impact International Journals and Publications

© IIJP 2026 | Volume 2, Issue 2, pp. 1457-1466 | ISSN: 2636-4484

EFFECTS OF NUMBERED-HEADS TOGETHER COOPERATIVE LEARNING STRATEGY ON STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN FOUNDRY IN KANO STATE, NIGERIA

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ARTICLE INFO

Article No.: 0378

Accepted Date: 25/05/2026

Published Date: 19/06/2026

Type: Research

ABSTRACT

This study investigated the effects of Numbered Heads Together on students' academic achievement, interest and retention in foundry in technical colleges of Kano state, Nigeria. Two research objectives, research questions and corresponding hypotheses guided the study. The study adopted a quasi-experimental design**,** specifically the pre-test, post-test, and post-posttest non-equivalent control group design**.** The population comprised 2940 NTC II metal students from all technical colleges, 2 intact classes from 2 colleges out of which 32 were randomly selected. The Foundry Achievement Test (FAT) served as the instrument for data collection. The instrument was validated by six experts and yielded a reliability coefficient of 0.812 using the Cronbach Alpha method. The study lasted for 6 weeks after data were collected. The data were analyzed using mean and standard deviation to answer the research questions, while hypotheses were tested using ANCOVA. The findings revealed that NHT strategy is more effective in improving students' academic achievement and retention in foundry compared to conventional teaching method. The study also revealed that, there is significant differences between the mean academic achievement and retention scores of students taught foundry using NHT and those taught using conventional teaching method. Based on the findings, the study recommended that the awareness for significance of the NHT in enhancing students' academic achievement should be intensified. Technical college teachers should adopt and use the NHT learning strategy to improved students' academic achievement in Foundry and other metalwork subjects.

Keywords: Numbered-Heads Together (NHT), Academic Achievement, Retention and Foundry

Introduction

Technical and Vocational Education and Training (TVET) is a type of education that focused on skills provision and practical knowledge for a specific occupation or vocation; it is designed to prepare learners or trainees for a career or trade that makes them self-employed or employed others (Abba, Buba, & Tukur, 2020). According National Policy on Education (NPE,2013), the goals of Technical and Vocational Education and Training shall be to: Provide courses of instruction and training in engineering, and other technologies, applied sciences, business and management, leading to the production of trained manpower. And Give training that imparts the necessary skills for the production of technicians, technologists and other skilled personnel who shall be enterprising and self-reliant. TVET is education linking in addition to general education the study of technologies, related sciences and acquisition of practical skills, attitude, understanding information relating to occupations in various sectors of the economic and social life (Lkama & Dabo, 2019). TVET is a planned program of correct learning methodologies that enable for self-reliance and leadership preparation in field of work and perhaps an opportunity to progress academically. The professions in technology, aspects of apprenticeship, mind-set for job creation mostly took place in technical colleges (Goyol & Sunday 2020). The courses and subjects offered were designed to equip students with practical knowledge and skills that would make them self-employed or employable (Asukwu, Daniel, Michika, & Vincent, 2022).

Technical colleges give students training on skills in different courses and relevant trades in addition to general studies and other science subjects (Udu, 2017). According to Okwelle and Okoye (2012) in Buhari and Idris (2024) Technical colleges are principal vocational institutions that provide technical education in Nigeria, responsible with imparting necessary skills that lead to the production of craftsmen and technicians who are skilled and self-reliant in the world of work. Work is referred to courses offered in technical colleges including: Electrical and electronics works, Automobile technology, Building technology and General Metalwork (Welding and fabrication, Machining, Forging, Foundry).

General Metalwork deals with the process of working with metal to create machine parts, it is a process of shaping, forming, melting and bending metals to originate and create tools, objects and equipment or structures (Buhari & Idris, 2024). Metalwork is designed to help students to take advantage of their hands, portable tools and machines in the workshops to produce simple work pieces, demonstrate knowledge, understanding of materials, and apply the principles of logical planning in the manufacturing using metals in Solid or liquid state (Foundry) and also observe safety measures in operation the machineries and using tools.

Foundry is defined as a method of pouring molten metal into a cavity or shape which when solidified is removed as a product. Foundry is one of the oldest manufacturing processes in general metalworking (Olsen, 2020). The teaching and learning of Foundry, has five 5 steps these are: Pattern making, Core making, Mold preparation, Melting and pouring, and Cleanings. Since, foundry involved a number of steps in teaching, for better understanding students should work together and learn in cooperation.

