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Article Review Request

1 message

Ümmühan Ormancı <ummuhan45@gmail.com> Wed, May 28, 2025 at 3:16 PM
To: wati sukmawati <wati_sukmawati@uhamka.ac.id>

wati sukmawati:

I believe that you would serve as an excellent reviewer of the manuscript, "Improvisation of science instructional materials: insights from primary and secondary school teachers," which has been submitted to Journal of Turkish Science Education. The submission's abstract is inserted below, and I hope that you will consider undertaking this important task for us.

Please log into the journal web site by 11.06.2025 to indicate whether you will undertake the review or not, as well as to access the submission and to record your review and recommendation. The web site is https://www.tused.org/index.php/tused

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Thank you for considering this request.

Ümmühan Ormancı

"Improvisation of science instructional materials: insights from primary and secondary school teachers"

Improvisation of science instructional materials is crucial to alleviate the scarcity of standard science instructional materials. This study investigates the status of improvised science education materials used in primary and secondary schools in Addis Ababa, Ethiopia. A total of 185 teachers (i.e., general informants) from 18 primary and 11 secondary schools were involved in face-to-face individual interviews. Generally, practical works such as conducting laboratory sessions and using improvised science instructional materials, though positively perceived by most of the respondents (87.5%, χ-squared = 103.5, df = 1, p-value < 2.2e-16), were practically less common. This problem could arise from the scarcity of vital resources, such as time, capital, technical skills, and the inability to effectively use limited resources. Making use of improvised materials requires considerable technical skills, which are unfortunately not acquired by most of the respondents (χ-squared = 63.961, df = 1, p-value = 1.269e-15). Class size and time constraints need to be addressed to enhance the use of improvised materials in the science teaching and learning process. Stakeholders should train primary and secondary school teachers to enhance their creative skills to make use of improvised science instructional materials.

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Article Review Acknowledgement

5 messages

Ümmühan Ormancı <ummuhan45@gmail.com> Mon, Jun 2, 2025 at 2:11 PM
To: wati sukmawati <wati_sukmawati@uhamka.ac.id>

wati sukmawati:

Thank you for completing the review of the submission, "Improvisation of science instructional materials: insights from primary and secondary school teachers," for Journal of Turkish Science Education. We appreciate your contribution to the quality of the work that we publish.

wati sukmawati <wati_sukmawati@uhamka.ac.id> Tue, Jun 3, 2025 at 9:53 AM
To: Ümmühan Ormancı <ummuhan45@gmail.com>

My pleasure Prof, may I request a certificate for this review process?
[Quoted text hidden]

Ümmühan Ormancı <ummuhan45@gmail.com> Thu, Jun 12, 2025 at 7:17 PM
To: wati sukmawati <wati_sukmawati@uhamka.ac.id>

Thank you again, the certificate is below. Sincerely

wati sukmawati <wati_sukmawati@uhamka.ac.id>, 3 Haz 2025 Sal, 05:53 tarihinde şunu yazdı:
[Quoted text hidden]

wati sukmawati.pdf
131K

wati sukmawati <wati_sukmawati@uhamka.ac.id> Fri, Jun 13, 2025 at 7:22 PM
To: Ümmühan Ormancı <ummuhan45@gmail.com>

Thank you very much Dr. Ümmühan Ormancı

Dear Dr. Ümmühan Ormancı I will submit a paper to TUSED Journal, can I ask for assistance so that my paper can be given the opportunity to be published in the TUSED journal as a requirement for my professorship? Thank you in advance Dr.
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Ümmühan Ormancı <ummuhan45@gmail.com> Tue, Jun 17, 2025 at 4:26 PM
To: wati sukmawati <wati_sukmawati@uhamka.ac.id>

As the editor, I will provide as much support as I can. However, there are many factors involved in the process, so unfortunately, it is not possible to give a clear answer at this time. Sincerely

wati sukmawati <wati_sukmawati@uhamka.ac.id>, 13 Haz 2025 Cum, 15:22 tarihinde şunu yazdı:
[Quoted text hidden]

JOURNAL of TURKISH SCIENCE EDUCATION (TUSED)

http://www.tused.org

Dear Wati Sukmawati,

Thank you for being the reviewer of the article titled "*Improvisation of science instructional materials: insights from primary and secondary school teachers*" in 28.05.2025. Your contribution is always valuable for our journal.

Regards.

Prof. Dr. Salih ÇEPNİ
Editor of TUSED

Journal of Turkish Science Education

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Review:Improvisation of science instructional materials: insights from primary and secondary school teachers

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Introduction

The article addresses a critical issue in science education, particularly in developing countries like Ethiopia, where there is a lack of standard instructional materials. The focus on improvisation of science instructional materials is timely

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Introduction

The article addresses a critical issue in science education, particularly in developing countries like Ethiopia, where there is a lack of standard instructional materials. The focus on improvisation of science instructional materials is timely and relevant, as it aligns with the global challenge of resource scarcity in education. The use of locally available materials to teach science is not only a cost-effective approach but also enhances creativity and critical thinking among both students and teachers.

Strengths

1. **Relevance of the Topic**: The topic is highly relevant to current educational challenges in developing countries. The exploration of improvisation in science education is crucial, especially in contexts with limited resources. This study contributes to the body of knowledge on resource-based learning and provides insights that can help improve science education practices in similar low-resource settings.

2. **Comprehensive Methodology**: The study employs a cross-sectional design with a large sample size (185 teachers across 29 schools), using face-to-face interviews. The use of both descriptive and inferential statistics enhances the robustness of the findings. The pretesting of the instruments (questionnaires) adds credibility to the data collection process.

3. **Clear Data Analysis**: The statistical analyses, including chi-square tests, are well executed, and the results are presented in a clear and organized manner. The use of graphs and tables to illustrate the findings is commendable, making the data easy to digest.

4. **Contextual Understanding**: The study provides a detailed exploration of the challenges faced by Ethiopian teachers in implementing science instruction. The discussion about the lack of technical skills, inadequate resources, and large class sizes is insightful and adds depth to the analysis of the educational environment in Ethiopia.

