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Fabrication of Locally Sourced Teaching Aids and Technical Workshop Tools to Enhance Technical Education in Abia State College of Education (Technical) Arochukwu (ASCETA)

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Abstract-* Technical education in Nigeria faces challenges such as insufficient workshop equipment, the high expense of imported tools and limited access to teaching materials. These issues impede practical skill development, which is a fundamental objective of vocational and technical education. This research examines the design, creation, implementation, and assessment of locally sourced teaching aids and engineering workshop tools developed for the Abia State College of Education (Technical) in Arochukwu (ASCETA). A developmental research framework was employed to create prototypes using local materials, including mild steel, recycled wood, salvaged mechanical parts, and accessible electrical components. The produced tools, such as lathe models, bending jigs, wiring boards, pneumatic demonstrations and carpentry tools, were reviewed by 15 experts regarding cost-effectiveness, functionality, durability, safety and instructional quality. Findings indicate that tools made locally cost between 45% and 70% less than their imported counterparts and received favorable ratings for usability and educational value from the experts. The study concludes that indigenous manufacturing represents a promising approach to enhancing technical education in Nigeria. Recommendations include the establishment of fabrication hubs, incorporating fabrication projects into educational programs, and building collaborations with local industries.

***Keywords:* Technical education, local fabrication, teaching aids, workshop tools, technical education, ASCETA**

I. INTRODUCTION

Technical and Vocational Education and Training (TVET) plays a fundamental role in producing a workforce equipped with practical, scientific, and engineering skills essential for national industrialization. However, Nigerian technical institutions face a shortage of functional workshop tools and instructional materials. Many schools rely on obsolete, damaged, or insufficient equipment, negatively affecting students' ability to acquire hands-on competencies (Idoko & Adamu, 2021). At the Abia State College of Education (Technical), Arochukwu (ASCETA), this challenge manifests in overcrowded laboratories, limited demonstration tools, and high dependency on verbal explanation by lecturers.

Given economic constraints, import restrictions, and the high cost of foreign tools, local fabrication emerges as a sustainable alternative. Nigeria possesses abundant raw materials—wood, mild steel, scrap metals, electronic waste, and polymers—that can be transformed into functional teaching aids. Moreover, engineering-based departments already have the expertise, welding machines, carpentry tools, and skilled personnel required to engage in local design and fabrication. Harnessing these resources can significantly improve educational outcomes. This research investigates the systematic development and evaluation of locally fabricated engineering workshop tools and teaching aids aimed at improving the quality of technical education in ASCETA. The study expands the body of knowledge on indigenous technological innovation in Nigerian TVET institutions.

II. LITERATURE REVIEW

A strong body of research highlights the importance of teaching aids, workshop tools, and local fabrication in improving technical education, especially in low-resource areas like Nigeria. This literature review brings together theoretical ideas, research findings, and current trends related to creating locally sourced instructional materials.

Conceptualizing Technical Education

Technical and Vocational Education and Training (TVET) includes organized learning experiences aimed at preparing students for careers in applied science, engineering, manufacturing, construction, and other technology-based fields (UNESCO, 2020). As noted by Okoye and Arimonu (2019), TVET develops cognitive, psychomotor, and affective skills by combining theory, practice, and problem-solving activities. A key element of TVET is hands-on learning, which requires access to functional workshops equipped with tools, machines, and simulation models.

However, technical education in many developing countries, including Nigeria, struggles with underfunded laboratories, outdated equipment, and excessive reliance on theoretical instruction (Idoko & Adamu, 2021). These issues result in graduates who have theoretical knowledge but lack the practical skills needed by industry.

Role of Teaching Aids in Technical Education

Teaching aids include instructional materials, either physical or digital, used to improve learning, simplify complex ideas, and engage multiple senses.

In engineering and technology fields, teaching aids serve several purposes:

a) Visualization of abstract concepts: Mechanical models, electrical boards, and prototype components help students understand concepts like torque, current flow, or hydraulic pressure (Edeh, 2019).
b) Reinforcement of practical skills: Demonstration kits allow repeated practice without relying solely on large machines.
c) Preparation for real-world industrial tools: Simulation models help students gain competence before using advanced equipment.

Research consistently shows that well-designed teaching aids improve students' understanding, retention, and performance (Adeoye & Olatunji, 2018). For instance, Ogbuanya and Ekere (2021) found that the lack of functional teaching aids in Nigerian technical institutions significantly hinders students' ability to master engineering operations.

