



## Effect of Hybrid 3D Simulation on Mechanical Engineering Craft Students' Achievement and Retention in Sheet Metal Fabrication in Kano State, Nigeria

<sup>1</sup>Sani Muhammad, <sup>2</sup>Muhammad Muhammad Inti, <sup>2</sup>Ismaila Yelwaji Shehu

<sup>1</sup>Department of Technology and Vocational Education,  
Aliko Dangote University of Science and Technology, Wudil, Kano State, Nigeria

<sup>2</sup>Department of Mechanical Technology Education,  
Abubakar Tafawa Balewa University, Bauchi, Nigeria

### ABSTRACT

The study determined the effect of Hybrid 3D Simulation on Mechanical Engineering Craft Students' achievement and retention in sheet metal fabrication in Kano State. Three research questions were raised and answered, and three null hypotheses were tested. The study adopted a pre-test-post-test control group design. A sample of sixty (60) students from two intact classes of technical colleges (NTC II) were selected using a convenience sampling technique. The researcher used a hybrid 3D simulation instructional package as treatment for the experimental group, while the control group was exposed to the conventional lecture method. The instrument used for data collection was the Sheet Metal Fabrication Achievement Test (SMEFAT), a 25-item multiple-choice achievement test adapted from NABTEB, NECO, and WAEC question papers, modified by the researcher to suit the purpose of the study. For the reliability test, both Pearson correlation and regression analysis were used. The correlation analysis revealed a strong positive correlation between pre-test and post-test scores ( $r = 0.855$ ,  $p < 0.001$ ), while the regression analysis confirmed a strong relationship between pre-test and post-test scores, with post-test scores significantly predicting pre-test scores ( $F = 48.716$ ,  $p < 0.001$ ). This indicated that the instrument was suitable for the study. An independent sample t-test was used to analyze the hypotheses. The findings revealed that the hybrid 3D simulation package was very effective in improving student academic achievement compared to the conventional lecture method. It also showed that the hybrid 3D simulation method is more effective in enhancing knowledge retention than the conventional lecture methods. It was recommended that mechanical craft teachers be encouraged to use hybrid 3D simulation for effective teaching of sheet metal fabrication processes in the classroom.

### ARTICLE INFO

#### Article History

Received: May, 2024

Received in revised form: June, 2024

Accepted: June, 2024

Published online: June, 2024

### KEYWORDS

Hybrid; 3D-Simulation; Mechanical Engineering Craft; Sheet Metal Fabrication; Achievement; Retention; Conventional Lecture Method

### INTRODUCTION

Sheet metal Fabrication is a skill-based course designed to equip the trainees with knowledge, attitude and skills to carry out sheet metal work, and welding processes on all types of metals in order to produce various finished metal products. The major goal of the course in

Technical Colleges is to produce competent craftsmen and master craftsmen for industrial and technological development in Nigeria. In this essence, Sheetmetal Fabrication has been enshrined as a course of study in various technical schools' trades which includes the mechanical engineering craft practice, welding and fabrication,

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



motor vehicle mechanic work, refrigeration and air conditioning, and carpentry and joinery among others (NBTE 2004). Furthermore, the demand for skilled Sheetmetal fabrication technicians is high in today's modern technology and market, with applications in industries such as aerospace, automotive, construction, and consumer goods (Oyedepo, et al, 2021). Despite the growing importance of sheet metal fabrication applications, students in mechanical engineering craft practice and other metal work related programs often struggle to develop the necessary skills and knowledge required for the work environment. It can be established that the technical schools' students are not coping with the challenges at the work place which is an indication of existence of a problem in the scheme. Gyasi, (2013) as cited in Muhammad, (2020) expressed that, poor welding and fabrication management practices, and lack of professional training qualification, and certification are among the major hindering factors to welding and fabrication as a manufacturing process. At one hand, to effectively implement the professional training scheme, the provision of facilities, qualified teaching staff, learning approaches, method of teaching, the learner's interest and learning styles need to be given greater emphasis.

