

Effect of Task Instructional Sheets on Foundry Students' Retention in Polytechnics in North Central Nigeria

Abdullahi, S. M

Scientific Equipment Development Institute, Minna, Niger State, Nigeria

Abstract: This study was designed to determine the effect of task instruction sheets on foundry students' retention in polytechnics of North Central, Nigeria. This study adopted a quasi-experimental research design. Specifically, the pre-test post-test non-equivalent control group design which involved groups of students in their intact classes assigned to experimental and control group. The sample size for this study was 271 and comprised 236 males and 35 female students in all the intact classes in the participating schools. The experimental group had a population of 138 subjects made up of 116 male and 22 female students while control group had a population of 133 subjects comprising 120 male and 13 female students. Two research questions were formulated and three null hypotheses tested at 0.05 level of significance. The instruments used for data collection for this study was Metal Casting Technology Retention Test (MCTRT). To ensure content validity of the MCTRT. The MCTRT was trial-tested to determine the suitability and reliability coefficient which was found to be 0.87 for MCTRT using Kuder-Richardson formular 20 (KR-20) approach. To collect data, students in both groups were subjected to pre-test before experiment, posttest after the experiment as well as administering of MCTRT. Mean was used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses that guided the study at .05 level of significant. The study found out that there was a positive effect of gender on students' retention in sand casting favoring boys. The study also found out that there was significant interaction effects of treatments and gender on Foundry students' retention in sand casting. It was therefore, recommended among others that Foundry lecturers/ teachers should adopt the use of task instruction sheet in teaching sand casting, The National Board for Technical Education (NBTE) should support instructional effectiveness by training teachers on the use of task instruction sheet as well as in design of task instruction sheet lesson plans for use in polytechnics.

Keywords: Foundry, students, retention, polytechnic, sheets

I.INTRODUCTION

Technological advancement has brought about numerous changes in manufacturing and production processes in industries. Effort to reduce production cost on metallic objects has necessitated the use of more cost effective manufacturing process such as sand casting which is a cost effective manufacturing process (Jain, 2010). Foundry according to Beeley (2011), is a factory where molten metal is poured into moulds to make desired objects of various shapes. It can also be referred to as a place equipped for carrying out metal

casting. Casting is a manufacturing process that involves pouring a liquid content into a hollow mould until the content cools and solidifies to form the desired shape (Kumar, 2011). Therefore metal casting is a manufacturing process in which hot liquid metal is poured or forced into a mould after which the liquid metal cools and solidifies to form a piece of metal. This implies that a casting is the object or product produced when hot liquid metal poured into a mould cools and solidifies.

In a foundry, metals are cast into shapes by melting them into a liquid, pouring the metal in a mould, and removing the mould material or casting after the metal has solidified as it cools. Kumar (2011) revealed that the most common metals processed are aluminium and cast iron. However, other metals, such as bronze, brass, steel, magnesium, and zinc, are also used to produce castings in foundries. Gregory (2011) enumerated the types of casting techniques or processes as centrifugal casting, die casting, vacuum casting and sand casting. Even though there are various types of casting techniques, sand casting is the focus of this study because it is the most commonly used technique for metal casting in foundry industry. Sand casting according to Gregory (2011) is a metal casting process or technique that involves pouring a molten metal into a sand mould after which the molten metal cools and solidifies to form a casting of desired shape.

Sand casting is therefore distinguished from other casting technique because it is characterized by the use of sand as the mould material. Srinivasan (2010) highlighted six basic steps involved in sand casting operation, these include: obtaining the casting geometry, patternmaking, core making, moulding, melting and pouring as well as cleaning and other required finishing operations. Obtaining the casting geometry involves getting design dimensional measurement for the desired casting; patternmaking is production of the pattern or a physical model of the casting used to make the mould; core making is the production of core usually made of sand which are placed into a mould cavity to form the interior cavities of castings.

