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Exploring Undergraduates' Underachievement in Science Technology Engineering and Mathematics: Opportunity and Access for Sustainability

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ABSTRACT

Growing human capacities in STEM remain the most practicable way to solving present and future challenges. Improved test score, opportunities to learn, resources and facilities have been recommended in the literature to build capacity and improve achievement for effective and qualitative delivery in STEM classrooms. We focus on the two primary stakeholders in teaching and learning in the university who are students and lecturers. This manuscript explores the causes of underachievement among undergraduates in STEM fields by employing a mixed methods for data collection and analysis among 150 undergraduates and 45 lecturers from six public universities using purposive and quota sampling. Three main research questions were raised on student, lecturer and institution base factors along with perceived hindrances to STEM learning and teaching. Three instruments; Students Factors for Underachievement (SFUA), Lecturers Factor for Underachievement (LFUA) and Lecturers Perceived Factors for Underachievement (LPFU) were employed for data collection through survey and interview. Among other findings, poor prior knowledge among learners, non-utilisation of instructional resources, inaccessibility to library and laboratory and it resources were principal hindrances of undergraduates, lecturers and institution-base factors. The study concluded that efforts and better commitment is required from stakeholders to alleviate the present inadequacies and recommend interventions to remediate areas of need.

Keywords: opportunity to learn, STEM, sustainability, underachievement

INTRODUCTION

STEM fields remain competitive and indispensably in attracting international students across the globe for sustainability in fields of need (Chang et al., 2022; OECD, 2021). The demand among international students for opportunities in STEM has doubled from 1998 to 2019 (European Migration Network, 2019; OECD, 2022). Countries like United States, United Kingdom, New Zealand, Australia, Canada among others have limited capacity domestically to cope with demand in expertise, especially in STEM fields (OECD, 2021; Roungos et al., 2020). These countries outsource experts through international students and direct employment from other nations for national and global competitiveness and sustainability (Chang et al., 2022; Ling et al., 2019; Nguyen et al., 2020; The and Koh, 2020). The afore stated establishes the rationale for monitoring education globally to meet the requirements of the jobs available in the fields of STEM and beyond. Potential employees must be held to the standards required both in education and training for relevance. Hence, the rationale to inference opportunities and access in STEM education and training globally.

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The need to consolidate efforts in the development of experts in the field of Science Technology Engineering and Mathematics (STEM) to handle the ever evolving and increasingly demanding world have gained prominence from the 1960s to date (European Parliament, 2015). Government of both developing and developed worlds have attracted citizens through scholarships and other incentives towards STEM education owing to its endless potentials, possibilities and the need for sustainability (National Science Foundation, 2018; OECD, 2009; US Department of Labour, 2019). The Rocard report emphasised the need to encourage young people into STEM to cater for immediate and future demand of expertise in these fields (Rocard, 2007). Investment in STEM and its education world over runs into trillions of any standardised currency. These investments are justifiable owing to the need to sustain leadership in technology, economy and security. However, the result of these investments requires adequate attention as the present situation is short of the desired (Organisation for Economic Co-operation and Development [OECD], 2015, 2019a, 2019b; Roungos et al., 2020). Over the years, the focus in STEM achievement has been on test/examination results of learners and its implication on the development of expertise for job placement (European Commission, 2016; Eurostat, 2019). The success recorded so far may be interpreted as achievement, and in other instances underachievement.

Underachievement connotes discrepancy between ability and achievement among learners. The gap between what learners are capable of achieving and what opportunity they are afforded to achieve that which commiserate with their ability remains a debate in the literature among educators and scholars (Elliott, 2014; Kurz, 2011; Walkowiak et al., 2017). Over the years, the quest to improve learners' achievement have brought about perspectives to ensure a more positive trend (Ergul, 2021; Ismail et al., 2019). A body of knowledge has it that learners should only account for utilization or non-utilization of opportunities within their reach (Pinter, 2013; Tate, 2005; Walkowiak et al., 2017). Floden (2007) posited that opportunity to learn (OTL) should be the focus and not learners' achievement, as there are findings which established relationship between OTL and learners' achievement (Walkowiak et al., 2017; Wang, 1998). Kurz (2011), Porter (2002) and Scherrer (2013) all reported that the interpretation given to assessment should be treated with caution as they do not reflect facts in the classroom in terms of learners' opportunities and peculiarities, curricula, teachers' characteristics, education resources, infrastructure among others. Several challenges have been identified with learners in STEM fields. Time allocation, accessibility, infrastructure, socio-economic factors and more, are hindrances to learners, OTL and by extension their achievement (Elliot et al., 2015; Eurostat, 2019; Fong and Kremer, 2020).