The teaching methods usually determine success for concrete learning to take place. There are many types of teaching methods, ranging from the conventional lecture method, demonstration and description methods to the activity base method to mention but a few. The major impediment in using the conventional lecture method is that lesson contents are taught in abstract terms in which learning tasks are not clearly described and demonstrated in such away the learners can assimilate, comprehend and relate such tasks with the real-life situations. This makes learning to be very difficult as the learning transfer tends to be negative or zero. Researches has shown that conventional lectures are often characterized by a one-way communication, where the teacher give lectures and students listen passively (Gopal, 2018). This approach neglects the diverse learning needs and styles of students, leading to a lack of engagement and

motivation (Kember, 2018). Some studies have also highlighted the limitations of conventional lectures in promoting deep learning and understanding. For instance, research by Krause and Coates (2018) found that students who attended conventional lectures showed limited understanding of complex concepts and were less likely to apply critical thinking skills. Similarly, a study by Vitasari et al. (2018) found that conventional lectures were less effective in promoting student engagement and motivation compared to interactive and student-centered approaches. Furthermore, conventional lectures often fail to provide opportunities for feedback and assessment, which are essential for student learning and improvement (Boud & Molloy, 2018). In another related finding, a research by Carless and Boud (2018) emphasized the importance of feedback in promoting student learning and understanding, highlighting the limitations of conventional lectures in this regard. However, this created a gap between the intended learning outcomes and the student achievement and retention. Academic achievement and retention are two crucial outcomes in education that have been extensively researched. Students' academic achievement refers to their performance in academic tasks, while retention refers to their ability to recall what has been taught over a long time for subsequent use. Research has shown that academic achievement and retention are influenced by a complex array of factors, including student characteristics, teaching methods, and learning environments (Pascarella & Terenzini, 2018).

It was established that, the student's ability to retain knowledge when taught is dependent on several factors. According to Abdullahi, S. M (2020) retention of learning is affected by the degree of original learning, the learner's memory capacity, and the method of teaching. This highlighted the necessity for teachers to use the most effective teaching method and strategy which encourage student's active participation in learning, and provides suitable learning environment to improve achievement and retention. Moreover, teaching method is one of the major factors that influences

---

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



effective learning as it forms the foundation of the instructional process. A research study has emphasized the importance of teaching methods and learning environments in promoting students' academic achievement and retention. For example, a study by Freeman et al. (2018) found that active learning approaches, such as problem-solving and group work, were more effective in promoting students' academic achievement and retention than traditional lecturing methods.

In another development, with the emergence of computer technologies in teaching and learning, the instructional methods have taken a new quantum (Onwusa, 2015). With this development, various computer paradigms that involves the use of pictorial views, animations and simulation which are termed as the computer assisted instruction are today used to demonstrate the abstract learning task and the practical skills intended in the learning objectives. Computer assisted instruction enables the students to learn by self-evaluation and timely reflection on successes and otherwise in their learning process. It has also been established that, the exercises that help learners in the visualization of abstract concepts will encourage their conceptual comprehension. These exercises would be consistent and harmonizing to conventional teaching, and could be concrete physical exercises, or computer simulations and animations (Simsek, 2017).

In this extent, Simulations as an aspect of computer assisted instruction, provides educators with the chances of giving teachers an instructional tool that can enable learners to transform their alternate science and technology theoretical contents into practical concepts. The hybrid 3d simulation method is an excellent computer assisted instruction that can present the sheet metal fabrication processes to the learner effectively. This is because processes like the Bending, Forming, Cutting, Folding, Notching, Finishing and many more can easily be illustrated using various forms of models. The simulation technique is one of the methods that have become indispensable for today's technologies and can be used as part of computer-aided education. Simulation is a type of technology by which

theoretical knowledge is transformed into practice, which simplifies the difficult-to-comprehend, abstract activities and realistically embodies them and can reach a solution in a short time. This makes production skills of various sheet metal fabrication intricate shapes and contours to be learned and comprehended easily and in more concrete terms.