Moulding consists of all operations necessary to prepare a mould for receiving molten metal; melting and pouring is the preparation of molten metal for casting and transfer of the molten metal into the mould cavity; while cleaning refers to

all operations necessary for the removal of sand, scale, and excess metal from the casting. Example of engineering products that can be produced through sand casting technique include engine block, pump, crank shaft, cam shaft, engine bracket, cylinder head, door handles, locks, the outer casing or housing for electric motors, wheels of many cars, planes and valve housing among others (Jain, 2014).

Retention of learning according to Anene (2015) is the ability of a learner to recall what has been learned after a period of time. Therefore retention of learning in sand casting connotes the ability of foundry students' to efficiently recall concepts, principles, processes and operational procedures for carrying out effective sand casting operation learned over a period of time. Momoh-Olle (2007) defined retention of learning as the repeat performance of a learner's behaviour earlier acquired after an interval of time. Retention is the preservative factor of the mind (Kundu & Totoo, 2007). According to Kundu and Totoo (2007), whatever touches consciousness leaves trace or impression and is retained in the mind in form of images. Boyle, Duffy and Dunleavy (2013) posited that students' retention in learning is influenced by factors such as teachers' pedagogical ability, teachers' knowledge of subject matter, motivation, students' interest in learning the course, meaningfulness of subject matter, methods of instruction, memory capacity of the learner among others.

It is however not certain as to the effect TIS would have on the gender disparity that exists in technical education and mechanical engineering subjects especially Foundry technology. This is because gender is a major issue that affect female enrolment and performance in Foundry. The Foundry class in Polytechnics in North central Nigeria is dominated by male students. The high ratio of male to female students in Foundry class appears as if the course is meant only for the male gender (Yakubu, 2014).

Gender refers to sex deference and the status of being male or female. Gender factor has assumed prominence in engineering, science, vocational and technical education subjects. In Nigeria technical educational system, gender is important as it tends to influence the pattern of school enrolment and academic performance of students. Raymond (2013) opined that the general societal belief that technical trades and engineering related tasks belong to the male students could be responsible for the high ratio of males to females in technical colleges in Nigeria. This according to Owodunni (2009) is partly because gender roles affect familiarity with academic content, career aspirations, attitude toward subjects, teacher expectations and preferred approaches which also affect academic performance. It has been documented that disparity exists between male and female students performance in engineering, science, vocational and technical subjects.

It is on the basis of the unpredictability of the effect of TIS on foundry students' retention in sand casting that it becomes

necessary to carry out this study to determine the effect of task instructional sheets on foundry students' retention in polytechnics of North central, Nigeria.

II. STATEMENT OF THE PROBLEM

Foundry students graduating from Polytechnics at National Diploma (ND) and Higher National Diploma (HND) levels are expected to be able to have acquired adequate technical knowledge and skills in sand casting and other areas of Foundry technology needed to further education, secure employment, practice foundry trade, become self-reliant economically and be able to employ others (FRN, 2013). Unfortunately Foundry graduates from Polytechnics in North Central Nigeria appears not to have fully achieved these objectives, as they roam about the streets without the needed practical skills for employment. This is obvious from the high rate at which the graduates abandon their trades for commercial motor cycling (Okada) and other unskilled areas of human endeavor for daily survival. According to Adetokunbo (2009), the rising rate of unemployment among mechanical engineering students from Polytechnics who have been taught Foundry courses is alarming and has generated numerous questions on the functionality and relevance of the conventional teaching method used in teaching Foundry courses at the Nigerian polytechnics.

This according to the Diraso, Manabete, Amalo, Mbudai, Arabi and Jaoji (2013), is due to the fact that their lessons are mostly through theoretical demonstration method and students virtually do not have opportunity to apply what they learnt in solving new or unfamiliar problems. Yakubu (2014), affirmed that the conventional demonstration method deprive students the full opportunity to participate in practical tasks at every stage of learning a foundry operation and the skill inherent. Perhaps, the use of task instructional sheets technique which allows active students' participation in specific instructional tasks may help improve students' retention in sand casting.

