What Factors Influence Students to Persist and Achieve on Science, Technology, Engineering and Mathematics (STEM) Courses in Nigerian Universities?

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Abstract

STEM (Science, Technology, Engineering and Mathematics) is widely thought to be essential to economic growth, technological innovations and sustainable development. The role of a technologically educated population in promoting social and economic development has long been recognized. Understanding the factors that influence persistence and achievement of undergraduates on STEM courses will help in planning and refining STEM policy. It will also provide higher education institutions with better and more effective approaches to improve the experience of STEM students. Most research into STEM intake, policy and enabling factors has been conducted in developed countries such as the USA, the UK and other European countries. The academic background and experience of the undergraduates from these countries are different from the ones from Nigeria, which could affect their persistence and achievement. This study addressed gaps in the literature by examining what student experiences can improve persistence and achievement of undergraduates studying STEM courses in public universities in Nigeria. The qualitative research study was undertaken with 25 STEM undergraduates in the first year of their courses, who were individually interviewed. The factors that have influenced their persistence and achievement were then analysed thematically. After coding process, nine themes emerged from the data, namely intrinsic value, expectancy of success, utility value, sociocultural factors, industrial action, self-efficacy, difficulty, the quality of teaching and learning, and cost.

1. Introduction

Gonzalez and Kuenzi [1] defined 'STEM' education as teaching and learning in the fields of science, technology, engineering, and mathematics, including educational activities across all grade levels, from pre-school to post-doctorate, and in both formal and informal classroom settings. Debates on science, technology, engineering, and mathematics (STEM) education over the past decade have often been driven by the prediction of shortage of STEM prepared workers and educators around the world due to the changing global economy and workforce. For example, it has been estimated that employment in STEM-related occupations will double that of other occupations in future [2]. Becker and Park [3] suggest that 75% of the fast-emerging occupations require knowledge and skills in STEM.

STEM professions have been viewed as drivers of economic development in the world [4]. Tytler [5] points out that education and research in STEM are progressively gaining a recognition as fundamental drivers of national development, economic productivity, and societal well-being. Indeed, the report from the World Economic Forum [6] estimates that 65% of children entering students presently in primary schools will ultimately work in new job types and functions that currently don't yet exist, many in the STEM domain. In addition, it is expected that the global workforce will undergo profound shifts through technological movements such as the Fourth Industrial Revolution driven greatly by research and development in biotechnology, genetics, 3D printing, nanotechnology, robotics, artificial intelligence and machine learning [4]. In addition, the creation of many new cross-functional roles through technological advancement will require both technical and analytical skills [6].

The recognition of STEM education as an international topic of discussion is obvious in government efforts of different countries to develop policies regarding school mathematics and science, and tertiary level education and research in the STEM fields [5]. Both industrialized and developing countries are increasingly concentrating on boosting their citizens' STEM capabilities [5]. Marginson et al. [7] examined initiatives focused on STEM participation through a country comparison project which covered the Anglosphere (United States, Canada, New Zealand, United Kingdom, Australia), Europe (Western Europe and Russia), Asia (China, Taiwan, Japan, Singapore, South Korea), Latin America (Argentina, Brazil), the Middle East (Israel), and South Africa. The study revealed that it essential to improve participation and performance in STEM in all students, in teaching and teacher education, in the curriculum and via pedagogy at primary through tertiary levels; it is also necessary to enhance public perceptions. More students need

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to be encouraged to aspire to STEM learning and STEM-based careers. However, several studies have indicated that the production of STEM graduates is not keeping pace with the growing demand for STEM professionals [8, 9].

There is a large volume of published studies showing that insufficient production of STEM graduates may have negative impact on industrial and economic growth. Researchers have made efforts to determine the factors that influence students' interest in STEM in a number of high-income countries, such as the USA, the UK, and also in other European countries. However, there is limited research in low-income countries including in the Nigerian context, concerning the potential determinants of university student interest in STEM. The academic background and experience of undergraduates from the countries where the most research has been conducted in STEM education are different from the ones from Nigeria. This study addressed gaps in the literature by examining what student experiences can improve persistence and achievement of undergraduates studying STEM courses in public universities in Nigeria.

2. Literature Review

Previous studies have reported that STEM education is confronted with many challenges in the public universities in Nigeria. These are shortages of infrastructural facilities, chronic lecturer strike, a lack of science lecturers, lecturers' brain drain, inadequate funding, a poor research climate and corruption [11, 12, 14]. These challenges have resulted in the loss of interest in STEM education by students who would have become future scientists and engineers [10]. In this section, I will examine the contribution of these factors to the decline of STEM education.