5. **Practical Implications**: The study offers practical solutions, such as the need for teacher training to enhance the skills required for improvising teaching materials. This recommendation is essential for improving science education in resource-constrained settings.

Weaknesses

1. **Lack of Comparative Analysis**: While the study focuses on the status of improvisation in Addis Ababa, it could benefit from a comparison with other regions, both urban and rural, within Ethiopia. A broader geographical scope could provide more generalizable findings.

2. **Limited Discussion on Long-term Impact**: The article mentions the positive perception of improvised materials but lacks a deeper exploration of their long-term effectiveness on student performance. Longitudinal studies could provide valuable insights into how improvisation impacts student outcomes over time.

3. **Teacher Training Limitations**: Although the study highlights the importance of teacher training, it does not delve deeply into the types of training programs that could be implemented or the specific skills that need to be developed. A more detailed examination of successful teacher training models could strengthen the recommendations.

4. **Missing Insight into Student Perspectives**: The article mainly focuses on teachers' views on improvisation. Including student perspectives on the effectiveness of improvised materials would add a more holistic view to the study.
5. **Potential Bias in Sample**: The study could benefit from a more balanced representation of gender and school types (public vs. private). While the sample includes both, there is a significant gender imbalance, with a higher proportion of male teachers. This could introduce bias in the findings.

Improvisation of science instructional materials: insights from primary and secondary school teachers

Short title: Insights on improvised science instructional materials

Abstract

Improvisation of science instructional materials is crucial to alleviate the scarcity of standard science instructional materials. This study investigates the status of improvised science education materials used in primary and secondary schools in Addis Ababa, Ethiopia. A total of 185 teachers (i.e., general informants) from 18 primary and 11 secondary schools were involved in face-to-face individual interviews. Generally, practical works such as conducting laboratory sessions and using improvised science instructional materials, though positively perceived by most of the respondents (87.5%, χ-squared = 103.5, df = 1, p-value < 2.2e-16), were practically less common. This problem could arise from the scarcity of vital resources, such as time, capital, technical skills, and the inability to effectively use limited resources. Making use of improvised materials requires considerable technical skills, which are unfortunately not acquired by most of the respondents (χ-squared = 63.961, df = 1, p-value = 1.269e-15). Class size and time constraints need to be addressed to enhance the use of improvised materials in the science teaching and learning process. Stakeholders should train primary and secondary school teachers to enhance their creative skills to make use of improvised science instructional materials.

Keywords: improvisation of science instructional materials, laboratory, teaching and learning process, primary and secondary school teachers, insights

Introduction

Improvisation refers to the act of creating or using alternative instructional materials or practices in the absence of standard laboratory facilities, equipment, or teaching aids. Improvisation is an important form of ingenuity because it develops creativity, flexibility, confidence, and critical thinking (Obodo et al., 2020). Improvisation can be employed at various levels of the teaching and learning processes, including brainstorming, illustration, and investigation. The education systems in less developed countries are significantly constrained by the scarcity of standard instructional materials (Holdhus et al., 2016; Anyakaorah, 2021). Acquiring standard teaching and learning materials is both financially and technically demanding; consequently, the education ecosystem in developing countries may rely on locally available materials (Anyakaorah, 2021). Well-chosen, appropriately utilized, and well-integrated improvised materials in the teaching and learning process equip learners with significantly enhanced knowledge and skills, improved learning achievement, and better memorization abilities (Nnorom and Obianuju, 2021).

Access to instructional materials helps retain long-lasting memories compared to verbal instructions (Agogo, 1993). Improvisation is particularly important when the standard instructional materials are unaffordable, when technical skills for operating and renovating materials are inadequate, or when replacement items are not readily available (Newby et al., 2007). Using improvised teaching materials ensures that students observe, feel, recognize, and appreciate as they learn. Therefore, improvisation is used instead of actual teaching resources and equipment when these resources are unavailable (Adamu, 2024). Both teachers and students benefit from the creativity and critical thinking developed through the use of

improvised teaching materials (Sawyer, 2011). Subsequently, teachers are compelled to think creatively and develop novel ideas to disseminate knowledge when they are tasked with creating instructional materials (Beattie, 2000).

Systematic studies on the design and development of instructional materials, including the selection of appropriate teaching and learning strategies and materials, the evaluation of results, and recommendations for improvements are crucial for the effective and efficient use of improvised instructional materials (Nnorom and Obianuju, 2021). The status of the utilization of improvised science teaching materials in Ethiopia's primary and secondary school education ecosystem has received little attention. Nonetheless, it is believed that educators and learners use educational materials made from locally available resources, at least in part. Studying the improvisation of science instructional materials helps to identify prevailing opportunities and threats, as well as develop a plan for enhancing the use of improvised science instructional materials. This study evaluates the status of the utilization of improvised science instructional materials in primary and secondary schools in Addis Ababa.

Conceptual framework

The theoretical foundation of improvisation in science instructional materials relies on constructivist learning theory, resource-based learning, and the principles of multiple intelligences. Improvisation is a principle-driven practice that involves creativity and innovation, as well as the relevance and effectiveness of improvised materials, their affordability and accessibility, and their suitability. Improvisation can be applied to laboratory equipment, teaching aids, ICT-driven resources, and experimental work. To engage in improvisation, there should be a needs assessment, auditing of available resources, design and development,

implementation, followed by evaluation and collection of feedback from end users. However, regardless of its importance in low-resource settings, improvisation comes with challenges, including inadequate skill sets, safety issues, and resistance to accepting improvised materials. To overcome these problems, extensive studies should be conducted on the available skill sets of users, the safety of improvised materials compared to standard ones, and raising awareness of the indispensable importance of improvised materials when standard ones are lacking. Based on these theories, a graphical conceptual framework is presented in Figure 1.