Moreover, in the literature, it was determined that simulations improved student success and performance (Abdel-Maksoud, 2019; Koc-Unal, 2019; & Bayram, 2019). This pave a way of considering the best simulation system that shall be incorporated as teaching tool, for teaching the sheet metal fabrication processes. As such, The Hybrid 3D Simulation is a powerful process simulation system designed to analyze complex, three-dimensional (3D) metal forming processes. It is a practical and efficient tool for the prediction of metal flow, heat transfer and more. Manufacturing operations can be simulated on the computer using the Hybrid 3D Simulation, thereby avoiding much of the cost and delay of workshop process trials. Typical applications include hot forging (closed and open die), warm and cold forming, cogging, rolling, drawing, extrusion, heating, machining and mechanical joining.

However, owing to the fact that the effectiveness of conventional teaching method in teaching sheet metal fabrication has been called into question, and there is a need for innovative approaches to enhance student learning outcomes and retention. The integration of hybrid 3D simulation has the potential to enhance student learning outcomes and retention in Sheetmetal fabrication, but there is a need for empirical research to investigate its effectiveness.

Perhaps, so many studies were carried out on computer 3D simulation and animation teaching methods on students' academic achievement in physics, biology and English in Nigeria and world over. But, the review of the related literature revealed that no research has been conducted on effects of hybrid 3D simulation on student achievement and retention of Sheetmetal fabrication in Technical Schools in Kano State. In this instance, there is need for a research that will determine the efficacy of hybrid

---

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



3D simulation to establish whether its use will have differential effects on mechanical engineering craft students' achievement and retention in Sheetmetal fabrication.

### Aim and Objectives of the Study

The main aim of the study was to examine the effect of hybrid 3D simulation on mechanical engineering craft students' achievements and retention in Sheetmetal fabrication in Kano, Nigeria. Specifically, the study intends to achieve the following Objectives: -

- 1- Determine the pretest mean achievement scores of mechanical engineering craft students taught metal fabrication processes using Hybrid 3D Simulation and those taught with Conventional Lecture Method in Kano State?
- 2- Determine the post-test mean achievement of mechanical engineering craft students taught metal fabrication processes using Hybrid 3d Simulation and those taught with Conventional Lecture Method in Kano State?
- 3- Determine the difference between post-test mean Retention score of mechanical engineering craft students taught Sheetmetal fabrication processes using Hybrid 3D Simulation and that of those taught using Conventional Lecture Method in Kano State?

### Research Questions

The following research questions will be used to guide this study:

- 1- What is the difference between pretest mean achievement scores of mechanical engineering craft students taught metal fabrication processes using Hybrid 3D Simulation and those taught with Conventional Lecture Method in Kano State?
- 2- What is the difference between post-test mean achievement of mechanical engineering craft students taught metal fabrication processes using Hybrid 3D Simulation and those taught with

Conventional Lecture Method in Kano State?

- 3- What is the difference between post-test mean Retention score of mechanical engineering craft students taught Sheetmetal fabrication processes using Hybrid 3D Simulation and that of those taught using Conventional Lecture Method in Kano State?

### Hypotheses

The following null hypotheses will be tested at 0.05 level of significance:

- HO<sub>1</sub>:** There is no significant difference between the pre-test mean achievement scores of the Control Group (Conventional Lecture Method) and that of the Experimental Group (Hybrid 3D Simulation) of mechanical engineering craft practice students taught Sheetmetal Fabrication in Kano state.
- HO<sub>2</sub>:** There is no significant difference between the post-test mean achievement scores of the Control Group (Conventional Lecture Method) and that of the Experimental Group (Hybrid 3D Simulation) of mechanical engineering craft practice students taught Sheetmetal Fabrication in Kano state.
- HO<sub>3</sub>:** There is no significant difference between the retention mean score of the Control Group (Conventional Lecture Method) and that of the Experimental Group (Hybrid 3D Simulation) of mechanical engineering craft practice students taught Sheetmetal Fabrication in Kano State.