Hence the need to carry out this study to establish the gap in the existing body of knowledge regarding the effect of task instructional sheets on foundry students' retention in polytechnics of north central, Nigeria.

Purpose of the Study

1. Task instructional sheets on students' retention of learning in sand casting.
2. Gender (male and female) on students' retention of learning in sand casting when taught with task instructional sheets.

Research Questions

1. What is the effect of task instructional sheets on students' retention of learning in sand casting?
2. What is the effect of gender (male and female) on students' retention of learning in sand casting when taught with task instructional sheets?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

- 1: There is no significant difference between the retention mean scores of students taught sand casting using task instructional sheets and those taught with conventional teaching method.
- 2: There is no significant difference between the male and female students taught sand casting using task instructional sheets and those taught with conventional teaching method with respect to their retention in sand casting.
- 3: There is no significant interaction effect of treatment given to students and their gender with respect to their retention ability in sand casting.

III. METHODOLOGY

This study adopted a quasi-experimental design. Specifically, the pre-test post-test non-equivalent control group design was employed for the study. The study was carried out in the Polytechnics offering Mechanical Engineering at North central Nigeria which comprised the following geographical areas: Benue State, Kogi State, Kwara State, Nasarawa State, Niger State, Plateau state and Federal Capital Territory, Abuja. The choice of Polytechnics in North central geo political zone is due to the rising level of unemployment prevailing among graduates of Mechanical Engineering programme from Polytechnics in this region.

The target population of this study as gathered from the Head of Departments in the Polytechnics involved was 637 ND 2 Mechanical Engineering students in all the intact classes in all the accredited public (state and federal government) owned polytechnics in North central Nigeria. This comprised 565 males and 72 females. ND 2 Mechanical Engineering was used for this study because at this level all the Mechanical Engineering students offer the course Foundry Technology and Forging Operations (MEC 215) as a subject for the first time, thereby exposing a large population of engineering students to the fundamentals of foundry technology and practice needed for self-reliance and employment upon graduation from the ND programme.

From the target population of 637, multi-stage sampling technique involving three stages was used to arrive at a sample size for this study which is 271 that comprised 236 male and 35 female students in all the intact classes in the participating schools.

Two polytechnics each was assigned as experimental group A which was taught with task instructional sheet technique and the other two polytechnics as experimental group taught with conventional method. During the field work (experiment), to control experimental bias, the researcher kept the names of the experimental schools A and B as secret. Since all the intact classes in the participating schools were used, there was no sampling at this stage. Therefore, a sample size of 271 was

arrived which comprised 236 males and 35 female students in all the intact classes in the participating polytechnics. The experimental group A had a population of 138 subjects made up of 116 male and 22 female students while experiment group B had a population of 133 subjects comprising 120 male and 13 female students.

The instruments used for data collection in this study are Metal Casting Technology Retention Test (MCTRT). The MCTRT which was developed by the researcher is a 40-item multiple-choice objective test that covered metal casting technological concepts.

To ascertain the appropriateness of the instrument developed, three experts from Industrial and Technology Education Department, Federal University of Technology (FUT) Minna. They assessed the appropriateness of the language usage in the test, the sequential presentation of task and content coverage of course in the metal casting technology.

After the validation of the instruments, a trial test or pilot testing of instruments (MCTRT) was conducted on foundry students in Fidei Polytechnic, Gboko, Benue State. The students in this school were used for the trial study because they do not form part of the study as it is a privately owned polytechnic; while this study focuses on public Polytechnic. Since the test items of MCTRT are multiple choice type, Kuder-Richardson formula 20 (K-R 20) was used to determine the reliability coefficient which was found to be 0.89.

The lecturers subjected the students in both groups to pre-testing before experiment. In the pre-test the MCTRT was administered on the students. Answer sheet was provided for the students to fill in the correct answer. The researcher collected the answer sheet and marks them to obtain the students' scores.