Studies have focused on various aspects of STEM: STEM education across Europe (Rocard, 2007; Roungos et al., 2020), STEM integration for sustainable development in Africa and underachievement (Fong and Kremer, 2020; Tikly et al., 2018); access, attraction, persistence and retention in STEM (Sithole et al., 2017; Tate, 2005); diversity in STEM teaching (Ergul, 2021; Fomunyam, 2019; Lucietto et al., 2018); STEM skills vis a vis challenges and opportunities (Ismail et al., 2019; Korkmaz et al., 2021), function of libraries and instructional resources in STEM learning (Baek, 2013; Hooker, 2017), difficulty in implementing approaches in STEM (Baiduc et al., 2016; Diana et al., 2021). The instruments in this study were developed from these cited works. However, of the studies cited, reflection on teaching and learning of STEM in higher education (University) is bereft of literature at the moment. The present study differ from previously cited works from the perspective of what opportunity are available to learners and educators of STEM to deliver on their respective objectives. The direction of this study is also unique as undergraduates and lecturer were allowed to opine on learner, lecturer and institution-base factors.

Conceptual and Theoretical Approach

Opportunity to learn (OTL) was first conceptualised by Carroll in 1963 to mean the time afforded for learners to learn a particular concept. Other scholars have operationalised OTL to relay what is taught to students and what is assessed in achievement test given to such learners; others view it as the interrelation among exposure, coverage emphasis on content and the quality of instruction afforded to learners (Husen, 1967; Stevens, 1993; Wang, 1998). While the curriculum of universities spells out categorically the content and emphasis on what should be taught to undergraduates, the quality of delivery in STEM fields which encompasses pedagogical prowess, access to resources and infrastructure are not well-defined and remain the focus of this work. We embedded this manuscript in the sociocultural situation theory of Lev Vygotsky (1978), which examines societal/environmental contribution to individual development of learners. This theory was founded on human learning as social process based on cognitive functioning as a result of interaction. Psychological growth from sociocultural lens assumes that learners' development is a product of factors such as; mentor-type duties of teachers, parent, social group and environment. Opportunity to learn is not limited to learners' conception of psychometric attribute and location of knowledge, rather, an overall relationship between learner and experience within action and interaction about his/her thinking and feeling. Learners assume connection between perception and cognition in the social world in which they reside. To this study, we view this theory to be adequate in examining the associative factors responsible for undergraduates' achievement in STEM fields by amplifying the environment, facility, priority, infrastructure among others as they contribute to underachievement rather than alluding the overall responsibility to the learner. While

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the field of STEM is broad, and the expectations from learners are unique, what characterise OTL in STEM is beyond the willingness of learners, in this case, undergraduate. We allow for undergraduates and lecturers reflection on academics and sociocultural factors responsible for underachievement in this study.

Literature Review

While primary and secondary schools have received several interventions to support STEM education across Africa through MasterCard foundation and others (Tikly et al., 2018), there is the rationale to improve status quo by stakeholders towards poverty eradication and sustainable development. This section review research done in the fields of STEM with a view to update this audience. The study of Tikly et al. (2018) researched the support required in STEM education at senior secondary schools across Sub-Saharan Africa towards the attainment of sustainable development goals. The study found the attainment of student to be low from primary to secondary schools which by extension affected both enrolment and achievement of post-secondary education in STEM fields. This study's objective among others was to identify barriers to student learning of STEM subjects, and make recommendation on ways to remediate the challenges identified by examining factor responsible for university students' (undergraduate) underachievement in STEM unlike the study of Tikly and colleagues, however, their study recommended improved remuneration for teachers as a form of motivation, employment of suitably qualified teachers, moderate class size, a more ambitious curriculum, training and adequate educational resource and infrastructure to bridge the gaps identified.

An investigation of competences among STEM candidates was done by Ergul (2021). Science and mathematics teachers were obligated to design and create a moving object (parachute) in physics. Participants were expected to consider free fall, lift force and air resistance in their design, as well as make use of items which are found in everyday life. The study sampled 106 preservice first grade teachers from the Department of Mathematics and Science education at a public university in Turkey. The study reported 4.38% success in terms of competency among the sample which lead to the generalisation that most preservice teachers do not possess the STEM competencies required at the level under review. Training was recommended for preservice teachers to remediate the gap in knowledge.

