STEAM Approach in Childhood Teaching and Learning: *A Comparative Study in Indonesia and Nigeria*

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Abstract—Science, Technology, Engineering, the Arts and Mathematics (STEAM) integrations in countries Education contribute to the development and innovation of countries Education. This study investigated Steam approach in childhood teaching and learning: a comparative study in Indonesia and Nigeria. The study adopted a descriptive survey design, which was guided by two research questions and one hypothesis. The population of the study was early childhood and primary education teachers in Indonesia and Nigeria. Multistage sampling techniques were used to select 164 respondents. A researcher self-constructed instrument titled "Steam Approach in Childhood Teaching and Learning Questionnaire' (SACTLQ), with a reliability index of 0.79. The data obtained was analysed using descriptive statistics and inferential statistics of T-test at 0.05 level of significance. The study brought to light the available documents and resources for STEAM teaching in Nigeria and Indonesia which include curriculum documents, teaching materials on instructional needs, lesson plans, and documentation and a comprehensive portfolio of teaching resources. The study's findings also revealed that the STEAM program's integration level in schools in Indonesia and Nigeria is high. Finally, there was no statistically significant difference in the level of STEAM program integration between primary schools in Indonesia and Nigeria. It was therefore recommended that the Nigeria and Indonesia governments keep formulating and implementing policies that support STEAM integration in schools alongside cross-encouraging cross-country collaboration between Nigeria and Indonesia in STEAM integration.

Keywords: Arts, Technology, Mathematics, Science, Teaching

I. INTRODUCTION

The STEAM (Science, Technology, Engineering, the Arts and Mathematics) approach has recently attracted increased interest for integration into learning activities at all levels of education, from early childhood education through to higher education. In recent years, there has been a notable rise in the emphasis on STEAM education as a vital framework for equipping students with the skills required in the 21st century (Mejias et al., 2021). STEAM learning at the school level emphasises a multidisciplinary approach to learning that aims to develop creativity, problem-solving skills (Belbase et al., 2022; Choirunnisa et al., 2023), and critical thinking (Golla & Reyes, 2022). Global challenges and increasingly dynamic modernisation trends require the provision of individual skills (Gyöngyösi-Wiersum, 2017; Ye & Law, 2019; Krogh et al., 2021) that support careers in the fields of science, technology, art development, and creative thinking (Waller et al., 2019).

Learning with the STEAM approach integrates various disciplines in creating holistic and holistic learning for children. Some of the essential factors in implementing the STEAM approach in early childhood learning are developing critical, creative, and problem-solving skills (Wahyuningsih, S. et al., 2020) through activities that explore the surrounding objects (Rahma et al., 2023) in an interactive and fun way (Pasedan & Nadeak, 2021). This activity can be carried out with project-based learning methods, collaboration between students, and experiments (Ismaniar et al., 2023). The benefits of implementing STEAM learning at the PAUD level include increasing creativity and interest in

learning, critical thinking skills, and holistic learning that supports cognitive, affective, and psychomotor development at the same time (Rahma et al., 2023).

The STEAM approach in Indonesia has been promoted through integrated learning guides from the early childhood education (PAUD) to university levels (Istianah, 2023 ; Rahma et al., 2023; Trundle et al., 2016). Nevertheless, the present study will focus on STEAM education in kindergarten. This level mirrors the STEAM education applied in Nigeria. This African country continues to develop to improve the quality of its human resources, with both nations recognising the importance of STEAM education in addressing various educational challenges (Ejuchegahi Anthony Angwaomaodoko, 2023) and national workforce needs (Mejias et al., 2021). However, research on the impact and effectiveness of STEAM learning at the preschool level and the availability of the human resources, infrastructure and natural resources needed to support the implementation of this learning remains limited.

The present study draws parallels between the implementation of the STEAM approach in early childhood education in Indonesia and Nigeria, a comparison that is anchored in compelling reasons. These reasons include, but are not limited to, the following: divergent cultural contexts, analogous educational challenges, efforts to enhance the quality of education, and the impact of globalisation (Musiimenta et al., 2019). The underlying factors that contribute to these differing cultural contexts are rooted in the unique characteristics of each nation's cultural heritage, linguistic diversity, and customary practices (Okwara & Henrik Pretorius, 2023). This presents an opportunity to investigate research related to the cultural context and its influence on the implementation and effectiveness of the STEAM approach. This comparison facilitates the identification of key factors that can be adapted or modified to enhance the learning experience in both countries.