Data analysis was carried out with the use of mean and Analysis of Covariance (ANCOVA). The research questions were analyzed using the mean; the mean gain of each group was computed to determine the effects of task instructional sheet on student's achievement, skill performance and interest. While the hypotheses formulated to guide the study was tested at 0.05 level of significance using ANCOVA.

IV. RESULTS

Research Question 1

What is the effect of task instructional sheets on students' retention of learning in sand casting?

Table 1: Posttest and Retention test Mean Scores of Experimental and Control Groups in the Retention Test

Group	N	Posttest	Retention test	Mean Gain
		\bar{X}	\bar{X}	
Experimental	138	76.65	60.12	-16.53
Control	133	38.65	29.79	8.86

Table 1 shows that the experimental group had a mean score of 76.65 in the post-test and a mean score of 60.12 in the retention test leading to a posttest-retention test mean gain of -16.53 for the experimental group. The control group had a mean score of 38.65 in the post-test and a mean score of 29.79 in the retention test resulting to a posttest-retention test mean gain of 8.86 for the control group. This result reveals that, the students in the experimental group taught with TIS performed better in the retention test than the students in the control group. Hence the students taught sand casting with the task instructional sheets displayed higher retention of learning than those taught without it.

Research Question 2

What is the effect of gender on students’ academic achievement in sand casting when taught with task instructional sheets?

Table 2: Pre-test and Post-test Mean Scores of Male and Female Students Taught Sand Casting in the Achievement Test

Gender	Task Instructional Sheets				Conventional Teaching Method			
	N	Pretest	Post-test	Mean Gain	N	Pretest	Posttest	Mean Gain
		\bar{X}	\bar{X}	\bar{X}		\bar{X}	\bar{X}	\bar{X}
Male	116	12.66	80.26	67.60	120	10.79	39.13	28.34
Female	22	8.14	57.64	49.50	13	6.00	34.23	28.23

The result presented in Table 2 revealed that male students in the experimental group taught sand casting using Task Instructional Sheets (TIS) had a pre-test mean achievement score of 12.66 and a post-test mean achievement score of 80.26, resulting to a pre-test post-test mean gain of 67.60, while their female counterpart taught using TIS had a pre-test mean achievement score of 8.14 and a post-test mean achievement score of 57.64, resulting to a pre-test post-test mean gain of 49.50. Also male students in the control group had a pre-test mean achievement score of 10.79 and a post-test mean achievement score of 39.13, resulting to a pre-test post-test mean gain of 28.34, while their female counterpart had a pre-test mean achievement score of 6.00 and a post-test mean achievement score of 34.23, resulting to a pre-test post-test mean gain of 28.23. With these results, male and female students taught sand casting using Task Instructional Sheets had a higher mean gain score in the achievement test than those taught without it. This result also showed that the male students performed better than females. This could be an indicator of the existence of a gender attribute or factor that has an effect on the achievement of students in sand casting.

Hypotheses Testing

H₀₁: There is no significant difference in the mean retention scores of students taught sand casting using task instructional sheets and those taught without it.

H₀₂: There is no significant difference in the mean retention scores of male and female students taught sand casting using task instructional sheets and those taught without it.

H₀₃: There is no significant interaction effect of treatments given to students and their gender with respect to their mean retention scores in sand casting.

Data that tested these research hypotheses are presented in Table 3.

Table 3: Summary of ANCOVA for test of Significance of Three Effects: Treatments, Gender and Interaction Effects of Treatments and Gender on Students’ Retention in Sand Casting

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	102555.299 ^a	4	25638.825	3585.773	.000
Intercept	783.297	1	783.297	109.550	.000
MCTART2	492.276	1	492.276	68.848	.000
Treatment	1103.212	1	1103.212	154.292	.000
Gender	387.301	1	387.301	54.167	.000
Treatment * Gender	638.770	1	638.770	89.337	.000
Error	1901.941	266	7.150		
Total	749847.000	271			
Corrected Total	104457.240	270			

^aSignificant at sig of F<0.05

*df=degree of freedom, F= ANCOVA F-ratio calculated, Sig.=Probability value calculated, Sig of F= Significance of F calculated, F<0.05=Alpha level for taking decision on hypothesis when compare with calculated Sig of F (p-value).

