenticeship Instructional Package, indicating that there is no gender bias in the cognitive apprenticeship Instructional Package at improving students' interest in Physics. the findings of this study were in line with Eze *et al.*, (2020) where a pre-test, post-test quasi-experimental method to investigate the effect of gender on students' academic achievement and retention in auto mechanic technology at technical colleges in Delta State, Nigeria. The study discovered that there was no significant difference in the interest and performance of male and female students taught auto mechanics technology using the cognitive apprenticeship teaching technique. The findings of this study were at variance with the findings of Ogunlola *et al.*, (2020) conducted a pre-test, post-test, non-equivalent control

group quasi-experiment with students in intact classes. The population and sample consisted of all 64 National Technical Certificate (NTC) II students of fabrication and welding engineering craft practice in Ekiti State. There are 53 males and 11 females. Data was collected using two instruments: the fabrication and welding achievement test and the fabrication and welding interest inventory. It was found that the mean interest and retention scores of male and female students were significantly different. The findings also support Okotubu (2023) who found that students taught using the cognitive apprenticeship approach were more interested in auto repair technology than students taught using the demonstration method and that cognitive apprenticeship teaching does not differ by gender in terms of interest.

Conclusion

Based on the analysis of data and the interpretation of the results of this study, it can be established that Cognitive Apprenticeship Instructional Strategy (CAIS) is an effective teaching method that improves students' interest in Physics. It can further be concluded that CAIS is gender-neutral, as there was no significant difference in the interest of male and female students who received instruction using CAIS and CAIS is a better alternative to traditional teaching methods, such as the Teacher Demonstration Approach at increasing the enrolment of students in higher institutions as results of sustained interest in Physics from secondary schools.

Recommendations

Given the findings and conclusions reached in this study, it is hereby recommended that:

1. The Cognitive Apprenticeship Instructional Strategy (CAIS) should be adopted as a teaching method in Physics education, particularly in Benue State, to improve students' interest in Physics.
2. The Physics curriculum should be reviewed and aligned to incorporate CAIS, ensuring that it is integrated into the teaching and learning process.

3. The implementation of CAIS should be continuously monitored and evaluated to assess its effectiveness, identify areas for improvement, and make necessary adjustments.

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