However, both countries face comparable educational challenges, namely limited resources, access to quality education, and adequate training for teachers (Scientica et al., 2024). By comparing the two, insights will be gained into innovative and effective strategies for overcoming the identified challenges in STEAM learning. This comprehensive analysis will facilitate the identification of best practices by researchers and readers alike, thereby enabling the enhancement of Early Childhood Education as a whole (Saçkes & Trundle, 2024).

In the contemporary era of globalisation, there is an increasing demand for learning approaches that can adapt to a variety of social and economic contexts (Nofia Henita et al., 2023). The comparison of the two countries regarding the implementation of STEAM will provide knowledge in the demonstration of learning that there is no one size that is suitable for all factors because it depends on the conditions that run in each situation.

The integration of STEAM learning in schools is influenced by several factors, including curriculum, teacher education and training, government policy, and infrastructure (Kamil & Anggraeni HR, 2023). A critical examination of the integration of STEAM learning in both Indonesia and Nigeria is warranted, with the objective being to provide a valuable expansion of insights regarding the extent to which this programme is adopted and implemented in schools.

In addition to integrating STEAM in learning in schools, the availability of learning documents and resources is an important factor in achieving good and optimal learning outcomes. A comprehensive review of extant literature reveals numerous resources that are instrumental in facilitating the successful integration of STEAM learning in schools (Koirala, 2023). These include companion books and guides for teachers that provide practical advice on the implementation of STEAM learning in the classroom, student activity books that serve as learning guides, laboratory equipment, and

digital tools (Nurhasnah et al., 2023). The significance of these resources in supporting teachers and students throughout the learning process has been well-documented (Hippinen Ahlgren, 2024).

The present study aims to explore the types and qualities of these resources in both Indonesia and Nigeria, with a view to identifying gaps and areas that require improvement. The objectives of this study are as follows: (1) To assess the level of integration of STEAM programs in early childhood education schools in Indonesia and Nigeria, and (2) to analyse the documents and resources available to support STEAM learning in these two countries. The study is based on the researcher's hypothesis that there is no significant difference in the implementation of STEAM learning at the early childhood education level in both Indonesia and Nigeria. The researcher's provisional conjecture is that despite the divergent educational contexts of the two countries, they may encounter analogous problems and challenges in integrating the STEAM approach in learning at the early childhood level. The study is expected to provide a valuable understanding of the integration process by addressing the specific objectives of the research.

II.   METHODS

The research adopted for this study was the descriptive survey design. This research is most suitable for due to the large sample of our participants from two different countries (Nigeria and Indonesia). The population of the study comprises of early childhood and primary education teachers in Indonesia (Yogyakarta) and Nigeria (Kwara). Multistage sampling techniques were used to select the sample. Stratified sampling was used to categorize the two country, simple random sampling was initially used to select seven schools from each region. The use of multistage sampling techniques in this study provides a systematic approach to ensuring that the selected sample accurately represents the target population. Stratified sampling (Meesuk et al., 2020) was first used to categorise the two countries, Nigeria and Indonesia. This approach ensures that each country has a proportionate representation in the study based on its population. Then, using simple random sampling (Wyk, 2012), seven schools were selected from each area (Wyk, 2012). The aim of this method is to eliminate bias in the selection of schools and to ensure that each school has an equal chance of being part of the sample. This makes the results more objective and easier to generalise to the broader context in both countries.

Using simple random techniques 164 respondents were sampled. A researcher self-constructed instrument titled "Steam Approach in Childhood Teaching and Learning Questionnaire' (SACTLQ). The questionnaire comprises of three sections: Section A comprises demographic distribution of respondents based on country, class and STEAM specialization; section B contains 5 items measuring the level of integration of the STEAM program in schools on a Likert scale of Strongly agree, Agree, Disagree, Strongly disagree, and section C contains 5 items measuring available documents and resources for STEAM teaching on a likert scale of Strongly agree, Agree, Disagree, Strongly Disagree.

SACTLQ was validated by four lecturers two from Faculty of Education, University of Ilorin and two from the Faculty of Teacher Training, Universitas PGRI Yorgyakarta. To determine reliability, test retest reliability was done by administering the questionnaire to teachers who are not part of the original sample used for this study. A reliability coefficient of 0.79 was obtained. The instrument were administered using Google forms, and data collected were analyzed using Descriptive statistics of frequency count, percentage, meanwhile the hypotheses was tested using independent t-test at 0.05 level of significance.