Korkmaz et al. (2021) conducted a scale adaptation of basic skills in STEM among senior secondary school students. The instrument was based on "self-perception basic STEM skills" for university students but adapted to suit secondary school students to elicit basic STEM level skills. With 501 participants in a descriptive model survey, exploratory factor analysis was employed for construct validity with the instrument being on a 7 Likert scale of 23 items categorizable into three. The study found students' basic STEM skills for science and mathematics to be at intermediate level but low for engineering and technology. In a similar study, Ismail et al. (2019) researched issues and challenges with STEM empowerment among teachers of secondary schools in Malaysia. The study sought to identify hinderances to science teachers' implementation of STEM in secondary schools and the training required to remediate the issues identified. The study involved 15 science teachers through a qualitative interview. Lack of facilities, inadequate support from school leaders, time constraint, poor financing and heavy workload were among the issues raised by the participants. The study recommends collaboration with higher institutions, industries for training and empowerment.

Sithole (2017) explored learners' attraction, persistence and retention towards STEM. A reported attrition and low enrolment informed the study as many STEM entrants switch to non-STEM course while others drop out from the university. Strategies which were devised to remediate the situation included tutoring prior mathematics requirement, orientation programmes, peer academic communities, professional development for lecturers and outreach programmes. In a similar study, Fong and Kremer (2019) investigated expectancy-value and underachievement in mathematics. Achievement in high school, STEM interest and college attendance were the sources of data. The longitudinal study which lasted for 7years (between 2009-2016) sampled 23,000 high school students in four tranches and focused on learners' academic trajectory. Math ability and achievement, college outcome, motivation, intrinsic and attainment values, unitality and self-efficacy were factors considered in the study as covariate of dependent variables. Discrepancy in standardised mathematics score between 9-12 grade allowed for structured equation modelling for the effect of motivation on mathematics underachievement along with future STEM and college outcomes. Motivation in mathematics with respect to value and expectancy beliefs had significant association to mathematics underachievement. Also, positive effect was observed directly with mathematics attainment value with respect to STEM and Mathematics intrinsic value.

Problem Statement

STEM education remains vital for improved economic development for international competitiveness, job creation and economic relevance (Badmus and Jita, 2023; Baiduc et al., 2016; Ismail et al., 2019). Despite this importance, the teaching and learning of STEM especially at public universities have been plagued with challenges

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which span from sociocultural issues, teaching resources, basic infrastructures, time allocation and disruption, poor financing and attitude to learning among others (Fong and Kremer, 2020; Fomunyam, 2019). Previous studies have investigated through survey and quantitative methods underachievement among undergraduates in mathematics and science (Tikly et al., 2018; Sithole, et al., 2017), historical developments in STEM as well as it implication for future development and poverty eradication (Badmus and Omosewo, 2020; Lucietto et al., 2018), importance of STEM to economic and national growth (Baiduc et al., 2016), examined availability, utilization and integration of resource for STEM teaching (Hooker, 2017; Ismail et al., 2019; Tikly et al., 2018). In this study, we examine causes of underachievement among undergraduate with respect to the opportunity they are afforded to learn, as well as give voice to learners in stating the challenges encountered in learning STEM unlike previous studies. Lecturers and institution-base factors were critically examined through undergraduates and lecturers' lens. Furthermore, interviews were conducted to investigate hindrances encountered by lecturers about the teaching, as well as their views on hindrances to students' underachievement in STEM.

METHODOLOGY

This study employed explanatory sequential design of mixed methods approach with quantitative and qualitative components. The qualitative aspect involved the narrative type by collecting data involving individual experiences as it helps explain situations of both learners and educators in STEM fields. Analysis was done using non-numerical data via text, audio to relate concept, opinions and/or experiences of respondents. Semi-structured interview was employed to generate qualitative data using open-ended questions. The quantitative component indulged descriptive survey by way of generating numerical data that were transformed into useable descriptive statistics.