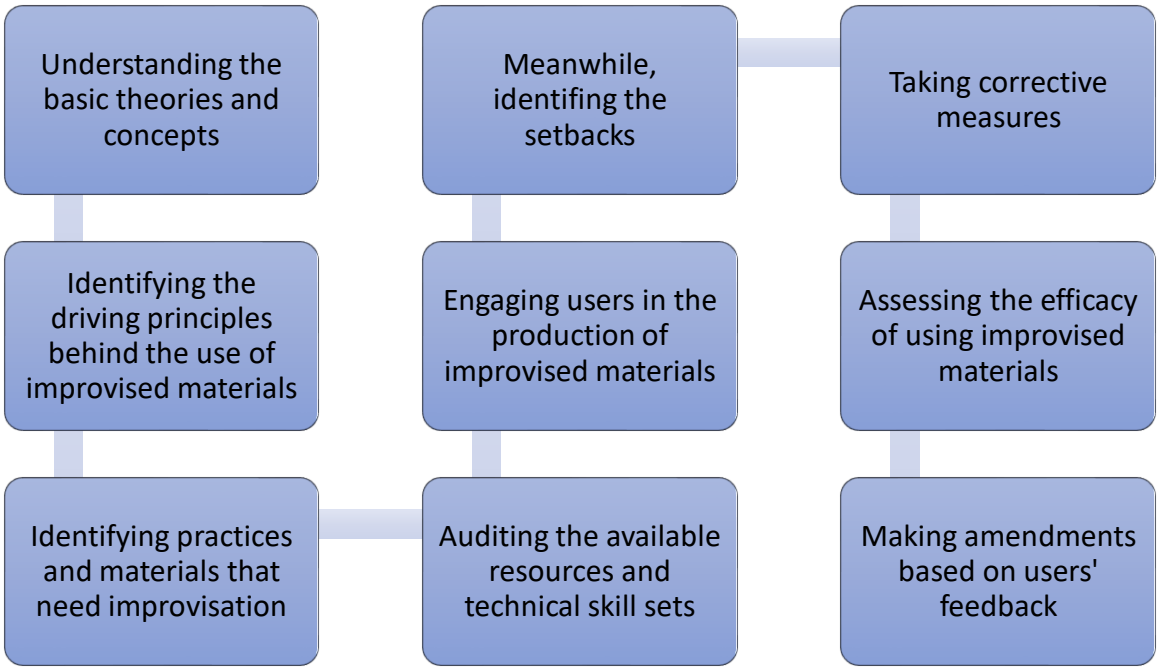


Figure 1. The conceptual framework for the production and use of improvised science materials.

Hypothesis

Based on the background information provided and the conceptual framework developed, we have hypothesized that there is no variation in the demographic characteristics of teachers in the visited schools. In all visited laboratory practices, everything is running smoothly. The respondents possess adequate knowledge and skills to produce and use improvised science

instructional materials. Improvised science instructional materials are efficient and suitable for the teaching and learning process. There are no setbacks concerning the production and use of improvised science instructional materials. These hypotheses are tested using a well-established research methodology.

Methodology

Research design

This is a cross-sectional study involving one-on-one face-to-face interviews with respondents. To the best of our knowledge, there are no studies of this type in Addis Ababa, although the scarcity of science instructional materials is evident. This study paves the way for longitudinal studies capturing repetitive responses.

Implementation of the research

The research tool used was a semi-structured questionnaire to interview the respondents. Accordingly, eighteen primary schools and eleven secondary schools were selected from the eastern and northeastern parts of Addis Ababa using stratified sampling methods that involved school level (primary vs. secondary) and school type (public vs. private).

The study sites and populations

A cross-sectional study was conducted in Addis Ababa. Representative respondents were interviewed from primary and secondary public and private schools in Addis Ababa to assess the status of the utilization of improvised science instructional materials and practices. A total of 185 teachers participated in face-to-face individual interviews.

Data and instrument

The data were obtained by analyzing the knowledge and skills of the respondents. The instrument used for knowledge assessment was a semi-structured questionnaire. The general interview questions were pretested with five experienced respondents. The checklist consists of 35 questions that were pretested and revised based on the feedback received. Amendments were made according to the outcome of the pretest. After testing their validity and reliability, all 35 test questions were used in their revised form for data collection and analysis. The instrument used for assessing attitudes, practices, and knowledge skill sets is the pretested questionnaire. The explanatory variables included gender, age, school type, school level, and level of education. The response variables mainly included the types of improvised materials and practices used, as well as the purpose and extent of using these materials and practices, along with their advantages and disadvantages.

Data analysis

Summary statistics were utilized to compute measures of central tendency and dispersion. Data were summarized using frequency counts and corresponding percentages. Inferential statistics were employed to make projections about the study population. SPSS (IBM Corp., 2020) and R (R Core Team, 2016) were used for data analysis.

Ethical clearance

The study was approved by the Institutional Scientific Ethical Review Committee (SERC) of the Kotebe University of Education, with a reference number SERC/117/2024. Informed verbal consent was obtained from all respondents.

Results

The visited schools

In our study, we included 29 schools that are located in different parts of eastern and northeastern Addis Ababa. Among the respondents, 68 (36.8%) were primary school (Grades 1–8) teachers, while 117 (63.2%) were secondary school (Grades 9–12) teachers. The proportion of sampled secondary school teachers was significantly high (χ-squared = 12.978, df = 1, p-value = 0.00032). In the sampled schools, a mean of 6.4 teachers with a corresponding standard deviation of 5.3, a median of 4, a mode of 1, and a range of 1–16 teachers were interviewed.

Professional and academic characteristics of the respondents

Among the respondents, their sex was reported as follows: 86 (77.5%) were male, and 25 (22.5%) were female, indicating a statistically significant difference (χ-squared = 33.523, df = 1, p-value = 7.044e-09). Among the respondents, 110 (59.5%) were from public schools, and 75 (40.5%) were from private schools, with their proportions showing statistically significant differences (χ-squared = 6.6216, df = 1, p-value = 0.01007). Among the respondents, 58 (31.5%) taught general science (a course that combines biology, chemistry, and physics), 46 (25.0%) taught biology, 35 (19.0%) taught chemistry, 42 (22.8%) taught physics, 2 (1.1%) taught agriculture, and 1 (0.5%) taught mathematics. The proportions of the respondents who taught different courses showed statistically significant differences (χ-squared = 92.326, df = 5, p-value < 2.2e-16).