Cooperative learning is a strategy that allows students to be actively involved in teaching and learning. According to Wang (2020) cooperative learning strategy is a team of learners that requires individual participation through responses, positive interdependence, face-to-face interaction, interpersonal adjustments, skills, and processing of knowledge to improve their understanding of a subject matter. There are several cooperatives learning methods used in this regard. These includes Team Accelerated Instruction (TAI), Teams Games Tournament (TGT), Students Team Achievement Division (S TAD), Think-Pair-Share (TPS), Cooperative Based (BS) JIGSAW IV as well as Numbered-Heads Together (NHT).

In Numbered-Heads Together (NHT) students are learning in small groups; learners in the group should work together and assume personal as well as group responsibility during theory as well as practical (Mauliza, 2020). In this strategy each member of the group is responsible for their group assignments, so that, there is no distinction between students who can give and receive input from one another. Numbered-Heads Together (NHT) is unique among the Cooperative learning strategies that encourage working together between learners, fundamentally building up strengths, increasing their potential and better academic achievements (Oppermann, 2019).

Academic Achievement refers to the students' or scholars' measurable outcome or performance in their Academic pursuit typically evaluated in terms of grades, test scores and other assessments (Hattie & Donoghue, 2020). It is described as phenomenon that encompasses various aspects, including cognitive achievements, such as grades and test scores, as well as non-cognitive outcomes, such as motivation, interest, retention, self-efficacy, and social skills (Organization for Economic Cooperation and Development (OECD) 2020). It is contended that, students' academic achievement is dependent on several interrelated factors such as learning environment, instructional methods, teaching strategies, teachers' attitudes, students' attitudes, interest to the learning activities and motivational background and retention (Eze, Ezenwefor & Obidile, 2020).

Retention is the ability of the students to keep or retain the knowledge of what was learned, and be able to remember or put in to use practically when it is required. Retention entails the ability of a student to recall or remember what has been taught after a given period of time especially with respect to measuring students' progress, and is an important aspect of the educational progression (Eze & Nwalo, 2021). The success of retrieval depends upon effective and meaningful learning that involves connection of prior knowledge that stimulate future recall of learnt aspects through the use of better teaching strategy (Emmanuel & Omobolanle, 2020). Thus; inability to retain learnt skills for long period of time by metalwork students will result in poor academic achievement in Foundry.

Despite the overall relevance and importance of foundry in provision of jobs for national development, the academic achievement of metalwork students in Technical Colleges of Kano State in not encouraging (Afolabi, 2020). Several researchers blamed the teaching approaches adopted by teachers as inappropriate (Adeyemi, 2020). Most teachers in technical college employed conventional teaching which have resulted in articulating low academic achievement of students in examination. National Business and Technical Examination Board (NABTEB) (2019-2023) shows that the percentage of students who passed metalwork at credit level and above fluctuates, and have not increased as expected through the years. This study, therefore, employed NHT in teaching foundry to observe if students' academic achievement, and retention would improve.

Statement of the Problem

The aim of training students with practical skills and general knowledge in technical colleges among others is to prepare them for white collar and blue-collar jobs in the labor market. But in recent academic sessions the students' academic achievement in technical subjects fluctuates. Adeyemi (2020) asserted that technology education has recorded low academic achievement of students in various technical course over the years. In view of these trends in the students' achievement, there is no doubt that the situation needs urgent attention. Sylvester and Friday (2020) opined that, in the situation where instructional method is irrelevant, it is extremely difficult to both students and teachers to be in the same phase during learning; teacher not enjoying the teaching while the student were bored and passive, these burnt out the enthusiasm of the teachers and also belittled the retention in the students, and also leads to the fluctuations of their academic achievement in metalwork. National Business and Technical Examination Board (NABTEB) chief examiners report (2019-2023)

have also shown that the percentage of students results in metalwork at credit level and above is low, which could be attributed to teaching strategy among others, and it may be the reason, why, students in technical colleges especially those that offered Metalwork technology are lacking the necessary skills for gainful employment (Dokadawa, 2017); it may also be the reason why criminal activities are on the rise in Kano State (Yakasai, 2018).