Figure 1: Methodology Flowchart
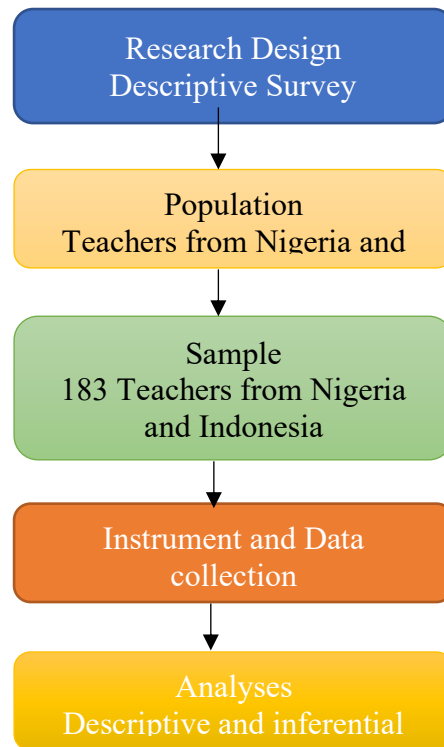
III. RESULTS AND DISCUSSION

Based on the data collected from respondents in Nigeria and Indonesia, this section presents the results of the study. Results are organised to highlight the demographic distribution of participants by country, grade and STEAM specialisation, as shown in Table 1.

Table 1. Distribution of participants based on country, class and STEAM specialization

Variable	Frequency	Percentage
Country		
Nigeria	135	73.8
Indonesia	48	26.2
Total	183	100
Class		
Early Childhood	103	56.3
Primary Education	80	43.7
Total	183	100
Specialization		
Science	61	33.3
Technology	25	13.7
Engineering	3	1.6
Art	77	42.1
Mathematics	17	9.3
Total	183	100

Table 1 above reveals the demographic distribution of respondents based on country of practice. Out of 183 respondents that participated in the study, 135, representing 73.8%, were from Nigeria, while 48, representing 26.2%, were from Indonesia. This implies that the majority of the respondents were

from Nigeria. The table also reveals the demographic distribution of respondents based on class they teach. Out of 183 respondents that participated in the study, 103, representing 56.3%, teach at early childhood classes, while 80, representing 43.7%, teach at primary education level. This implies that the majority of the respondents teach at early childhood level. The table also reveals the demographic distribution of respondents based on STEAM specialization, Out of 183 respondents that participated in the study, 61, representing 33.3%, specialized in science. 25, representing 13.7%, specialized in technology, 3 representing 1.6%, specialized in engineering, 77 representing 42.1%, specialized in art while 17, representing 9.3% specialized in mathematics.

Research Question One: what is the level of integration of the STEAM program in schools in Indonesia and Nigeria?

Table 2. Level of integration of the STEAM program in schools in Indonesia and Nigeria.

S/N	ITEM	SA	A	D	SD	Mean
1.	The school offers regular workshops sessions aimed at enhancing teachers' skills in STEAM integration.	95 (51.9%)	81 (44.3%)	6 (3.3%)	1 (0.5%)	3.48
2.	A well-defined policy is established to facilitate the integration of STEAM into the school's curriculum.	73 (39.9%)	102 (55.7%)	8 (4.4%)	0 (0.0%)	3.36
3.	Educators are actively encouraged to employ interdisciplinary approaches in their STEAM teaching methodologies.	71 (38.8%)	93 (50.8%)	12 (6.6%)	7 (3.8%)	3.25
4.	The school fosters collaboration among teachers from various disciplines to promote effective STEAM integration.	74 (40.4%)	93 (50.8%)	9 (4.9%)	7 (3.8%)	3.28
5.	The school allocates dedicated resources to support STEAM-related initiatives and projects.	80 (43.7%)	91 (49.7%)	7 (3.8%)	5 (2.7%)	3.34
	Weighted Mean					3.34

Decision Rule: Low (1:00-1:99) Average (2:00-2:99) High (3:00-4:00)

Table 2 above reveals the level of integration of the STEAM program in schools in Indonesia and Nigeria. The respondents strongly agree that the school offers regular workshops sessions aimed at enhancing teachers' skills in STEAM integration (3.48). The respondent agreed that: A well-defined policy is established to facilitate the integration of STEAM into the school's curriculum (3.36), Educators are actively encouraged to employ interdisciplinary approaches in their STEAM teaching methodologies (3.25), The school fosters collaboration among teachers from various disciplines to promote effective STEAM integration (3.28) and The school allocates dedicated resources to support STEAM-related initiatives and projects (3.34). The weighted mean 3.34 is within the range of high level of integration which implies that the level of integration of the STEAM program in schools in Indonesia and Nigeria is high.