Regarding the level of education of the respondents, 1 (0.6%) had a certificate, meaning they attended a short-term training program after completing the 12th grade; 12 (10.6%) earned a

diploma, a two-year training program after completing the 12th grade; 111 (62.0%) possessed bachelor's degrees; and 48 (26.8%) obtained Master of Science degrees. The proportions of the level of education showed statistically significant differences (χ-squared = 155.91, df = 3, p-value < 2.2e-16). The age group distribution of the respondents is presented in Figure 2, and the proportions revealed statistically significant differences (χ-squared = 129.15, df = 3, p-value < 2.2e-16). The mean teaching experience was 13.6 years, with a standard deviation of 7.3, a median of 12.5, a mode of 10, and a range of 1 to 44.

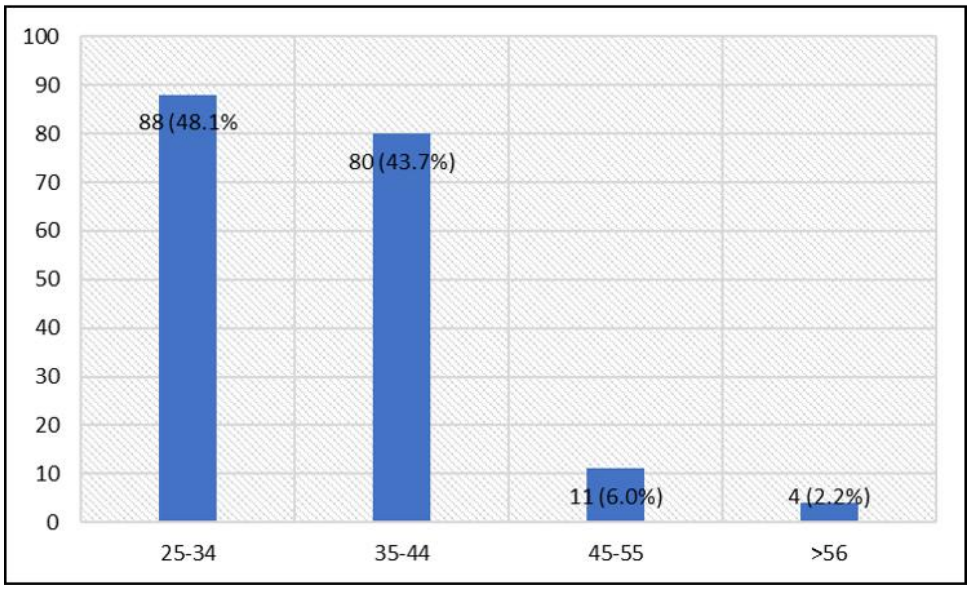
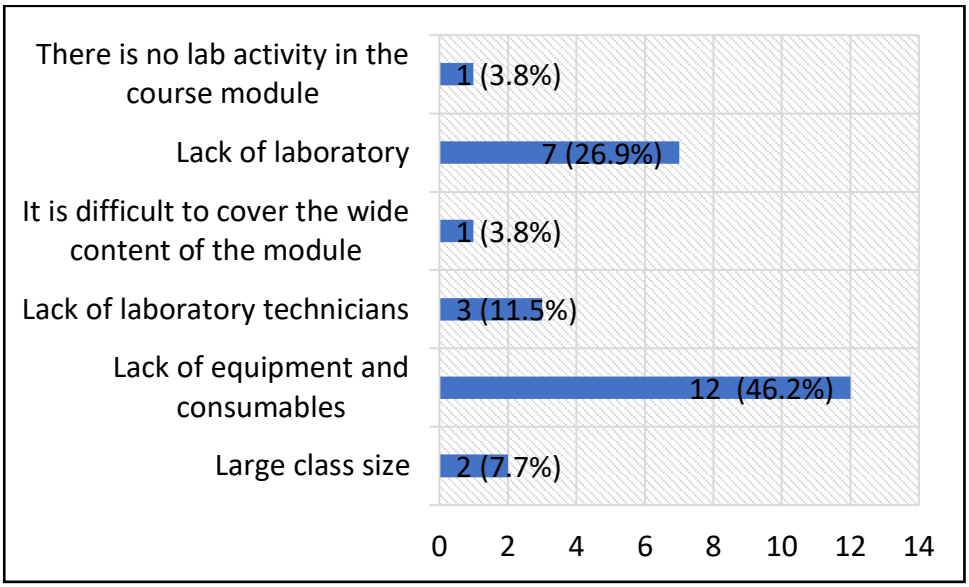


Figure 2. Frequency distribution of various age groups among the respondents.

The use of laboratory facilities in the science teaching and learning processes

A significantly high proportion of the respondents (χ-squared = 103.5, df = 1, p-value < 2.2e-16) used laboratories in the teaching and learning process (161, 87.5%) compared to those who did not use laboratory sessions (23, 12.5%). Among the respondents who engaged in laboratory work, 43 (26.5%) conducted two laboratory sessions per week, 88 (54.3%) held one laboratory session per month, 20 (12.4%) conducted one laboratory session per semester, 8 (4.9%) provided laboratory work depending on the content of the book, and 3 (1.9%) taught a course

178 at grade 3, and according to their perception, this lower grade does not require laboratory work
179 (χ-squared = 148.68, df = 4, p-value < 2.2e-16). Those respondents who did not conduct
180 laboratory sessions cited the lack of laboratory activities in the text, lack of laboratory facilities
181 and equipment or consumables, vastness of text content, lack of professionals, and large class
182 sizes as reasons (Figure 3), and the reported proportions showed statistically significant
183 differences (χ-squared = 22, df = 5, p-value = 0.0005236).