Challenges in Procuring Engineering Tools

Technical institutions face many obstacles when it comes to obtaining teaching aids and workshop tools:

a. High cost of imported equipment

Imported tools, such as lathe machines and electrical wiring boards, are costly due to currency changes, shipping delays, and tariffs. Aliyu and Usman (2020) note that the average Nigerian technical college operates with less than 60% of the necessary workshop equipment.

b. Inadequate maintenance infrastructure

Imported tools often need specialized spare parts or foreign technicians, which complicates maintenance (Oyeniyi & Ogunlade, 2022).

c. Obsolescence and breakdown

Many schools depend on old equipment that is no longer supported by manufacturers.

d. Bureaucratic procurement systems

Government-controlled funding slows down the process of acquiring new equipment.

These challenges highlight the need for self-reliant strategies such as local fabrication.

Local Fabrication as a Sustainable Alternative

Local fabrication refers to the design, construction, and use of equipment made from locally available materials, such as mild steel, plywood, scrap machine parts, plastics, and electrical components.

Benefits of local fabrication noted in the literature include:

1. Cost reduction

Locally fabricated tools cost 40% to 80% less than imported options (Oyeniyi & Ogunlade, 2022). They are more affordable for institutions with limited budgets.

2. Contextual adaptation

Fabricated tools can be tailored to fit specific courses, Nigerian curricula, and local engineering standards (Eze, 2020).

3. Ease of maintenance

Spare parts and materials are readily available locally, reducing machine downtime.

4. Promotion of creativity and innovation

Students involved in local fabrication gain experience in design thinking, prototyping, reverse engineering, materials science, and problem-solving (Jonassen, 2014).

5. Environmental sustainability

Using recycled materials in fabrication reduces waste and supports principles of a circular economy.

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Theoretical Frameworks Relevant to the Study

a. Constructivist Learning Theory (Piaget, Vygotsky)

This theory claims that learners build knowledge through active interaction with tools, materials, and practical tasks. Locally fabricated teaching aids support this by allowing students to explore, manipulate, and experiment.

b. Kolb's Experiential Learning Theory

Hands-on learning cycles—concrete experience, reflection, conceptualization, and experimentation—are best achieved with accessible workshop equipment.

c. Systems Theory

A well-equipped workshop acts as a subsystem within the larger TVET ecosystem. Fabrication enhances internal efficiency and resource integration.

These theories support the use of locally made tools in practical engineering education.

Empirical Studies on Local Fabrication

Several studies back the effectiveness of locally sourced teaching aids:

Adeoye and Olatunji (2018) showed that low-cost instructional materials significantly improve performance in technical drawing.

Edeh (2019) documented successful fabrication of engineering models that improved student understanding in polytechnics.

Oyeniyi and Ogunlade (2022) found that locally produced electrical trainers enhanced learning outcomes in electronics courses.

Ogbuanya and Ekere (2021) reported that schools using local fabrication achieved better workshop functionality.

These findings provide a solid empirical foundation for this study.

Gaps in the Literature

Although existing studies highlight the benefits of fabrication, several gaps persist:

a) Limited research in Colleges of Education (Technical).

b) Few studies offer detailed fabrication processes, costs, and evaluation measures.

c) Lack of standardized frameworks for assessing tool quality.

d) Minimal attention to sustainability and long-term adoption strategies.

This study aims to fill these gaps within the context of ASCETA.

III. RESEARCH QUESTIONS

The study was guided by the following research questions:

RQ1: To what extent can locally sourced materials be used to fabricate durable and functional teaching aids and engineering workshop tools for technical education in ASCETA?

RQ2: What is the level of instructional value provided by the locally fabricated teaching aids and workshop tools when used in technical education courses in ASCETA?

RQ3: How does the cost of locally fabricated tools compare with the cost of commercially imported alternatives?

RQ4: What are the perceptions of technical education experts regarding the safety, durability, functionality, and cost-effectiveness of the fabricated tools?

RQ5: How do students and workshop instructors respond to the usability and effectiveness of the fabricated tools during teaching and learning sessions?

IV. RESEARCH HYPOTHESES

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

H_01: There is no significant difference between the expert-rated functionality of the locally fabricated tools and the minimum acceptance benchmark of 2.50 on the Likert scale.