Sampling

The population for this study were undergraduate students and lecturers in STEM fields across Nigerian universities across North Central States. We are conscious of the fact that private and public universities do not have similar challenges in learning STEM with respect to the locale. The previous statement is attributed to the infrastructure and resources at the disposal of private universities in Nigeria, to this end, public universities was the focus of this study. The sample was limited to six public universities, and we assume the data collected will reflect what is obtainable in other public universities across the country since they are all funded and regulated by the same agency of government. Quota and purposive sampling techniques which are non- probability sampling techniques were employed in the selection of respondents at different stages which makes the sampling multi-stage. The selection of both undergraduates and lecturers were distributed evenly among the six participating universities base on some criteria. These criteria are that; respondents must be lecturer/students in one of the public universities of interest; respondent must be studying/Lecturing in STEM fields; in the case of lecturers, such lecturer must have minimum of 5 years' experience (this was initially 10 years but was reduced due to the willingness of respondents in some universities) and respondents must be willing to participate in the study. A total of 150 undergraduates (25 per university) and 45 lecturers from STEM fields (5-8 lecturers per university depending on the departments). **Table 1** shows demographic information of the respondents.

Instrumentation

Our search in literature to adopt instrument/s to measure the factors responsible for undergraduate underachievement in STEM led to course-base factors which are subject-centric and differ in approach to the perspective of this study with respect to sociocultural theory and paradigm of opportunity to learn as used in this study. We considered the locale of the study and peculiarity of public universities in Nigeria to aggregate the concerns raised in studies under review. We opted for researchers designed instruments to accommodate the afore-mentioned peculiarities. The first instrument was Students Factors for Underachievement (SFUA) in STEM fields. The instrument had four sections with the first section providing the demographic data of the respondents. Section two contained 7 structured items which elicited data to answer relevant questions on student-based factors, third section had 7 items to answer lecturer-based factors as perceived by students and the last section with 6 items to answer institution-based factors. Before SFUA was adopted, we ascertain the suitability of the instrument for the target population in terms of its appropriateness, adequacy, content coverage (STEM) and relevance to the research questions. We determined the credibility of the instrument by allowing for three colleagues (with Ph.D.) from the fields of science, mathematics and technology education to scrutinise and make input before arriving at the final draft of the instrument which was validated through expert judgement [the research questions and instruments were given to five lecturers in STEM field who are above senior lecturers and above to moderate and posit on

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Table 1. Demographic information of the respondents

Variables	Grouping	Frequency	Percentage
Gender of students	Male	68	45.3
	Female	82	54.7
	Total	150	100.0
Academic level of students	100	39	26.0
	200	33	22.0
	300	34	22.7
	400	44	29.3
	Total	150	100.0
Qualification of lecturer	BSc	1	2.0
	M.Eng	1	2.0
	MSc	18	40.0
	PhD	25	56.0
	Total	45	100.0
Experience of lecturer	0-5	20	47.0
	6-10	15	33.0
	Above 10 years	9	20.0
	Total	45	100.0

Source: Fieldwork, 2022.

Table 2. Mean rating of student-based factors

S/N	Items	Mean	Standard deviation	Rank
	Students-based factors			
1	Interest in STEM classes	3.12	0.84	2nd
2	Difficulty to study among peers	3.07	0.83	3rd
3	Poor prior knowledge	3.14	0.73	1st
4	Limited practical sessions	2.67	0.79	7th
5	Studying less during the day	2.74	0.81	5th
6	Finding reading boring and uninteresting	2.83	0.92	4th
7	Priorities (clothes, jewelries etc.) to books	2.70	0.87	6th

* Mean ≥ 2.50 = Accepted; Mean < 2.50 = Rejected

clarity, relevance and coherence]. The final draft was designed into google form which were made available to each respondent in their various universities.

The second instrument, Lecturer Factors for Underachievement (LFUA) in STEM fields was administered to STEM lecturers via interview. This instrument had 10 interview questions and was scrutinised through the same process as SFUA. The third instrument Lecturers Perceived Factors for Undergraduates' Underachievement (LPFU) elicited data through interviews with lecturers on the perceived challenges they think students face in learning STEM. Most of the interviews were conducted electronically via Telegram, Zoom and WhatsApp. Zoom allowed for recording of the interview while Telegram and WhatsApp were recorded externally after which transcribing was done.

Ethical Consideration

All ethical (anonymity, voluntary participation and withdrawal) issue were adequately attended to base on the ethical standard of the parent university where this research was conducted.

RESULTS

Research Question One: What student-base factors are responsible for Underachievement of undergraduates in STEM?