2.1. Shortage of infrastructural facilities

The effective running of STEM courses in every university requires infrastructural facilities. These facilities include lecture halls, classrooms, laboratories, examination halls, staff offices, water, electricity, hostel accommodation, staff quarters, students and staff recreational facilities, sports and games facilities, etc [12]. Lack of these facilities will hinder effective teaching and learning which will result in poor quality of education, while sufficient supply of these facilities will improve the standard of education. It is worrisome that infrastructural facilities remain insufficient for managing a system that is growing at a fast pace in Nigeria [11]. The public universities in the country are deteriorating rapidly due to the lack of maintenance and repair of the existing buildings. There is shortage of all the resources necessary for STEM education. Lecturers' halls, laboratories, students' hostels, library space, books and journals and office space are not sufficient to meet the demand of the students who are enrolled on the STEM courses. The furnishings in the university laboratories and classrooms are often derelict. Libraries are not conducive for studying [12]. The inadequate supply of electricity has had negative effects on universities across the country. These include ventilation and meaningful research activities in the universities.

2.2. Strike action

The administration of the public higher institutions of learning in Nigeria is contending with prevalent strike actions by different union groups. The strike actions are attributed to different reasons, including poor working conditions, inadequate infrastructural facilities, underfunding of the public higher institutions of learning and ineffective implementation of agreements reached with union groups. The constant strike actions in Nigerian universities have resulted in interruptions to teaching and learning. The resulting effects of strike action by university lecturers can be devastating and include loss of skills among students, such as executive functions, including planning, reorganization, flexible thinking and multi-tasking. Other negative effects of continuous strike actions include poor quality of education, poor patronage of public universities, low rankings internationally and a bad image for public universities in the country [12].

2.3. Lack of science lecturers

The Federal Government of Nigeria carried out an assessment on the needs of Nigerian public universities in 2012. The report revealed that there is shortage of qualified teachers in Nigerian universities [11]. This shortage is one of the reasons why the quality of education is declining in Nigeria [14]. This shortage of university lecturers is one of the major contributing factors to the challenges of STEM education in the country. For example, there is an acute shortage of lecturers in computer science and technology-based disciplines, engineering, medicine and surgery in public universities [12]. There are insufficient academic staff in many public universities in the country and there is a lack of funds for university management to employ the required number of lecturers. This has led to an increase in the number of visiting lecturers in the system. There is exclusive reliance on part-time and underqualified academics by many universities which has led to poor quality of education in STEM area [13, 14]. Many of the lecturers are unable to meet their primary obligations with their employers because they are always on the road travelling from one university town to another. Insufficient STEM teachers is also responsible for the high student-

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teacher ratio in Nigerian universities which has resulted to poor quality education [12]. The report from NEEDS [13] revealed that the lecturer-to-student ratio in the public universities is unmanageable. For example, at the University of Abuja the academic staff-to-student ratio was 1:122, at Lagos State University the ratio was 1:144, and at the National Open University the ratio was 1:363. These data indicate wide differences between public universities in Nigeria and other countries. For example, the staff-to-student ratio in the University of Cambridge is 1:3 and in Harvard university is 1:4 [14]. These shortages are ascribed to a number of reasons, including poor working condition, inadequate production of lecturers in these fields by the higher institutions in the country and the emigration of lecturers to high-income countries for improved standard of living [13].

2.4. Lecturer brain drain

According to Ogunode and Abubakar [14], a brain drain is a massive movement of professionals from developing countries to developed countries to work because of better working conditions. The brain drain in Nigeria is attributed to various factors including insecurity, underfunding, unconducive working environments, poor motivation and political interference [12]. The country has lost many of its lecturers to foreign universities. Nigerian universities suffer brain drain to high-income countries such as the UK, Australia, Canada and the USA, particularly in the STEM disciplines. Many mathematicians, engineers, doctors and nurses have relocated from Nigeria to these high-income countries in search of better working conditions.[13]. These high-income countries are enjoying the benefits of utilizing the immigrants' skills that are lacking in the country of emigration of these immigrants. In the case of Nigeria, this has resulted in high student-teacher ratios, poor quality of education, declines in research outputs from universities and diminishing scope of mentoring junior researchers by experienced and senior lecturers [12].

2.5. Inadequate funding

The dwindling level of public funding in Nigeria in the face of rising demands and the rising cost of higher education is a threat to the survival of the educational systems in the country. The country has never enjoyed the benchmark of 26% of the total budgetary allocation to education, recommended by UNESCO. The performance and sustainability of higher education in public institutions in Nigeria has been negatively affected by the inability of the Federal Government of Nigeria to implement this 26% funding formula for education [14]. The management and administration of STEM courses are very cost-intensive. Unfortunately, there is insufficient allocation of the annual budget for the administration and management of STEM provision in the universities [12]. Lack of adequate funds has hindered the completion of capital projects embarked upon in many public universities in the country [14]. The negative implications of underfunding in public higher education of learning in Nigeria include constant strike action, shortage of academic staff, brain-drain, inadequate infrastructure and poor quality of education [12].