184

185 Figure 3. Reported reasons for not being involved in laboratory practices.

186 **Knowledge and skill about the use of improvised science instructional materials**

187 Most of the respondents were knowledgeable about the improvisation of science instructional
188 materials (156 (86.2%) vs. 25 (13.8%), χ-squared = 94.812, df = 1, p-value < 2.2e-16).
189 Accordingly, a comparably high proportion of the respondents have used improvised materials,
190 specifically 156 (85.2%) vs. 27 (14.8%) (χ-squared = 90.934, df = 1, p-value < 2.2e-16). However,
191 the use of improvised materials shows considerable inconsistencies. For instance, 76 (41.5%)
192 use improvised science instructional materials regularly, 86 (47.0%) use them occasionally, and
193 21 (11.5%) did not use improvised materials; these proportions show statistically significant
194 differences (χ-squared = 40.164, df = 2, p-value = 1.899e-09).

Most of the respondents (116 (63.0%) vs. 68 (37.0%); χ-squared = 12.522, df = 1, p-value = 0.0004022) believed that improvised materials are crucial for improving the teaching and learning process. Regarding the efficacy of improvised materials, most of the respondents rated them as productive (84, 46.2%), partly productive (97, 53.3%), and 1 respondent (0.5%) indicated they are unproductive (χ-squared = 89.418, df = 2, p-value < 2.2e-16). Most of the respondents believed that improvised materials do not lead to misconceptions (144 (77.3%) vs. 36 (19.5%)); however, some respondents expressed their concerns, including the lower accuracy of improvised materials (1, 0.5%), understanding could be decreased when using improvised materials (1, 0.5%), the improvised material should fit the purpose (1, 0.5%), if used correctly, improvised materials are as effective as standard materials (1, 0.5%), and improvised materials should be designed based on the knowledge of the users (1, 0.5%). Most of the respondents (168, 93.3%) believed that the use of improvised materials builds confidence, while a few of them did not recognize this importance (12, 6.7%) (χ-squared = 135.2, df = 1, p-value < 2.2e-16). Most of the respondents (175, 97.2%) believed that improvised materials enhance creativity skills, and only a small number disagreed (5, 2.8%) (χ-squared = 160.56, df = 1, p-value < 2.2e-16).

Impact of improvised science instructional materials on the teaching and learning processes

The impact of improvised materials on the improvement of the teaching and learning process and students' achievement was, in most instances, positively perceived. Accordingly, 163 (88.1%) respondents had a positive perception; however, 6 (3.2%) did not notice its positive impact. Moreover, 1 (0.5%) respondent was unsure, 1 (0.5%) reported that it depends on the

type of topic covered, and 1 (0.5%) stated that it may have some impact (χ-squared = 601.49, df = 4, p-value < 2.2e-16).

Durability of improvised science instructional materials

Responses regarding the durability of improvised science instructional materials are presented in Figure 4. Accordingly, most of the respondents agreed that improvised materials are durable, and the proportions of different responses show a statistically significant difference (χ-squared = 262.62, df = 4, p-value < 2.2e-16).

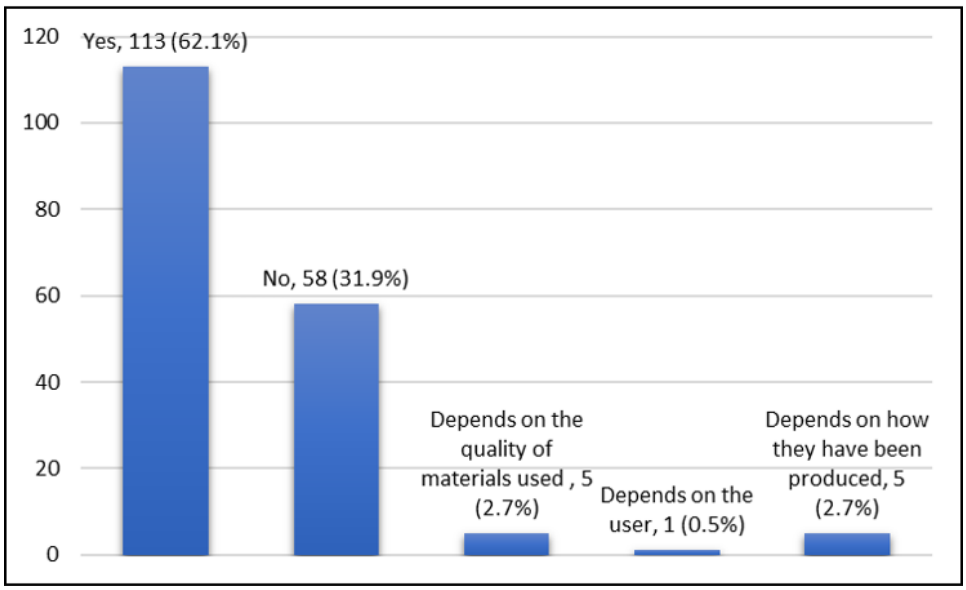


Figure 4. Reported factors that affect the durability of improvised science instructional materials.

Production of improvised science instructional materials

Respondents were asked whether producing improvised materials is a demanding task, and their responses are summarized in Figure 5. A significant proportion of the respondents lacked adequate knowledge and skills to produce improvised materials. Accordingly, 109 (59.9%) were able to produce improvised materials, whereas 73 (40.1%) lacked the skills, and these proportions show a statistically significant difference (χ-squared = 7.1209, df = 1, p-value =

0.007619). One of the constraints reported was the absence of adequate and appropriate resources for producing improvised materials. In this study, 117 (65.0%) of the respondents reported that there were insufficient resources available to produce improvised materials; however, 63 (35.0%) reported the availability of sufficient materials (χ-squared = 16.2, df = 1, p-value = 5.699e-05). For most of the respondents (128, 71.9%), time was a limiting factor in producing improvised materials; however, fewer respondents (50, 28.1%) did not face the issue of time constraints (χ-squared = 34.18, df = 1, p-value = 5.025e-09).