Table 2 revealed that the mean score and standard deviation of the undergraduate student's responses on student-based factors responsible for Underachievement of undergraduates in STEM. Value greater than or equal to the benchmark value 2.5 indicates that the participants accepted, while a mean lower than 2.5 indicates that the participants rejected. To determine the prominent student-based factor contributing to underachievement of undergraduate learning in STEM, ranking of the participants responses was rated. Students' poor prior knowledge ranked 1st as student-based factor which contributes the most to Underachievement of undergraduates learning in

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Table 3. Mean rating of lecturer-based factors

S/N	Items	Mean	Standard deviation	Rank
	Lecturer-based factors			
1	Poor teaching method	2.78	0.97	2nd
2	Non-utilization of instructional resources	2.79	0.87	1st
3	Lateness to class	2.63	1.06	3rd
4	Entertaining questions after lectures	2.41	0.86	7th
5	Limited time allocation for classes	2.45	0.90	6th
6	Evaluating concepts not taught	2.60	0.93	5th
7	Poor content delivery	2.61	0.96	4th

* Mean ≥ 2.50 = Accepted; Mean < 2.50 = Rejected

Table 4. Mean rating of institutional-based factors

S/N	Items	Mean	Standard deviation	Rank
	Institutional-based factors			
1	Ill-equipped teaching and learning facilities	3.92	2.02	2nd
2	No modern and standardized books	3.91	1.00	3rd
3	No conducive atmosphere for learners	3.68	1.27	5th
4	Ill-equipped laboratory for practical	3.59	1.43	6th
5	Inaccessibility to library and laboratory and it resources	3.97	1.13	1st
6	Violence leading to disruption of learning	3.79	1.10	4th

* Mean ≥ 2.50 = Accepted; Mean < 2.50 = Rejected

STEM. While students' lack of concentration in practical classes which ranked 7th is the least student-based factor which contributes to Underachievement of undergraduates learning in STEM fields.

Research Question Two: What lecturer-base factors are responsible for Underachievement of undergraduates in learning STEM in Nigeria Universities?

Table 3 revealed the mean score and standard deviation of undergraduate students' response on lecturer-based factors responsible for their underachievement in STEM fields. The benchmark value 2.5 indicates that the participants accepted, while a mean value that is lower than 2.5 indicates that the participants rejected the response. From Table 3, items 1, 2, 3, 6 and 7 had mean value greater than the benchmark 2.50, this implies that, the participants agreed that poor teaching method, lecturers' non-utilization of instructional resources, lecturers' lateness to class, lecturers' evaluation of students on concepts not taught and poor content delivery all constituted to lecturer-based factors responsible for underachievement of undergraduate in STEM fields. However, Items 4 and 5 have mean scores less than 2.50. This implies that the respondents do not believe that lecturers are allowing questions in the lecture rooms and that inadequate time are allocated for classes. Based on the ranking of the responses of the participants, non-utilization of instructional resources by lecturers ranked the 1st while lecturers not giving room for questions during lectures ranked 7th. This indicate that the respondents accepted that non-utilisation of instructional resources by lecturers ranked the most as lecturer-based factors which contributed to Underachievement of undergraduates learning in STEM fields.

Research Question Three: What Institution-base factors are responsible for Underachievement of undergraduates in learning of STEM in Nigeria Universities?

Results from Table 4 revealed that the mean score and standard deviation of the undergraduate student's response on Institution-base factors responsible for Underachievement of undergraduates learning in STEM. Here, mean values greater or equal to 3.0 indicates that the participants accepted, while a mean value that is lower than 3.0 indicates that the participants rejected the responses. From Table 3, all the items have a mean value greater than the benchmark 3.0, this implies that, all participants agreed that all itemized institutional-based factors are responsible for underachievement of undergraduates in STEM fields. To determine the most prominent institution-base factor, the item with the highest mean is inaccessibility to library and laboratory and it resources while access to well-equipped laboratory for practical ranked 6th.

Research Question Four: What are the hindrances to STEM teaching as perceived by lecturers in Nigerian Universities?