### METHODOLOGY

The study employed quasi-experimental design. Specifically, the pretest, posttest, non-equivalent control group design was adopted. According to Gall and Borg (2007), quasi-experimental design can be used when it is not possible for the researcher to randomly sample the subject and assign them to treatment groups without disrupting the academic programmes of the schools involved in the study. As such, this design was used because the subjects will not be selected randomly and assigned to experiment and control groups.

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



Table I; Diagrammatic presentation of Research Design

Group	Pretest	Treatment	Posttest
Experimental	01	X	02
Control	01	-X	02

Where

01 = Pretest for both control and experimental group

02 = Posttest for both control and experimental group

X = Treatment given to the experimental group (Hybrid 3d Simulation Package)

-X = No treatment given to the control group (Conventional Lecture Method)

---- = Non-randomization

The notation above described the pretest- posttest control group design, where the subjects were assigned to treatment and control groups that were subjected to an initial measurement of dependent variable, then the treatment was administered and the dependent variable was measured again. The statistical analysis of this design involves an independent sample t-test to test the effect between the treatment and control groups.

The target population of this study comprises of 73 students of NTC II mechanical engineering craft practice in Kano State technical schools.

Convenience sampling technique was used in the selection of schools and students for the experiment, two out of three major Technical Colleges that offer mechanical engineering craft practice as a course of study were considered for the study. A total sample of 60 students was used for this study. Where 32 students from Government Technical College Kano and 28 students from Government Technical College Bagauda were used to form two intact classes as experimental group and control group respectively.

The instrument used for data collection in this study was Sheetmetal Fabrication Achievement Test (SMEFAT) (See Appendix B). It was a test paper containing 25 multiple choice questions to be adapted by the researcher from NABTEB, WAEC and NECO examination covering sheet metal work courses. The achievement test consisted of 25 items multiple choices questions for the pre-test which was administered to the students before the treatment

in order to ascertain their entry behavior. It was also used for the post-test but the arrangement of the items was changed (See Appendix C).

The hybrid 3d simulation lesson plan, the conventional teaching method lesson plan and the SMEFAT was given to two experts at Kano State University of Science and Technology, Wudil, and one from Vocational and Technology Education, Abubakar Tafawa Balewa University, Bauchi for face and content validation. The validators checked the adequacy of content, logical sequence and technical terms used. Their corrections, suggestions and amendments were made before the final copy of the instrument was used in the study. The reliability of the instrument was trial tested on a representative sample which did not participate in the final study. The correlation analysis reveals a strong positive correlation between Pre-test and Post-test scores  $r = 0.855$ ,  $p < 0.001$ . The correlation coefficient indicates that approximately 73% of the variation in Pre-test scores can be explained by Post-test scores. The regression analysis confirmed the strong relationship between Pre-test and Post-test scores, with Post-test scores significantly predicting Pre-test scores  $F = 48.716$ ,  $p < 0.001$ . The R-squared value indicates that the variation in Pre-test scores can be explained by Post-test scores. The regression coefficient  $B = 1.196$  indicates a strong positive relationship between Post-test scores and Pre-test scores. The results support the reliability of the test instrument, indicating that it can be used with confidence to measure the desired construct.

The pre-test was administered to both experimental and control group to obtain the

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



scores. Thereafter the experimental group student was subjected to the treatment, where the hybrid 3D simulation instructional method was used in teaching the sheet metal fabrication processes, while the conventional teaching method was used to teach the control group. At the end of the treatment, post-test was administered to both experimental and control group with the instrument to obtain the scores. The statistical package for Social Science (SPSS Version 27) was employed for analyzing the data, Mean and Standard Deviation were used to answer the research questions while the Independent Sample T-Test was used to test the research hypotheses at 0.05 alpha level of significance. In the decision rule, the researcher used 100% as the total score of the achievement test, where 40 was used as the mean cut-off points, therefore any mean score that is below 40 indicates fail. While any mean achievement score that is equal to or above 40

was considered as above mean cut-off point which indicates pass.