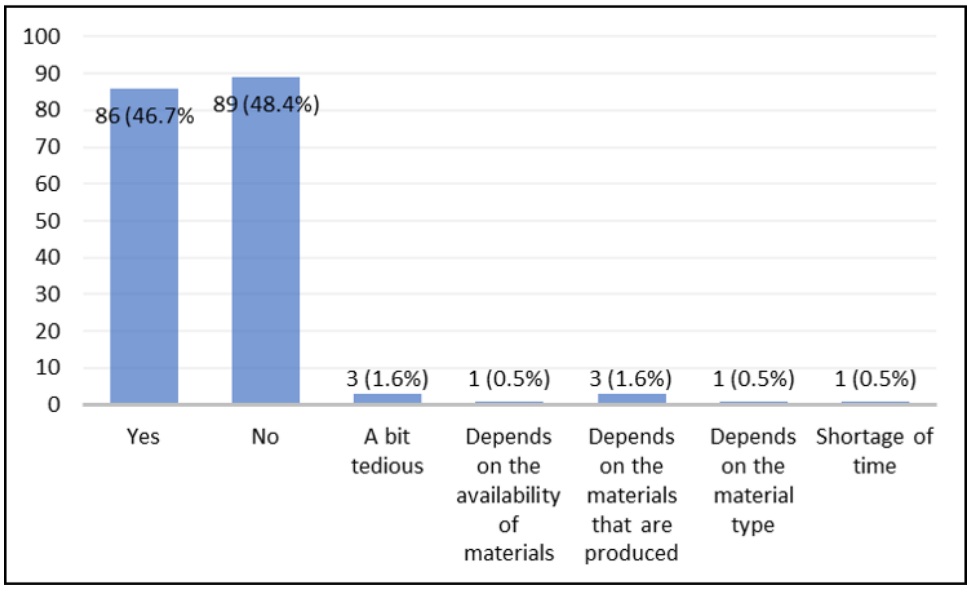


Figure 5. Reported factors associated with the tediousness of producing improvised science instructional materials.

Class size vs. the efficacy of using improvised science instructional materials

For most respondents (127, 70.9%), the class size was manageable for using improvised materials (52, 29.1%) (χ-squared = 31.425, df = 1, p-value = 2.073e-08). The efficacy of using improvised materials compared to standard teaching is presented in Figure 6, and the reported proportions indicate a statistically significant difference (χ-squared = 23.944, df = 2, p-value = 6.318e-06).

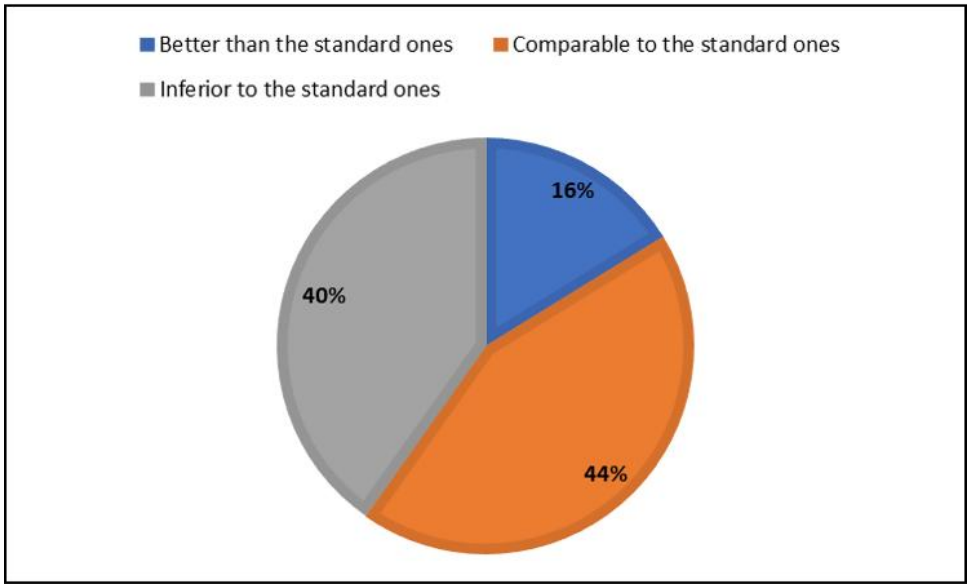


Figure 6. Reported cases on the comparison of standard versus improvised science instructional materials.

Regarding the assistance of improvised materials in the teaching-learning process, most of the respondents (166, 92.2%) agreed, 10 (5.6%) disagreed, 3 (1.7%) said they were not very helpful, and 1 (0.5%) respondent stated they were highly beneficial; however, there is a time constraint (χ-squared = 434.8, df = 3, p-value < 2.2e-16). Most of the respondents believed that the use of improvised materials saves time (146, 81.5%); however, 29 (16.2%) respondents did not notice this advantage, 1 (0.5%) respondent said they might have contributed a little, 1 (0.5%) respondent stated they may help for chapters with broad topics, improvised materials took more time (1, 0.5%), and 1 (0.5%) respondent was uncertain (χ-squared = 563.83, df = 5, p-value < 2.2e-16).

The accuracy of using improvised science instructional materials

The lower proportion of respondents believed that the use of improvised materials is deceptive (34, 19.5%); however, this was not the case for most respondents (140, 80.5%) (X-squared = 64.575, df = 1, p-value = 9.294e-16). For most respondents, the use of improvised science instructional materials could have improved the teaching and learning process (Figure 7), and the proportions of reported responses indicate a statistically significant difference (X-squared = 286.63, df = 2, p-value < 2.2e-16).