Analysis of responses from STEM lecturers through interview is summarized on Table 5. From Table 5, it is observable that the challenges faced by STEM lecturers range from poor attitude of students to learning, over-population in classrooms, inadequate instructional resources, students' poor prior knowledge, mathematical anxiety among students, poor remuneration, unconducive environment, time constraints, nature of topics, high cost of living, learning diversity, poor electricity supply, underage admission and administrative challenges. However, based on the frequency of responses by STEM lecturers to the hindrances itemized, it can be seen that most STEM

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Table 5. Challenges faced by STEM lecturers

Challenges of lecturers	Teachers with responses to challenge	Frequency
Poor attitude of students to learning	T_1, T_5, T_{16}, T_{22}, T_{24}, T_{27}, T_{29}, T_{32}, T_{33}, T_{35}, T_{37}	11
Over population in classrooms	T_2, T_3, T_{10}, T_{11}, T_{23}, T_{25}, T_{29}, T_{33}, T_{34}	9
Inadequate instructional resources	T_2, T_3, T_4, T_8, T_{10}, T_{13}, T_{20}, T_{21}, T_{23}, T_{27}, T_{33}, T_{34}, T_{42}, T_{43}	14
Students' poor prior knowledge	T_4, T_9, T_{12}, T_{31}, T_{38}, T_{39}, T_{40}	7
Mathematical anxiety among students	T_4, T_7, T_{15}, T_{31}	4
Poor remuneration	T_8, T_{25}, T_{28}, T_{29}, T_{32}, T_{36},	6
Unconducive environment	T_8, T_{45}	2
Time constraints	T_{14}, T_{37}	2
Abstract nature of topics	T_{17}, T_{20}	2
High cost of living	T_{17}, T_{35}, T_{38}	3
Learners' diversity	T_{19}, T_{26}, T_{30}, T_{32}, T_{43}, T_{44}	6
Poor electricity supply	T_{21}, T_{45}	2
Underaged admission	T_{30}	1
Administrative challenges	T_{32}	1

* T = STEM lecturer in the university
* 1, 2, 3, … are the numbers assigned to each of the STEM tutors
* T_1: STEM lecturer that was first interviewed

Table 6. Challenges of students

Challenges of students	Teachers with responses to challenge	Frequency
Limited learning facility / infrastructure	T_1, T_2, T_3, T_4, T_{10}, T_{11}, T_{15}, T_{17}, T_{28}, T_{33}, T_{35}, T_{36}, T_{38}, T_{42}, T_{45}	15
Overcrowded classes	T_2, T_5, T_{21}, T_{35}, T_{37}	5
Non-conducive learning environment	T_4, T_{17}	2
Inadequate prior knowledge	T_6, T_9, T_{14}, T_{20}, T_{22}, T_{31}, T_{34}	7
Mathematics anxiety	T_7, T_{20}, T_{21}	3
Peer influence	T_8, T_{38}, T_{42}, T_{43}	4
Admission into non-intended course	T_{11}, T_{14}, T_{17}, T_{19}, T_{29}, T_{34}	6
Time constraint	T_{12}, T_{27}, T_{33}, T_{38}	4
Electricity	T_{13}, T_{39}, T_{45}	3
Abstract nature of topics	T_{16}, T_{17}, T_{22}, T_{32}	4
Parental negligence	T_{18}, T_{26}	2
Poor student teacher relationship	T_{22}	1
Cost / no scholarship	T_{25}, T_{28}, T_{44}	3
Manpower	T_{28}	1
Under-age admission	T_{30}	1
Accommodation	T_{33}, T_{42}	2
Academic distractions	T_{39}, T_{40}, T_{43}	3

* T = STEM lecturer in the university
* 1, 2, 3, … are the numbers assigned to each of STEM tutors
* T_1 = STEM lecturer that was first interviewed

lecturers mentioned inadequacy of instructional resources as the challenges they faced most. Poor attitude of students to learning is second, third was overpopulation of classrooms, students' poor prior knowledge of basics required for higher learning, next to poor remuneration and learners' diversity with underage admission and management problem as the least concerns.

Research Question Five: What challenges do lecturers perceive students face in learning STEM disciplines in Nigeria Universities?