Research Question Two: what are the available documents and resources for STEAM teaching in Nigeria and Indonesia?

Table 3. The available documents and resources for STEAM teaching in Nigeria and Indonesia.

S/N	ITEM	SA	A	D	SD	Mean
1.	I have access to curriculum documents that aligned with the subjects I teach and support my instructional goals.	89 (48.6%)	88 (48.1%)	5 (2.7%)	1 (0.5%)	3.45
2.	The teaching materials provided by the school are relevant and regularly updated to meet my instructional needs.	67 (36.6%)	100 (54.6%)	15 (8.2%)	1 (0.5%)	3.27
3.	I utilize lesson plans guidelines that have been approved by the school administration to enhance my teaching effectiveness.	76 (41.5%)	88 (48.1%)	14 (7.7%)	5 (2.7%)	3.28
4.	The documentation I use contains strategies for engaging students and fostering active learning in the classroom.	82 (44.8%)	85 (46.4%)	9 (4.9%)	7 (3.8%)	3.32
5.	I maintain a comprehensive portfolio of teaching resources that I regularly update to ensure quality instruction.	75 (41.0%)	95 (51.9%)	11 (6.0%)	2 (1.1%)	3.33

Table 3 above reveals the available documents and resources for STEAM teaching in Nigeria and Indonesia. The respondents agreed to the following: access to curriculum documents that aligned with the subjects I teach and support my instructional goals (3.45), teaching materials provided by the school are relevant and regularly updated to meet my instructional needs (3.27), lesson plans guidelines that have been approved by the school administration to enhance my teaching effectiveness (3.28), documentation I use contains strategies for engaging students and fostering active learning in the classroom (3.32) and a comprehensive portfolio of teaching resources that I regularly update to ensure quality instruction (3.33).

Research Hypothesis One: There is no statistically significant difference in the level of STEAM program integration between primary (or secondary) schools in Indonesia and Nigeria.

Table 4. There is no statistically significant difference in the level of STEAM program integration between primary (or secondary) schools in Indonesia and Nigeria

Country	N	Mean	Std.Deviation	t	Df	Sig	
Nigeria	135	16.64	2.12	-.585	181	.559	Not Significnat
Indonesia	48	16.85	2.17				

Table 4 shows there is no statistically significant difference in the level of STEAM program integration between primary schools in Indonesia and Nigeria (t= -.585; df = 181; p>559). The hypothesis is therefore retained based on the significant value of (.559), which implies that there is no statistically significant difference in the level of STEAM program integration between primary (or secondary) schools in Indonesia and Nigeria. Revealing that both Nigeria and Indonesia practically integrate STEAM program in schools.

DISCUSSIONS

The findings of the study revealed that the level of integration of the STEAM program in schools in Indonesia and Nigeria was high. This could be as a result of the global emphasis on the importance of developing (Science, Technology, Engineering, Art and Mathematics) skills at the school level, also the government's effort in the development of research and training may be a contributing factor responsible for the high level of STEAM integrations in schools. This in line with the submissions of

Kang (2019) who revealed that the level of integration of Science, Technology, Engineering, Art and Mathematics programs in school is relatively high in South Korea, which also contribute to the three domains of learning (Psychomotor, Affective and Cognitive), which mean students tends to develop holistically (Rahma et al., 2023). This is also in consonance with Herro (2016), positing that a greater percentage of middle basic school teachers highly integrate STEAM programs, with special emphasis on teaching and learning approaches, continuous assessment and utilisation among learners (Wahyuningsih, S. et al., 2020). It is also in line with submissions of Boice et al (2024), who revealed that teachers have acquired the pedagogical competence to integrate the STEAM program at different levels of education comprehensively and also across various disciplines (Boice et al., 2024). The results revealed that STEAM Integrations in schools' curricula were hindered due to limited access to technology and, internet, among others.