Table 1: NABTEB Examination Results of General Metalwork 2019-2023 Kano State.

Session	Total No. of Students	No. of Students Passed	% Passed	No. of Students Failed	% Failed
2019/2020	418	209	50	209	50
2020/2021	528	238	45	290	55
2021/2022	544	250	46	294	54
2022/2023	599	311	52	288	48
2023/2024	691	289	42	382	56

Source: Science and Technical Schools Board, Kano State. (2024)

Table 1 indicated the dwindling results and failure of Metalworking students in NABTEB examinations for the five (5) years (sessions) considered in this study. To effectively teach Foundry technology theoretically and practically, teachers should have strategies that will enable them to enhance the teaching of the subject (Dokadawa, 2017). To cater for these important reservations, and to have stable and replicated good academic achievement, a traditional method of teaching appears to be obsolete, which perhaps poses a challenge to teachers and teaching strategies. With this background, there is a need to examine the effects of the Numbered-Heads Together (NHT) cooperative learning strategy on technical college students' academic achievement and retention in a foundry in Kano state.

Objectives of the Study

The aim of the study was specifically to:

1. Determine the effect of Numbered-Heads Together (NHT) cooperative learning on students' academic achievement in foundry among technical colleges in Kano state.
2. Investigate the effect of Numbered-Heads Together (NHT) on students' retention in learning of foundry in technical colleges in Kano state.

Research Questions

The following research questions were framed to guide the study:

1. What is the difference in the mean academic achievement score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method?
2. What is the difference in the mean retention score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method?

Research Hypotheses

The research hypotheses were tested at 0.05 level of significance.

H_{O1}: There is no significant difference in the mean academic achievement score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method.

H_{O2}: There is no significant difference in the mean retention score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method.

Methodology

The study adopted a quasi-experimental design involving pretest, post-test, and post-posttest nonequivalent control groups. The population comprised 2940 NTC II metal students from all technical colleges, 2 intact classes from 2 colleges out of 32 were randomly selected as the sample. The Foundry Achievement Test (FAT) with 30 objectives served as the

instrument for data collection. The instrument was validated by 6 experts; it was also subjected to reliability test and yielded coefficient of 0.812 using the Cronbach Alpha method. The study lasted for 6 weeks for both experimental and control groups, after data were collected. Descriptive statistics of mean and standard deviation were used in answering the research questions while inferential statistic, specifically ANCOVA were used in testing the hypothesis at a 0.05 level of significance. The data analysis was carried out using Statistical Package for Social Sciences (SPSS version 25).

Results

Research Question 1: What is the difference in the mean academic achievement score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method?

Table 2: Pre-test and Post-test Mean Scores of Academic Achievement of Students Taught Foundry Using Numbered-Heads Together and Those Taught with the Conventional Teaching Method

		Pre-test		Post-test		
Groups	**N**	$\bar{\chi}$	**SD**	$\bar{\chi}$	**SD**	**Mean Gain**
Numbered Heads Together	37	15.34	2.96	26.68	2.57	11.34
Conventional Lecture Method	32	16.66	3.11	21.85	2.98	5.19
Mean Difference		1.32		4.83		6.15

The result presented in Table 2 shows that the experimental group that were taught foundry using Numbered-Heads Together had a mean score of 15.34 and SD of 2.96 in pre-test and a mean score of 26.68 and SD of 2.57 in the post-test making a pre-test, post-test mean gain in this experimental group to be 11.34. The control group taught using conventional teaching method had mean score of 16.66 and SD of 3.11 in pre-test and mean score of 21.85 and SD of 2.98 in the post-test making pre-test, post-test mean gain of 5.19. With these results, both Numbered-Heads Together and conventional teaching method were effective in enhancing students' academic achievement in foundry, but the effect of Numbered-Heads Together on enhancing students' academic achievement in foundry is higher than the effect of conventional teaching method.

Hypothesis 1: There is no significant difference in the mean academic achievement score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method.