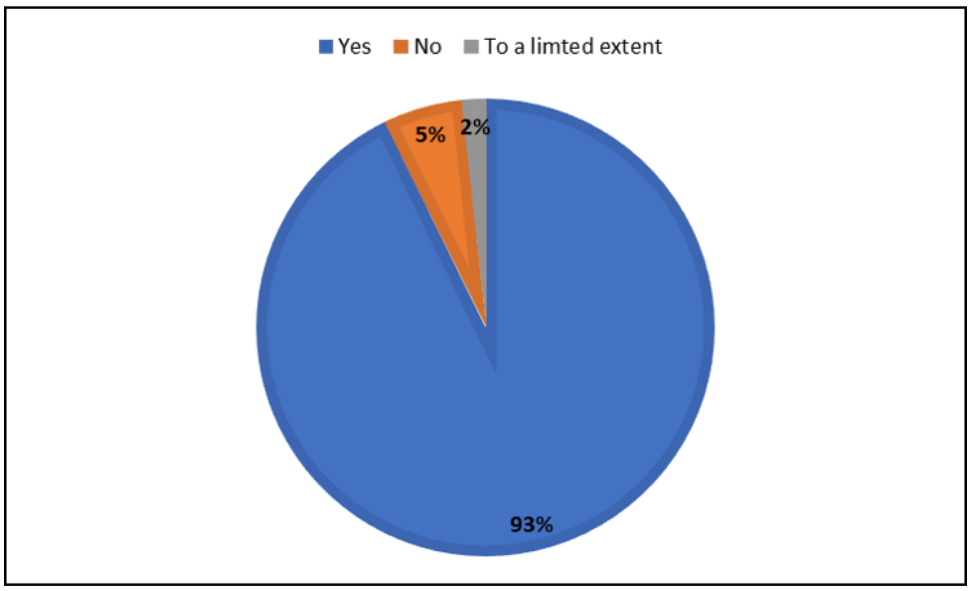


Figure 7. Reported frequency concerning the accuracy of improvised science instructional materials versus standard materials.

Locally available resources that can be used to produce improvised science instructional materials

Most of the respondents (172, 95.0%) believed that plants, animals, soil, timber, sand, or stone - locally available materials-can be used as improvised science instructional materials; however, 9 (5.0%) did not recognize this importance. Significantly, a large proportion of the respondents believed that improvised materials reduce the cost of education (172, 95.6%), while only a few disagreed (8, 4.4%) (χ-squared = 149.42, df = 1, p-value < 2.2e-16). Most of

the respondents (172, 89.6%) reported that improvised materials can be produced by both teachers and students, but 10 (5.2%) believed they must be produced by teachers, and another 10 (5.2%) believed they can be produced by students (multiple responses exist, χ-squared = 273.38, df = 2, p-value < 2.2e-16).

Training attended on the production and use of improvised science instructional materials

Regardless of the importance of training to assimilate the use of improvised materials, a low proportion of the respondents have attended training (36, 20.1%); accordingly, the vast majority did not attend training (143, 79.9%) (χ-squared = 63.961, df = 1, p-value = 1.269e-15). Among those who attended the training, 29 (87.9%) reported that the training was helpful; however, 4 respondents (12.1%) did not recognize its importance (χ-squared = 18.939, df = 1, p-value = 1.349e-05).

Discussion

Our study showed the low participation rate of female teachers in natural science education. However, to enter the realm of a sustainable science education ecosystem and to meet at least the United Nations 2030 Sustainable Development Goals 4, 5, and 10, the gender gap and underrepresentation of women in science education must be significantly addressed. More responses were received from secondary school teachers because, at least in the context of Ethiopia's general education system (which includes primary and secondary schools), secondary school students engage more in practical activities than their primary school counterparts.

In developing countries like Ethiopia, the use of standard science instructional materials often becomes impractical due to a scarcity of resources and inadequate skills. In the absence of standard instructional materials, the most feasible option is the use of improvised instructional materials. Utilizing improvised science instructional materials enhances the teaching and learning process, as well as the creativity skills of both teachers and students. Our studies found that the use of laboratory practices in the teaching and learning processes was limited, and there were considerable inconsistencies. This problem could stem from various constraints such as shortages of laboratory equipment, consumables, and trained laboratory personnel, along with inadequate and improper storage, time constraints, and a low level of laboratory infrastructure development (Alema et al., 2024). Limited laboratory practice could also be linked to a lack of budgets, insufficient funding, and mismanagement of available resources (Mangarin & Macayana, 2024). Furthermore, when conducted, laboratory activities have occurred less frequently. Ethiopian primary and secondary school textbooks are significantly congested with text, thus providing little room and time for practical activities.

Regardless of limited laboratory practices, we found considerable knowledge among primary and secondary school teachers regarding the use of improvised science instructional materials. However, there is significant variation and inconsistency among the respondents in their use of these materials. Nevertheless, there is broad consensus that improvised science instructional materials are essential for enhancing teaching and learning processes, as well as cognitive development. This improvement could be achieved by elevating students' investigative skills, which then enables them to learn about real-world science problems (Kelly et al., 2000).

Although linked to a low proportion of the respondents, there is a misconception regarding the use of improvised science instructional materials. Misconceptions may be associated with the perception of the low quality of improvised materials compared to standard ones. Improvised materials are perceived as not durable; their production takes a long time and is a tedious task. Moreover, teachers may be discouraged from improvising science instructional materials because production incurs costs, there are limited resources, they possess inadequate technical know-how and creativity, and there is insufficient hands-on training to utilize improvised materials. Furthermore, class size is usually large, which serves as a barrier to utilizing improvised materials (Ephraim, 2023).

Regarding the efficacy of improvised science instructional materials, most respondents did not question their effectiveness. A study conducted by Adediran et al. (2024) reported that using improvised instructional materials improves student engagement, enhances their understanding of difficult concepts, and enables them to achieve high academic performance. Moreover, when there is a scarcity of standard instructional materials, the only available option is to use improvised materials (see, for example, the discussion by Anyakaorah, 2021). The effectiveness of improvised science instructional materials, given the prevailing scarcity of standard resources, is promising according to most respondents, which aligns with the findings of Aina (2013). The use of improvised science instructional materials, as reported by most respondents, saves time by improving students' understanding of theoretically complex subjects. Therefore, they are essential for grasping difficult concepts and abstracting complex ideas (Okori & Jerry, 2017).