Analysis of data from STEM lecturers on challenges students face in STEM learning through interview is summarized on **Table 6**. From **Table 6**, it can be observed that the perceived challenges faced by STEM students in Nigerian Universities include; limited learning facility/infrastructure, overcrowded classes, unconducive learning environment, Poor prior knowledge, mathematics anxiety, peer influence, admission into non-intended course, time constraint, poor electricity supply, abstract nature of topics, parental negligence, poor student lecturer relationship, high cost of living, education, absence of scholarships, manpower, under-age admission, accommodation and academic distractions. However, based on the frequency of the responses of STEM lecturers to each of the challenges, it can be seen that most of the STEM lecturers mentioned limited learning facility as challenges that students are faced with most. Hence, Limited learning facility is the major challenge faced by STEM students in Nigeria Universities. All other challenges are as reported on **Table 6** in order of their frequency

DISCUSSION

Students' ignorance (poor prior knowledge) is the most prominent student-based factor which contributed to their underachievement among STEM undergraduates. According to UNESCO (2019) report, students' competence in STEM covers both the 'know-what' (the knowledge, attitudes and values associated with the disciplines) and the 'know-how' (the skills to apply that knowledge, taking account of ethical attitudes and values to act appropriately and effectively in each context). The research findings of Ergul (2021); Korkmaz et al. (2021) substantiated the position held in this study. Lecturers' non-usage of instructional resources majored among lecturer-based factor which contributes to Underachievement of undergraduates learning in STEM. Instructional resources are important in teaching and learning process for conceptualisation. When lecturers utilize instructional resources appropriately, it enhances the quality and effectiveness of teaching and learning. This finding aligns with Ruthevn, (2018), Torphy et al. (2020), Yeboah et al. (2019) and Talavera-Mendoza (2021) who observed that non-integrational of instructional resources in learning contributes majorly to students' poor achievement.

Institutional-based factor which contributes most to underachievement of undergraduates learning in STEM is unavailability of basic infrastructure and resources like unrestricted access to library and laboratory (electronic and physical) at all times. This hinder learners from performing basics learning responsibilities required of them as at when due. The provision of free access to library and laboratory allows for students to source relevant materials/resources useful to their learning in STEM. The studies of Baek (2013), Phillips and Lee (2019) and Musgrove et al. (2019) all corroborate the position of this study that libraries and laboratories (electronic and physical) are venues for learning science, technology, engineering, and mathematics (STEM) and have great potential for implementing both formal and informal STEM education. However, its unavailability or lack of access limits students learning to what they are being taught in the classroom only. Quality of instruction often reflect in competencies of learners and instructors. Inadequacy of instructional resources is chief among the challenges faced by STEM undergraduates and lecturers in public universities in Nigeria. Instructional resources play an integral role in enhancing quality of teaching/learning processes, thus, their inadequacy or unavailability affects teaching and learning process. The result of the current study agrees with the findings of Diana et al. (2021) and Ismail et al. (2019). An overview of responses from the participants revealed limited learning facilities and resources are a major challenge experienced by STEM lecturers and undergraduates in Nigerian Universities. The adequacy and availability of learning facilities in institutions as established in the literature enhance teaching and learning which allows for the realization of educational objectives at all levels.

CONCLUSIONS

From the findings, we conclude that better commitment is required from government and stakeholders on the revitalization of public universities in Nigeria. Non-availability, inadequacy and inaccessibility will limit the potential competencies and capacities for qualitative and effective teaching and learning in STEM field in public universities. By implication, poorly trained graduates may have negative impact on efforts towards poverty alleviation, eradication, and sustainable development of the country. Although much is expected from whom much is given, efforts must be intensified by both undergraduates and lecturers to improve areas of laxity. For undergraduates, poor prior knowledge is the most prominent student-based factor which contributes to underachievement of undergraduates learning STEM. Lecturers' non-usage of instructional resources majors on lecturer-base factors hindering undergraduate achievement in STEM. Access to infrastructure and library and laboratory resources is chief of the institutional-base factors contributing to underachievement of undergraduates learning STEM in this study. STEM Lecturers are faced with the challenges of inadequacy of instructional resources among others. The challenges faced by STEM lecturers and undergraduates affect instructional quality and effectiveness which often result in poor academic achievement, lack of requisite skills and job competencies.

RECOMMENDATIONS

Undergraduates are encouraged to embrace STEM and the knowledge therewith to improve their prospect in the field and by extension their achievement. Similarly, Guidance and Counselling units are encouraged to take up career advisory services and peer enhanced programmes to spur and acclimatise students with the benefits of careers in STEM to themselves and the nation. Where instructional resources are inadequate to teach in STEM fields, stakeholders are encouraged to make available and, where available, should be put to better use by instructors of STEM to promote effective teaching and learning. Capacities of lecturers should also be built where lacking to avail the right usage of such resources when available. In many instances, accessibility trumps unavailability of infrastructure in the public universities under review, while the essence of such resources is for students to make

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use of, management/administration of culpable institutions must do better at making these resources easily accessible to students.

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