Table 3: Analysis of Covariance (ANCOVA) of the Test of Significance Difference of Student Academic Achievement Taught Foundry Using Numbered-Heads Together and Those Taught with the Conventional Teaching Method

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	2438.57[a]	2	1219.29	26.87	.000	.529
Intercept	14280.92	1	14280.92	315.03	.000	.868
Pretest	382.74	1	382.74	8.45	.006	.150
Group	1841.38	1	1841.38	40.60	.000	.461
Error	2178.91	66	45.39			
Total	180675.00	69				
Corrected Total	4617.48	68				

a. R Squared = .528 (Adjusted R Squared = .504)

The result presented in Table 3 Shows that the type III sum of squared 1841.38 at df of 1, F-calculated value is 40.60 with a significance of F at .000 which is less than 0.05. The result

revealed that there is a significant difference between the effects of treatments (Numbered-Heads Together and conventional teaching method) on students' academic achievement in foundry. The null hypothesis is therefore rejected at 0.05 level of significance. Therefore, there is significant difference in the mean academic achievement scores of students taught foundry using Numbered-Heads Together and those taught using conventional teaching methods. The Partial Eta Squared (0.461) indicated a large effect size, meaning that approximately 46.1% of the variation in posttest achievement explained by the teaching method used.

Research Question 2: What is the difference in the mean retention score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method?

Table 4: Pre-test and Post-test Mean Retention Score of Students Taught Foundry Using Numbered-Heads Together and Those Taught with the Conventional Teaching Method

		Post-test		Post-posttest		
Groups	**N**	$\bar{\chi}$	**SD**	$\bar{\chi}$	**SD**	**Mean Gain**
Numbered Heads Together	37	26.68	2.57	22.10	2.64	4.58
Conventional Teaching Method	32	21.85	2.98	16.34	3.10	5.51
Mean Difference		4.83		5.76		0.93

The result presented in Table 4 shows that the experimental group that were taught foundry using Numbered-Heads Together had a mean score of 26.68 and SD of 2.57 in post-test, a mean score of 22.10 and SD of 2.64 in the post-posttest making a post-test, post-posttest mean gain to be 4.58. The control group taught using conventional teaching method had a mean score of 21.85 and SD of 2.98 in post-test and a mean score of 16.34 and SD of 3.10 in the post-posttest making post-test, post-posttest mean gain of 5.51. With these results, both Numbered-Heads Together and conventional teaching method were effective in enhancing students' retention ability in foundry, but the effect of number heads together on enhancing students' retention ability in foundry is higher than the effect of conventional teaching method.

Hypothesis 2: There is no significant difference in the mean retention score of students taught foundry using Numbered-Heads Together (NHT) and those taught using conventional teaching method.

Table 5: Analysis of Covariance (ANCOVA) of the Test of Significance Difference of Student Retention Taught Foundry Using Numbered-Heads Together and those Taught with the Conventional Teaching Method

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	1795.48a	2	897.74	23.84	.000	.498
Intercept	12984.21	1	12984.21	345.24	.000	.878
Post-test (Covariate)	314.62	1	314.62	8.37	.006	.149
Group	1478.13	1	1478.13	39.31	.000	.450
Error	1804.74	66	37.60			
Total	169845.00	69				
Corrected Total	3599.12	68				

R Squared = .498 (Adjusted R Squared = .474)

The result presented in Table 5 shows that the type III sum of squared 1478.13 at df of 1, F-calculated value is 39.31 with a significance of F at .000 which is less than 0.05. The result revealed that there is a significant difference between the effects of treatments (Numbered-Heads Together and conventional teaching method) on students' retention in foundry. The null hypothesis is rejected at 0.05 level of significance. Therefore, there is significant difference in the mean retention score of students taught foundry using Numbered-Heads Together and those taught using conventional teaching methods. The Partial Eta Squared (0.450) indicated a large effect size, meaning that approximately 45.0% of the variation in posttest retention explained by the teaching method used.

Discussions of Findings

This study investigated the effects of Numbered-Heads Together on students' academic achievement and retention in foundry in technical colleges of Kano state, Nigeria. The finding of the study revealed that students taught using the Numbered-Heads Together strategy performed better in academic achievement than those taught using the conventional teaching method. The experimental group students were in group of 5 students, the group members are accountable to each other, they wrote, read, brainstorm, and give the answers together with agreement of each member, these gave them opportunity to gained better understanding of the concept taught (foundry) and have good result in learning. This finding was consistent with Ogunbote and Dawodu (2023) who reported that cooperative learning significantly improved students' academic achievement in metalwork technology compared with lecture method because learners actively participated in the learning process.