Inadequate skill development training in the use of improvised science instructional materials was the most significant issue raised by most respondents. Notably, the teachers who received training, for example, were more motivated and began utilizing technology to teach the subjects for which they had been trained . Teaching strategies can be enhanced by encouraging inquiry-based learning. Training promotes self-directed learning and a student-centered teaching and learning process (Mahmood et al., 2022). In-service training provides teachers with competency-based knowledge and skills. It also significantly impacts teachers' learning concerning general, pedagogical content, and subject matter knowledge (Msamba et al., 2023).

Conclusion

Our study identified positive attitudes toward the adoption of improvised science instructional materials in the general education ecosystem of Ethiopia. However, bottlenecks, such as the scarcity of training on the use of improvised materials, need to be carefully addressed by policymakers. Comparative studies involving both rural and urban schools, along with interventions intended to identify the impact of utilizing improvised materials on student performance, should have been conducted to gain in-depth insights into existing opportunities and threats in the use of improvised science instructional materials.

Declarations

Ethics approval and consent to participate

The involvement in this study was strictly voluntary, and all information gathered from the respondents was kept confidential and used only for research purposes. Informed verbal consent was obtained from all respondents.

Consent for publication

All the authors agreed to publish the manuscript.

Availability of data and material

The data may be available from the corresponding author upon reasonable request.

Competing interests

The authors declare no competing interests.

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Authors' contributions

TM conceived the idea; TM and TTD conceptualized the thoughts and planned the study. All authors were involved in data collection. TM and TTD curated and analyzed the data and drafted the manuscript. All authors significantly contributed to the improvement of the draft manuscript.

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401

402 **References**

403 Adamu, M. (2024). Utilization of Improvised Resources and its Effect in Teaching and Learning
404 of Social Studies in Junior Schools in Bauchi State, Nigeria (Doctoral dissertation, Kenyatta
405 University). https://ir-library.ku.ac.ke/server/api/core/bitstreams/7f16b1e6-70b4-432b-a3f9-
406 a1d428f89338/content.

407

408 Adediran, Y. O., Ajayi, O. O., Olusanya, O. O., & Adeleke, A. (2024). Promoting civic competence
409 among pupils: the need for constant training on improvisation of instructional materials for
410 the teaching of civic education. Islamic University Journal of Social Sciences, 3(1), 28-40.

411

412 Agogo, P.O. (1993). The issue of instructional materials in education: A focus on Nigerian
413 tertiary institutions of science and technological education. Benue State Journal of Curriculum
414 and Teaching, 1(2), 24-28.

415

416 Aina, K. J. (2013). Instructional materials and improvisation in physics class: Implications for
417 teaching and learning. Computer, 2(20), 8.

418

419 Alema, B. G., Tesfamariam, G. M., Berhe, G. G., & Gebretsadik, T. T. (2024). Practices and
420 challenges in implementing chemistry laboratory work in secondary schools: A review. African
421 Journal of Chemical Education, 14(2), 31-60.

422

Anyakaorah, D. C. (2021). Improvisation of instructional materials for effective teaching and learning of computer in junior secondary schools in Ebonyi state. UNIZIK Journal of Educational Research and Policy Studies, 8, 20-29.

Beattie, M. (2000). Narratives of professional learning: Becoming a teacher and learning to teach. The Journal of Educational Enquiry, 1(2).

Ephraim, G. E. (2023). A survey of science teachers' attitude towards improvisation and utilization of improvised materials in Jos south local government area of Plateau state, Nigeria. International Journal of Multidisciplinary Research and Development 10(7), 45-49. https://www.allsubjectjournal.com/assets/archives/2023/vol10issue7/10131-1689661526915.pdf.

Holdhus, K., Høisæter, S., Mæland, K., Vangsnes, V., Engelsen, K. S., Espeland, M., & Espeland, Å. (2016). Improvisation in teaching and education—roots and applications. Cogent Education, 3(1), 1204142.

IBM Corp. (2020). IBM SPSS Statistics for Windows, Version 27.0, 2020, IBM Corp, Armonk, NY, https://www.ibm.com/support/pages/how-cite-ibm-spss-statistics-or-earlier-versions-spss.

Kelly, G. J., Brown, C., & Crawford, T. (2000). Experiments, contingencies, and curriculum: Providing opportunities for learning through improvisation in science teaching. Science Education, 84(5), 624-657.

Mangarin, R. A., & Macayana, L. B. (2024). Why Schools Lack Laboratory and Equipment in Science? Through the Lense of Research Studies. International Journal of Research and Innovation in Social Science, 8(10), 2835-2840.

Mahmood, S., Butt, M., & Manzoor, A. (2022). The impact of in-service training on teachers teaching and students learning. Global Educational Studies Review, VII (1), 322–335.

Msamba, E. M., Msuya, E. A., & Anangisye, W. A. (2023). The Impact of In-Service Education and Training on Teachers' Learning: Perspectives from English Foreign Language Teachers in Tanzania. Education Research International, 2023(1), 6135444.

Newby, T. J., Stepich, D. A., Lehman, J.D & Russet, J. D. (2007). Instructional technology for teaching and designing instruction: Integrating computers and media (2nd ed.). Upper saddle Rover, NJ: Merrill.

Nnorom, N., & Obianuju, C. M. (2021). Improvisation in science instruction and the roles of science teachers: an educational innovations for sustainable developments. COOU Journal of Educational Research 6(1): 390–406.

Obodo, A. C., Ani, M. I., & Thompson, M. (2020). Effects of Improvised Teaching-Learning Materials on the Academic Performance of Junior Secondary School Students in Basic Science in Enugu State, Nigeria. IOSR J. Res. Method Educ, 10(4), 23-30.

Okori, O. A., & Jerry, O. (2017). Improvisation and utilization of resources in the teaching and learning of science and mathematics in secondary schools in Cross River state. Global Journal of Educational Research, 16(1), 21-28.

R Core Team (2016). R: A language and environment for statistical computing, 2016, R Foundation for Statistical Computing, Vienna, Austria, https://www.R-project.org/.

Sawyer, R. K. (2011). What makes good teachers great? The artful balance of structure and improvisation. Structure and improvisation in creative teaching, 1-24.