The data presented in Table 3 showed F-calculated values for three effects: treatments, gender and interaction effect of treatments and gender on students’ retention in sand casting. The F-calculated value for treatment is 154.924 with a significance of F at 0.000 which is less than 0.05. With this result, there is a significant difference in the mean retention scores of students taught sand casting using task instructional sheets and those taught without it. The null hypothesis on the effect of treatments on students’ retention of sand casting is therefore rejected at 0.05 level of significance, while the alternative hypothesis is upheld. Hence there is significant difference in the mean retention scores of students taught sand casting using task instructional sheets. The F-calculated value for gender is 54.167 with a significance of F at 0.000 which is less than 0.05. This means that there is a significant difference in the mean retention scores of male and female students taught sand casting using task instructional sheets. Therefore, the null hypothesis on the effect of gender on students’ retention of sand casting is rejected at 0.05 level of significance, while the alternative form of the hypothesis is accepted. Hence there is significant difference in the mean retention scores of male and female students taught sand casting using task instructional sheets. Also the interaction of

treatments and gender has F-calculated value of 89.337 with significance of F of 0.000. Since 0.000 is less than 0.05, there is significant interaction effect of treatments given to students and their gender with respect to their mean retention scores in sand casting. Therefore the null hypothesis for interaction effect of treatment and gender with respect to students' retention in sand casting is rejected.

V. DISCUSSION OF FINDINGS

The data presented in Table 1 provided answers to research question two. The finding revealed that students taught sand casting using task instructional sheets retained their learning better than those taught with the conventional teaching method as it was noted that the students taught with Task Instructional Sheet (TIS) had a higher mean score in the retention test. Analysis of Covariance (ANCOVA) was used to test the hypothesis, Table 3. At the calculated F-value for treatment (154.292) with significance of F at (.000) and confidence level of .05, there was a statistically significant difference between the main effect of treatment (task instructional sheet and conventional method) on students mean retention scores in sand casting, in favour of TIS group which had higher mean retention scores. The finding is a confirmation that the difference between the main effect of task instructional sheet and conventional method was statistically significant at the given confidence level with regard to students retention of learning. The implication of this finding is that Task instructional sheet is more effective than the conventional teaching method in enhancing students' retention of learning in sand casting.

The findings compared favorably with the findings of Roy (2010) who in a study on the influence of task-centered pedagogy on the achievement of students in elementary schools found out that relative to students taught traditionally, students taught with task instructional sheets tend to exhibit higher retention, higher academic cognitive performance, better high-level reasoning as well as critical thinking skills. Ozofor (2010) in a study on development and validation of a task instructional sheet to facilitate student's performances in science and technology education found out that the higher retention of learning achievable through task instructional sheet method lies in the fact that the task instructional sheet assists students to follow written instructions and permits them to progress at their own individual rates thereby enabling them to easily recall the specific tasks procedures followed to achieve learning objectives. The higher retention attained through task instructional sheets could also be attributed to the fact that the performing series of specific tasks give students the avenue to be actively involved in constructing and transforming knowledge. To buttress this, the theoretical framework for constructivism holds that learning always builds upon knowledge that a student already knows; this prior knowledge is called a schema. Because all learning is filtered through pre-existing schemata, constructivists suggest that learning is more effective and easily recalled when a student is actively engaged in the learning process rather than

attempting to receive knowledge passively (Devries & Zan, 2008).

The data shown in Table 2 provided answers to research question six. The findings revealed that male and female students taught sand casting using task instructional sheets retained their learning better than those taught using conventional teaching method in the retention test. There was an effect of gender in favour of male in the retention test as male students taught sand casting using both instructional methods retained their learning better than their female counterparts.