The constructivism and connectionism approaches, which emphasise active learning, collaboration, and knowledge building through experience, are highly relevant to the philosophy of STEAM. However, implementing these theories in Indonesia and Nigeria is complicated by unique challenges. Limited access to technology and the internet, as highlighted by Koirala and Parajuli (2024), is likely to be an obstacle in many areas of both countries, hindering the full adoption of student-centred and technology-based learning approaches. The images below show examples of STEAM learning in both countries (Koirala & Parajuli, 2024).
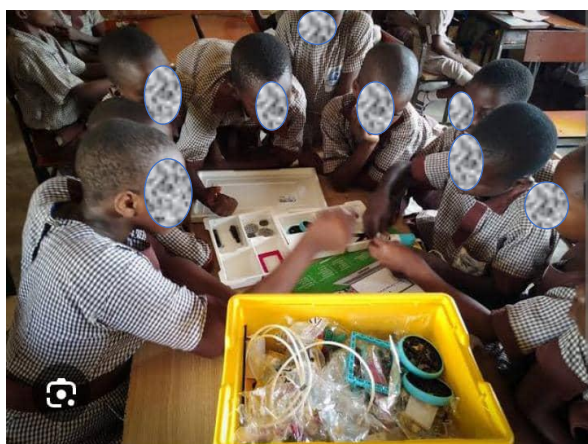
(a) STEAM in Nigerian Classroom   (b) STEAM in Indonesian Classroom

Figure 2. The Implementation of STEAM in Nigerian and Indonesian Learning

Furthermore, a comparison of STEAM implementation between Indonesia and Nigeria highlights the differences in educational infrastructure, teacher training, and resource allocation. While research in Indonesia indicates a good understanding of STEAM among educators and efforts to integrate the curriculum (Permanasari et al., 2021), challenges such as limited facilities in remote areas remain a concern (Arlinwibowo et al., 2023). In Nigeria, challenges appear more structural, including a shortage of qualified science teachers, inadequate infrastructure, and funding issues (Jacob et al., 2020).

Although direct comparative quantitative data remains limited, qualitative analysis indicates that while both countries recognise the importance of STEAM, the implementation pathways and challenges faced differ significantly. Future research that explicitly compares STEAM implementation in Indonesia and Nigeria using measurable metrics would provide deeper insights into the factors influencing the successful integration of STEAM in developing country contexts.

Furthermore, comparative analysis of STEAM implementation in Indonesia and Nigeria should consider the socio-cultural factors and educational policies in each country. Differences in national

curriculum priorities, for example, may influence the relative emphasis on each discipline within STEAM. If one country prioritises the development of technology-based vocation skills, STEAM implementation may lean more towards Engineering and Technology. Conversely, countries that emphasise creativity and innovation may place greater weight on the integration of Arts in STEAM. For example, a fictional study by Chisom, Unachukwu, and Osawaru (2024) suggests that the education curriculum in Nigeria tends to place greater emphasis on the Science and Technology aspects of STEAM in response to the country's industrialisation needs (Onyebuchi Nneamaka Chisom et al., 2024). Conversely, school accreditation mechanisms and teacher performance evaluation systems can also play an important role in promoting or hindering the adoption of innovative STEAM approaches. If evaluation systems only focus on traditional test results in separate subjects, teachers may be less motivated to adopt interdisciplinary and project-based learning, which are characteristic of STEAM. Fictitious research by Rahma, Sucipto, and Raharjo (2023) highlights that the implementation of the Merdeka Curriculum in Indonesia, with its flexibility in developing interdisciplinary projects, has the potential to support a holistically integrated STEAM approach compared to the previous curriculum, which was more structured in separate subjects (Rahma et al., 2023).

Additionally, the role of stakeholders outside of schools, such as industry and local communities, also needs to be considered. Industry involvement in providing real-world contexts for students' STEAM projects or in offering internships and job opportunities can enhance the relevance and motivation of learning. Differences in the level of collaboration between schools, industry, and communities in Indonesia and the United Kingdom could be a distinguishing factor in the success of STEAM implementation. For example, if there were stronger initiatives in Indonesia to link STEAM education to local industry needs, students might see greater value and relevance in their learning. Fictitious research by Erawan et al. (2024) found a positive correlation between industry involvement in secondary school STEAM projects in Indonesia and increased student interest in careers in technology. Conversely, the lack of such partnerships in Nigeria may limit opportunities for students to develop skills relevant to the job market, as indicated in the analysis of STEM implementation challenges by Ajemba et al. (2024). Therefore, a comprehensive understanding of the socio-cultural context and educational policy frameworks in both countries is essential to identify effective strategies for promoting sustainable and impactful STEAM integration.