### RESULT

The results were analyzed and presented based on the raised research questions and formulated hypotheses as follows:

**Research question one:** What is the difference between the pretest mean achievement scores of mechanical engineering craft students taught Sheetmetal fabrication processes using Hybrid 3D Simulation and those taught with Conventional Lecture Method in Kano State?

**HO<sub>1</sub>:** There is no significant difference between the pretest mean achievement scores of the Control Group (CLM) and that of the Experimental Group (H3DS) of mechanical engineering craft students taught Sheetmetal Fabrication using in Kano state.

**Table 1:** T-Test on the difference in the Pretest Mean Achievement Score of Control Group and Experimental Group.

Group	N	Mean	SD	DF	T	P	Std. Error Difference	Decision
Control Group (CLM)	28	34.6071	12.64718	58	.137	.892	3.29557	Accepted
Experimental Group(H3DS)	32	34.1563	12.81156					

Sig. (2-tailed) = p. value=0.892 >0.05

Based on Table 1 above, the t-test for equality of means ( $t(58) = 0.137$ ), while the p. value is  $p = 0.892$  which is greater than the 0.05 alpha value, this shows that, there is no significant difference between the pretest mean achievement scores of the control group and the pretest mean scores of experimental group. Therefore, this analysis supports the null hypothesis which implies that at entry level, the students in both the Experimental Group (H3DS) and the Control Group (CLM) have comparable baseline levels of knowledge and skill.

**Research question two:** What is the difference between the post-test mean achievement of mechanical engineering craft Students taught Sheetmetal Fabrication processes using Hybrid 3D Simulation and those taught with Conventional Lecture Method in Kano State?

**HO<sub>2</sub>:** There is no significant difference between the Post-Test Mean achievement Scores of the Control Group (CLM) and that of the Experimental Group (H3DS) of Mechanical Engineering Craft Students taught Sheetmetal Fabrication in Kano State.

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved

**Table 2:** T-Test of difference between Post-Test Mean Score of the Control Group and the Experimental Group

Group	N	Mean	SD	DF	T	P	Std. Error Difference	Decision
Control Group (CLM)	28	59.7143	7.44290	58	-7.363	.000	2.42409	Rejected
Experimental Group (H3DS)	32	77.5625	10.76715					

Sig. (2-tailed) = p. value=.000 <0.05

Based on Table 2 above, t-test analysis where  $df = 58$ ,  $t = -7.363$ , and  $p = 0.000$ . This indicates a significant difference in posttest scores between the experimental and control groups, hence p. value is less than .0001. As such the null hypothesis was rejected. This suggests that, the Experimental Group (H3DS) which received the Hybrid 3D Simulation Treatment had a positive effect on the achievement scores. This means that the Hybrid 3D Simulation had a significant impact on improving the student achievement, thereby making it more effective in teaching as compared to the Conventional Lecture Method.

**Research question three:** What is the difference between the retention mean score of mechanical engineering craft Students taught Sheetmetal Fabrication processes using Hybrid 3D Simulation and those taught with Conventional Lecture Method in Kano State?

**HO<sub>3</sub>:** There is no significant difference between the retention mean score of the Control Group (CLM) and that of the Experimental Group (H3DS) of mechanical engineering craft students taught Sheetmetal fabrication in Kano State.

**Table 3:** Independent Sample t-test of Difference between Retention Mean Score of the Control Group and the Experimental Group

Group	N	Mean	SD	DF	T	P	Std. Error Difference	Decision
Control Group (CLM)	28	47.7857	8.68953	58	-11.307	.000	2.05862	Rejected
Experimental Group (H3DS)	32	71.0625	7.25542					

Sig. (2-tailed) =p. value=.000<0.0

Based on Table 3 above, shows the  $df$  58,  $t$  -11.307, and p. value is .000, this shows that null hypothesis is rejected. As such, there is significant difference between the retention Mean Score of the Control Group (CLM) and that of the Experimental Group (H3DS) of students taught Sheetmetal fabrication using the Hybrid 3D Simulation. This implied that, the Hybrid 3D Simulation had a significant positive impact on retention as compared to the Conventional Lecture Method.