Analysis of Covariance (ANCOVA) was used to test the fifth hypothesis, Table 3. At the calculated F-value for gender (54.167) with significance of F at .000 and confidence level of .05, confirming that there was a significant effect of gender in favour of males in the mean retention scores of male and female students taught sand casting with TIS and when exposed to conventional teaching method. Also Analysis of Covariance (ANCOVA) was used to test the sixth hypothesis, table 3, at the calculated F-value for interaction effect of treatment and gender on retention (89.337) with significance of F at .000 and confidence level of .05. The findings on the interaction effect of treatment and gender on students' retention shows that there was a significant interaction effect of treatments given to students and their gender with respect to their mean retention scores in sand casting. The findings on the significant interaction effect of treatment and gender on students' retention in sand casting implies that TIS is gender bias in enhancing student' retention when used in teaching sand casting. Thus the male students are most likely to retain what is learnt in sand casting better than their female counterpart when TIS is used.

The higher retention obtained by students taught with task instructional sheets could possibly be due to the series of step by step information TIS method provides on how students can carry out series of tasks needed to complete an operation as his obtainable in the workplace through repetitive practice (Boyle *et al.*, 2013). In the view of Boyle *et al.* (2013), higher retention in a subject could be as a result of the fact that retention of learning is the repeat performance of a learner's behaviour earlier acquired after an interval of time, and in the context of this study connotes the ability of foundry students' to efficiently recall concepts, principles, processes and operational procedures for carrying out effective sand casting operation learned over a period of time.

The series of step by step information on how to perform specific operations provided by TIS creates consciousness in the mind of the students and also enhances effective repetitive practice among students. In a study on educational psychology, Kundu and Totoo (2007) revealed that whatever touches consciousness leaves trace or impression and is retained in the mind in form of images. This findings could also stem from the facts that task instructional sheets method is important not only to solving problems in a learning

environment that uses real-world contexts that immerses the learner in the culture of a particular practice, but also it allows learner to witness the practitioners of that culture solve problems and carry out tasks. Contextual scenarios in task instructional sheets method offer the opportunity for students to use a combination of technical skills, workplace skills related academic skills, problem-solving, creativity and other higher-order-thinking skills to solve the problem at hand. This according to Dabbagh and Bannan-Ritland (2015) improve students' academic achievement as well as retention of learning. Similarly, Rosenbaum *et al.* (2012) discovered that instructional methods that actively involve learners in task performance are relevant for promoting achievement and retention of learning. The significant effect of gender in favour of males in the retention test could be attributed to the dominating influence male students over their female counterparts in sand casting class as well as in the performance of sand casting operations which appears to be a masculine in nature.

VI. CONCLUSION

Based on the findings of the study, it was concluded that task instructional sheet is more effective than the conventional teaching method in improving students' retention in sand casting. Similarly, the study revealed that there was an effect attributed to gender on students' retention in sand casting. Also the study revealed that there was significant difference in the retention scores of students taught sand casting using task instructional sheets and those taught with conventional method. There was also a significant interaction effect of treatments given to students and their gender with respect to their retention scores in sand casting.

Despite the gender effect that exist, it was concluded that task instructional sheet is more effective than the conventional teaching method in improving students' retention in sand casting. It is therefore concluded that task instructional sheet is a viable teaching method for improving students' retention in sand casting.

VII. RECOMMENDATIONS

Based on the findings of the study the following recommendations are made:

1. Foundry technology teachers/lecturers should adopt task instructional sheets method to improve teaching and learning of foundry courses.
2. Task instructional sheets should be incorporated into the content and methodology courses of polytechnics at ND and HND level in foundry technology as well as mechanical engineering programme.
3. Encouraging female students' enrolment into mechanical engineering programmes especially foundry technology course. Providing enabling environment to enhance active female participation in foundry technology courses.
4. Government and spirited individuals should provide the state-of-the art foundry workshops so as to bridge

the gap between the workspace and the learning institutions.

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