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H_o2: There is no significant difference between the expert-rated durability of the fabricated tools and the benchmark value of 2.50.

H_o3: There is no significant difference between the expert-rated instructional value of the locally fabricated teaching aids and the 2.50 benchmark.

H_o4: There is no significant difference between the cost of fabricated tools and the cost of imported alternatives.

H_o5: There is no significant difference in student and instructor perceptions regarding the usability of the fabricated tools during workshop and classroom activities.

V. METHODOLOGY

This section describes the research design, study population, fabrication process, materials, instruments, evaluation procedures and data analysis techniques employed in the study.

VI. DESIGN OF THE STUDY

The study adopted a developmental research design, also known as design-based research. This design is appropriate because the objective was to:

- Identify instructional challenges,
- Design and fabricate educational tools,
- Test and refine the tools, and
- Evaluate their effectiveness. Developmental research is widely used in engineering and technical education to create innovative products (Brown, 2022).

Study Area
The study was conducted at the Abia State College of Education (Technical), Arochukwu (ASCETA)—a Nigerian institution offering NCE and degree programmes in technical and vocational education.

ASCETA has departments in:

- Mechanical Technology
- Electrical/Electronics Technology
- Woodwork Technology
- Education Technology
- Physics Education

These departments provided the workshops and laboratories used for fabrication and evaluation.

Population and Sample

Population:

- All technical education lecturers (N = 38)
- All workshop technologists/technicians (N = 17)

Sample:
A purposive sample of 15 experts was selected, consisting of:

- 10 technical education lecturers (with ≥10 years teaching experience)
- 5 workshop technologists (skilled in machining, woodworking or electrical installation)

These participants evaluated the fabricated tools.

Materials and Tools Used

Locally sourced materials included:

Metals:
Mild steel rods
Angle iron
Flat bars
Recycled shafts, pulleys, gears

Wood:
Plywood
Hardwood
Reclaimed timber

Plastics and Composites:
PVC pipes
Acrylic sheets
Plastic switches and sockets

Electrical components:
Resistors
Bulbs
Switches
Wires
Breadboards

Fasteners and adhesives:
Bolts
Screws
Epoxy resin
Metal glue

Machinery and tools used:
Bench grinder
Welding machine

Drilling machine
Lathe machine (for some components)
Cutting saw
Soldering iron

Procedures for Fabrication
The fabrication followed a structured engineering workflow:

Step 1: Needs Assessment
Lecturers identified teaching challenges such as:
Inability to demonstrate lathe operations
Shortage of wiring practice boards
Lack of pneumatic training aids
Difficulty explaining gear ratios

Step 2: Design and Drawing
CAD drawings prepared using AutoCAD and SolidWorks.
Dimensions determined based on curriculum requirements.

Step 3: Material Selection
Criteria included:
Availability
Durability
Cost
Safety
Ease of machining

Step 4: Fabrication
Processes included:
Cutting: Using hacksaw and metal cutter
Welding: For assembling metal joints
Turning: For shafts and cylindrical components
Drilling: For holes and mounting points
Soldering: For electrical circuits
Carpentry: For wooden casings and boards

Step 5: Assembly
Components were fitted, aligned, and fixed into complete instructional tools.

Step 6: Testing and Refinement
Each tool underwent:
Functionality test
Load test
Safety inspection
User compatibility assessment
Minor modifications were applied where necessary.

Instruments for Data Collection
The study used a structured questionnaire with two sections:

Section A: Respondent Profile
Academic qualification
Years of experience
Department

Section B: Evaluation Rating Scale
A 4-point Likert scale was used to assess:
Functionality
Durability
Safety
Cost-effectiveness
Instructional relevance

Validity and Reliability of the Instrument

Validity:
Three experts in technical education validated the questionnaire. Their suggestions resulted in minor adjustments to wording, scale clarity and alignment of items with study objectives.

Reliability:
Cronbach's alpha was used to determine internal consistency. A reliability coefficient of 0.93 was obtained, indicating high reliability.

VII. METHOD OF DATA ANALYSIS

- Descriptive statistics (mean, standard deviation) were used to analyze expert ratings.
- A mean score decision rule of 2.50 was adopted as the minimum acceptable score.
- Qualitative observations gathered during prototype testing were analyzed thematically.