### DISCUSSION OF FINDINGS

The findings on Research question one shows that, the mean pre-test score of the Control Group (CLM), was 34.61 with a standard deviation of 12.65, while for the Experiment Group (H3DS) the mean pre-test score was 34.16 with a standard deviation of 12.81. These results showed that prior to the instructional intervention, the two groups had similar mean scores on the pre-test, indicating that they started from comparable baseline levels of knowledge and skill. This was further proved by the result of the hypothesis one where, the t-test for equality of means also showed there is no

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



significant difference between the pre-test mean achievement scores of students taught using the Hybrid 3D Simulation instructional method and those taught using the conventional teaching method where the p value was 0.875. As such the null hypothesis was accepted. This further strengthen the finding that the student had the same level of knowledge which made them to be the right subjects for the study. This is in line with the findings of Nkok (2021), in which he established that the pretest mean scores of student in the experimental group and the control group are similar which shows that the student were having the same baseline of knowledge at entry level. The findings on research question two, showed that the mean score for the Control Group (CLM), was 59.71 with a standard deviation of 7.44, while for the Experiment Group (H3DS) was 77.56 with a standard deviation of 10.77. this showed that the Experimental Group that received the treatment out-performed the Control Group that was taught with the conventional lecture method.

Also, the hypothesis two further strengthen this where the independent samples t-test revealed a significant difference between the two groups, where the p. value = .0001 this showed that the null hypothesis which stated that There is no significant difference between the post-test mean achievement Scores of the Control Group (CLM) and that of the Experimental Group (H3DS) of mechanical engineering craft practice students taught Sheet metal Fabrication is rejected. Instead, the findings suggest that the hybrid teaching approach (experimental group) leads to significantly higher academic achievement among mechanical engineering craft practice students compared to the conventional teaching approach (control group) in technical schools in Kano state. This was supported by the finding of Baglama, Yucesoy and Yikmis (2015), Adebayo and Jimoh (2015), Abdel-Maksoud (2019), Koc-Unal(2019), among others who determine that the use of simulation in teaching, improves student success and achievement. As such the hybrid 3d simulation was found to be very effective in improving the mechanical engineering craft students' academic achievement in

Sheetmetal fabrication processes. Based on the findings on research question three, the retention mean score of the Control Group (CLM) was N=28, Mean=47.79 with standard deviation 8.69 and the Experiment Group (H3DS) retention mean score was N=32, Mean=71.06 and the standard deviation of 7.26. This indicated a substantial gap in achievement thereby favoring the Hybrid 3d Simulation retention. Also, the results of hypothesis three further support this, where the null hypothesis was also rejected because group difference is  $df = 58$ , the t-statistic is  $t = -11.307$ , and the p. value is .000 which is less than the alpha value .05, this showed that, the null hypothesis was rejected, which proved that, there is significant difference between the retention mean score of the Control Group (CLM) and that of the Experimental Group (H3DS) of students taught Sheetmetal fabrication using the Hybrid 3D Simulation. This was also proved by the findings of Adebayo and Jimoh (2015), Abdel-Aziz (2013), Mohammed (2014), Nkok (2021), among others found out that students exposed to computer simulation package did significantly better in retention of knowledge than the control group that were exposed to conventional lecture method of instruction, showing that hybrid 3d simulation enhances better retention of learning of Sheetmetal fabrication concepts in mechanical engineering craft students

## CONCLUSION

In conclusion, the result of this study provided empirical evidence that the use of hybrid 3D simulation enhanced students' achievement and retention in sheet metal fabrication processes more than the Conventional Lecture Method. Also, the hybrid 3d simulation method is more effective in attainment of good knowledge retention than the conventional lecture methods. The use of hybrid 3d simulation would be an innovative teaching tool that will promote effective teaching of Sheetmetal fabrication processes thereby improving on the students' achievement and fostering good knowledge retention.