The finding also agrees with Sherin and Waad (2025) who found that students exposed to Numbered-Heads Together achieved higher scientific concept acquisition than those taught conventionally. In addition, the finding aligned with Audu, Gimba and Abdulrahman (2026) who investigated NHT in algebra among secondary school students in Niger State, Nigeria, and reported that students exposed to NHT achieved higher mean scores and demonstrated better retention due to collaborative problem-solving. The above findings were supported by Astin's Student Involvement Theory 1984 who explained how students' active participation in academic and social activities influences their learning outcomes and persistence in school.

However, the finding on research question one contradicts Emerson, English and McGoldrick (2024), who conducted a study and reported that students exposed to cooperative learning strategies did not achieve significantly higher scores than those taught using individual learning approaches.

The corresponding hypothesis tested using ANCOVA revealed a significant difference in students' academic achievement; this agrees with Nursyamsi and Aloysius (2016) and Juweto (2015) in secondary school instruction, both of whom reported significant differences in favor of Numbered-Heads Together learning strategy. The implication is that despite some contradictions, Numbered-Heads Together learning strategy remains a more effective instructional strategy for improving academic achievement in technical subjects when properly implemented.

The finding of the study in research question two indicated that students taught using the Numbered-Heads Together (NHT) strategy retained more knowledge over time compared to their counterparts taught using the conventional teaching method. The retention occurred after good understanding of learned aspects, the NHT teaching strategy put students together during learning and unite them in every stage during, this gave them opportunity to remember and remind each other even after the lesson, this motivates retention. The finding is supported by Bloom Mastery learning theory 1968, where he explained that student will remember and retained knowledge when provided with the appropriate learning conditions. In mastery learning, students are assisted by the teacher to master each learning unit before proceeding

to the next. This instructional philosophy of Bloom Mastery learning theory is based on the belief that all learners can learn if given the appropriate amount of time and the appropriate instructional opportunities through re-teaching, peer tutoring and small group discussion. The finding aligns Darwaman (2021) who reported that senior high school students exposed to NHT demonstrated higher understanding scores than those taught conventionally.

Similarly, Tristaningrat et al. (2024) found out that NHT, particularly when reinforced with interactive media, improved long-term recall of concepts in natural and social sciences. Sherin and Waad (2025) further supported this finding, emphasizing that students engaged in NHT not only acquire concepts faster but also maintain understanding over time due to repeated peer interactions and accountability within the group. The implication of these findings is that cooperative learning strategy (NHT) can significantly reduce forgetting and promote lasting comprehension, making it a valuable pedagogical tool for technical and vocational education and training (TVET).

However, the finding is in contrast with Sari et al. (2023), who found the use of Numbered-Heads Together did not produce a significant improvement in students' learning outcomes over time, indicating that retention may not always be enhanced through cooperative strategy alone. Therefore, for NHT to effectively improve retention there should be some pedagogical additives like conducive learning atmosphere, good and relevant teaching aid and suitable instructional strategy. The corresponding hypothesis tested using ANCOVA revealed a statistically significant difference in retention between students taught with Numbered-Heads Together and those taught conventionally, this outcome is supported by Nwuba et al. (2023), who also demonstrated that NHT significantly fosters students' retention in technically oriented lessons.

Conclusion

This study aimed to provide a best learning strategy for students and modified teaching strategy for teachers teaching Foundry, metalwork and TVET in general. The study investigated the effect of NHT on students' academic achievement and retention in foundry. Thus, the study concluded that NHT improved students' academic achievement in foundry, it also concluded NHT improved metalwork students' retention abilities in learning of foundry in Technical Colleges in Kano State. Though, the study was limited to only male technical colleges, because there are no female technical college in Kano, which may affect the generalizability of the findings to all gender. However the study focused solely on foundry topics, which limits the applicability of the findings to other metalwork topics or technical subjects.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Adoption of NHT. the study recommended the adoption and consistent usage the NHT in teaching foundry in technical colleges. The teachers, school administrators are responsible in integrating NHT in to lesson plan, which will give students opportunity to work together and have good retention and enhanced academic achievement.
2. Teachers training and awareness. Kano State government through Science and Technical Schools Board should train teachers on how to apply NHT, and create awareness via publications, seminars, conferences about effectiveness of Numbered-Heads Together (NHT) in enhancing cooperative learning between students and providing better academic achievement.

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