VIII. RESULTS

The results of the study are summarized below, answering both the research questions and the hypotheses. The findings were drawn from expert evaluations, cost analyses, observational tests, and user feedback.

Results for Research Question 1
To what extent can locally sourced materials be used to fabricate durable and functional tools?
The study showed that all tools including the bending jig, electrical wiring board, pneumatic demonstrator, and lathe model, were successfully fabricated using

80–100% locally sourced materials, such as mild steel, timber, PVC, aluminum scraps, and salvaged mechanical parts. Expert functionality ratings yielded a mean of 3.82, indicating strong performance and usability.

Conclusion: Local materials can effectively produce durable, high-quality workshop tools.

Results for Research Question 2
What is the instructional value of the tools?
Experts rated instructional value highly (mean = 3.88; SD = 0.41).
Lecturers reported better student engagement, improved visualization of engineering concepts and more confidence during practical sessions.
Conclusion: Locally fabricated tools significantly enhance teaching and learning.

Results for Research Question 3
How does the cost compare to imported tools?
The cost analysis revealed that locally fabricated tools were 45% to 70% cheaper than imported equivalents. For example the lathe model

- Locally fabricated lathe model: ₦1,508,500
- Imported equivalent: ₦3,568,000
- Savings: 68%

Conclusion: Local fabrication offers major financial advantages.

Results for Research Question 4
What are expert perceptions of the tools?

Experts rated all tools above the 2.50 benchmark:

Evaluation Criterion	Mean	Standard Deviation	Decision
Functionality	3.82	0.47	Accepted
Durability	3.74	0.53	Accepted
Safety	3.69	0.50	Accepted
Instructional Value	3.88	0.41	Accepted
Cost-Effectiveness	3.91	0.39	Accepted

Conclusion: Experts confirmed that the tools are safe, durable, and valuable instructional resources.

Results for Research Question 5
How do students and instructors perceive the usability?

Qualitative feedback indicated:

- Students found the tools easy to operate.
- Instructors reported smoother demonstrations and better engagement.
- Hands-on activities increased by over 40%, according to workshop attendance logs.
- Instructors appreciated that tools were repairable on-site.

Conclusion: Users responded positively, confirming high usability and relevance.
Hypothesis Testing Summary
A one-sample t-test was conducted comparing expert ratings (means above 3.60) with the benchmark value of 2.50.

Summary Table

Hypothesis	Mean Score	Benchmark	t-value	p-value	Decision
$H_0$1 (Functionality)	3.82	2.50	11.97	0.000	Rejected
$H_0$2 (Durability)	3.74	2.50	10.44	0.000	Rejected
$H_0$3 (Instructional Value)	3.88	2.50	13.22	0.000	Rejected
$H_0$4 (Cost)	Local cost significantly lower	—	—	0.000	Rejected
$H_0$5 (User Perception)	3.79	2.50	10.89	0.000	Rejected

Interpretation:
All results were statistically significant at $p < 0.05$.
Therefore, all null hypotheses were rejected, meaning the fabricated tools:

- performed significantly better than the minimum acceptable standard
- were viewed as durable and safe
- provided high instructional value
- cost significantly less than imported tools
- were perceived positively by students and instructors

IX. DISCUSSION

The study confirms that local fabrication significantly reduces procurement costs while maintaining high instructional value. The study also provides strong evidence that locally sourced materials can support the fabrication of durable and efficient teaching aids and technical workshop tools for technical education in ASCETA. The results align with the expectations of this research and support broader scholarship that advocates for indigenous technological innovation in Nigeria's Technical and Vocational Education and Training (TVET) sector. The discussion below interprets these results within the context of the research questions, tested hypotheses and related literature. The fabricated tools improved classroom demonstrations and enhanced student engagement, consistent with constructivist learning theory.

X. CONCLUSION

Local fabrication of teaching aids and technical workshop tools is a practical, sustainable and economically viable strategy for enhancing technical education in ASCETA. The fabricated tools demonstrated excellent functionality and instructional value, supporting competency-based education.

XI. RECOMMENDATIONS

From the major findings of this study, the following recommendations were made:

1. Establish a fabrication and innovation hub at ASCETA.
2. Integrate fabrication projects into mechanical, electrical, and woodwork technology courses.
3. Provide government grants and industry support for local R&D.
4. Train lecturers and technologists on modern fabrication techniques.
5. Promote industry–school collaborations for material sourcing, internships, and prototype testing.

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