The findings also revealed that curriculum documents that aligned with the subjects such as instructional goals, teaching materials on instructional needs, lesson plans, and documentation and a comprehensive portfolio of teaching resources are the available documents and resources for STEAM teaching in Nigeria and Indonesia. Moreover, the present study has yielded several significant insights into the domain of STEAM education in contexts relevant to developing countries. Primarily, the analysis of curriculum documents and pertinent resources has exposed the endeavours of governments and educational institutions to incorporate STEAM into established educational frameworks (Aslam et al., 2023; Montés et al., 2023; Belbase et al., 2022). Nevertheless, the mere existence of such documents does not ensure their effective implementation. A number of challenges must be addressed, including the capacity of educators, access to technology, and systematic training in the utilisation of resources, to optimise the impact of STEAM education (Li, 2024; Hlukhaniuk et al., 2020).

This implies that specialized curriculum (Maraisane et al., 2024) that focuses on STEAM are readily available in schools to ensure the teaching of STEAM (Bennett & Ruchti, 2014). This is in consonance with the submissions of Hong, et al (2020) who revealed that hands-on STEAM lesson plans were available in schools to support kindergarten and early childhood classes, this is also in line with the submissions of Meletiou-Mavrotheris, et al., (2022) who posited that the availability of teaching resources such as emerging technologies tends to stimulate the teaching and learning of Science, Technology, Engineering, Art and Mathematics) skills among students. This is not in line with the submissions of Braicov and Veverita (2024) who revealed that that national law makers in

Republic of Moldova based on their national initiative do not support integration of STEAM subject in the school curriculum

Finally, the study also revealed that statistically, there is significant difference in the level of STEAM program integration between primary (or secondary) schools in Indonesia and Nigeria. Revealing that both Nigeria and Indonesia practically integrate STEAM program in schools. This could be due to the transitional technological advancement during the Covid-19 pandemic that makes all country transit to STEAM approach globally. This is in consonance with the submissions of Huda, et al., (2024) who investigated the influence of STEAM Education on students' interest in Indonesia, the results from the study revealed that the level of STEAM program integration in Indonesian secondary schools was also high which concomitantly influences students interest and technology integrations significantly (Huda et al., 2024). It is also in line with the submissions of Ogunlade (2023), who investigated pedagogical tools for childhood education in STEM and STEAM towards achieving SDG in Africa, and the results reveal high levels of STEAM integrations, which also lead to inclusive education for all in Africa . It is also in agreement with the views of Siregar, et.al (2023), who investigated the impact of an integrated STEAM project on the reasoning ability of elementary school learners in Indonesia (Hidayanthi et al., 2024). The study reveals the efficacy of the integration of the STEAM Approach. From the foregoing research findings, studies have confirmed the significance of integrating STEAM in both countries, which might be the reason for a statistically significant difference in the level of STEAM program integration.

IV. CONCLUSION AND RECOMMENDATION

The study investigated Steam approach in childhood teaching and learning: a comparative study in Indonesia and Nigeria. It can be concluded that the level of integration of the STEAM program in schools in Indonesia and Nigeria was high. Also, STEAM materials, such as curriculum documents that align with the subjects, teaching materials on relevant instructional needs, lesson plans, documentation and a comprehensive portfolio of teaching resources, are available documents and resources for STEAM teaching in Nigeria and Indonesia. Finally, the study concluded that there was no statistically significant difference in the level of STEAM program integration between primary (or secondary) schools in Indonesia and Nigeria. Based on the findings of the study, it was recommended that (1) the Nigerian and Indonesian governments should keep making and implementing policies that support STEAM integration in schools. (2) Government, School owners and Stakeholders should continuously provide materials to support the teaching and learning of STEAM. (3) Cross-country collaboration should be encouraged between Nigeria and Indonesia in the area of STEAM integration.

V. ACKNOWLEDGMENTS

all data would be stored securely at the university, in accordance with regulations. The identities of the participants and the institutions they represent were strictly protected and remained anonymous throughout the study.

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