## REFERENCES

Abdel-Maksoud, N. F. (2019). When virtual becomes better than real: Investigating

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved





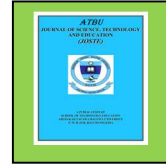
- the impact of a networking simulation on learning and motivation. *International Journal of Education Practice*.  
<https://doi.org/10.18488/journal.61.2018.64.253.270>
- Abdullahi, S. M. (2020). Effect of Task Instructional Sheets on Foundry Students' Retention in Polytechnics in North Central Nigeria. *International Journal of Research and Scientific Innovation (IJRSI)* 7(10).21-25
- Adebayo, A. O. & Oladele, O. (2016). Effects of Computer Simulation Instructional Strategy on Biology Students' Academic Achievement in DNA replication and transcription. *Asian Journal of Educational Research*, 4(2), 102-106
- Baglama, B. Yucesoy, Y & Yikmis, A. (2018). Using Animation As A Means Of Enhancing Learning of Individuals with special need *Tem Journal*, 7(7), 670-677. <https://doi.org/10.18421/Tem 73-126>
- Boud, D., & Molloy, E. (2018). Feedback in higher education: A review of the literature. *Higher Education Research & Development*, 37(4), 731-744.
- Carless, D., & Boud, D. (2018). The development of student self-assessment skills through feedback. *Higher Education*, 76(3), 517-531.
- Freeman, S., Eddy, S. L., McDonough, M., & Smith, M. K. (2018). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 115(34), 8410-8415.
- Gopal, N. (2018). Effectiveness of conventional lecture method in teaching mathematics. *International Journal of Science and Mathematics Education*, 16(5), 1071-1084.
- Gyasi, E.A (2013) Quality, Productivity, and Economy in Welding Manufacturing Case Study West Africa". Lapeenranta University of Technology.
- Kember, D. (2018). Understanding student engagement: A review of the literature. *Higher Education Research & Development*, 37(4), 745-758.
- Koc-Unal, I. (2019). *Investigation of the effects of virtual and real laboratory applications on the academic achievement of 5th grade science course electric unit teaching* (Unpublished master thesis). Necmettin Erbakan University, Turkey.
- Krause, K., & Coates, H. (2018). Student engagement and motivation in higher education: A review of the literature. *Higher Education Research & Development*, 37(4), 759-774
- Muhammad S. (2020). The Requisite Entrepreneurship Skills Needed for Improving the Work Capacity of Welding and Fabrication Practitioners in Kano State. *Wudil Journal of Science and Technology Education*, 4 (1) 20-26
- National Board for Technical Education (2004). National Technical Certificate and Advanced National Technical certificate curriculum and Modules specifications for Metalwork NBTE Research, 2(4), 8-16.
- Nkok, E. (2021) Effect of Computer Simulation on Students' Achievement and Retention in Sexual Reproduction In Plants In Niger State, *Nigeria International Journal of Innovative Social & Science Education Research* 9(3):10-18
- Onwusa, S. C. (2015). Assessment of Auto-Mechanics Teachers' Utilization of Instructional Materials in teaching in technical colleges in Edo and Delta States. Unpublished Master's Thesis. Vocational Education Department, Nnamdi Azikiwe University, Awka
- Oyedepo, S. O. et al, (2021). Effect of 3D Simulation on Students' Academic Achievement in Mechanical Engineering Craft Practice. *Journal of Education and Human Development*, 10(1), 1-9.

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved



- Pascarella, E. T., & Terenzini, P. T. (2018). How college affects students: A Third Decade of Research. San Francisco: Jossey-Bass.
- Şimşek, F. (2017). Effect of using animation and simulation in science course on academic success and knowledge retention of students. *International Journal of Education Science and Technology*, 3(3), 112-124.
- Vitasari, P. (2018). Improving student engagement and motivation through interactive lectures. *Journal of Education and Learning*, 11(2), 1-12.

---

Corresponding author: Sani Muhammad

✉ [sanimuhd02@gmail.com](mailto:sanimuhd02@gmail.com)

Department of Technology and Vocational Education, Aliko Dangote University of Science and Technology, Wudil, Kano State.

© 2024. Faculty of Technology Education. ATBU Bauchi. All rights reserved