2.6. Poor research

Research is vital in universities for the generation of new knowledge and the ultimate development of the society. University research contributes to national development. According to Ogunode and Abubakar [14], research and teaching are the two fundamental tasks of universities. The research from the public universities in Nigeria has not made a tangible impact on socio-economic well-being of the country's citizens or the technological development of the country. The major problem confronting research in Nigerian public universities is insufficient research funds [12]. Low research productivity in Nigerian public universities has also been attributed to other, related factors including low motivation among academic staff, poor participation of the private sector in research development, the brain drain, strikes, and rising workload resulting from declining staff-student ratios [12, 14]. The implications of low research productivity in public universities include poor STEM education, poor international rankings and poor patronage of public universities in Nigeria [12].

2.7. Corruption

Many public universities are in a bad condition due to corruption in the system. The officials of the public universities have sometimes diverted the limited funds provided by the government in support of research, development, and infrastructural facilities, for their own personal use. Ogunde and Abubakar [14] considered corruption in public universities as the absurd or deviant disposition of people in institutions of higher learning which violates ethical standards. The core values of education at this level have been negated by the culture of corruption in tertiary institutions. There are different dimensions of corruption in the country's universities, involving students, lecturers, non-academic staff and administrators. The Tertiary Education Trust Fund (TET Fund) has reported that many of the lecturers across the country's public universities have been diverting research grants to purchase cars and build houses [12]. Prior to this allegation, the Independent Corrupt Practices and other Related Offences Commission (ICPC) accused

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some academic and healthcare institutions of personnel budget inflation. The Commission reported that those who are expected to be above board have misappropriated public funds made available to lecturers to conduct ground-breaking and demand-driven research towards solving Nigeria's socio-economic and even political challenges [12]. The level of corrupt practices in Nigerian public universities is a threat to education and research. Instances of corruption among lecturers include the demand for sex from female students, huge amount of money from students for high grades, etc. Instances of corruption among non-academic staff include acting as agents for lecturers and receiving money from students for higher grades. In addition, there is monetary extortion from students before they see their results. Sometimes, non-academic staff pretend to be lecturers and demand money from naive parents and guardians with an assurance that this will secure admission for their children. Forms of corruption among students include examination malpractices, bribery of lecturers for unmerited grades, physical attacks on staff for preventing students from indulging in examination misconduct etc. [14]. Corruption has caused much damage to Nigeria's university education, including STEM education.

3. Methodological Framework

In this study, I chose a qualitative approach to examine the factors that influence first-year students to persist and achieve on STEM courses in Nigerian public universities. The data collected in a qualitative study normally finish up in a textual format, such as from conversations, focus groups, ethnographies, observation, focus groups and interviews. This approach helps to gain the understanding of the various dimensions of the problem under analysis because it produces in-depth and illustrative information. The choice of qualitative methods is driven by the desire to gain an understanding of the phenomenon investigated in large measure by depicting participants' experiences, for instance in their own words through interviews. To understand the tendency or non-tendency of STEM students to persist and achieve, it is important to investigate their perceptions of experiences, including social and academic involvement, because these decisions are made based largely on the perception of what exists. Qualitative data collection should generate rich, detailed descriptions of the academic and social integration of STEM students which can serve as a starting point for research in this area.

3.1. Sample

This study was conducted at a public university located in the south-west of Nigeria. The participants were 25 first-year undergraduates pursuing a STEM degree at a large, reputable university. I used purposeful sampling and, through the help of university officials, identified 25 undergraduates who had completed the second semester of their STEM courses. Interview participants were recruited via an email and text messages sent to all STEM undergraduates in the first year of their courses who had participated in a survey undertaken to examine the factors that motivate STEM undergraduates to persist and achieve on their courses. Six months after the survey I followed up all interested students and interviewed 25 of them. All students who were available for an interview were interviewed. The majors represented were: biological sciences, chemistry, physics, computer science, mechanical engineering, petroleum engineering, and electrical and electronics engineering. The participants were offered N1,000 ($1.3) as compensation if they agreed to be interviewed. I recognise that 25 students are a seemingly small sample size when compared with quantitative research. However, the information richness of the cases selected in qualitative research can be more important than the number of cases. The data gathered from these students can inform the future design of persistence and achievement research, though, the purposefully selected sample means that it may not be easily generalized to other students.

I conducted participant interviews using a semi-structured interview protocol to allow for flexibility in the order and precise content, depending on the participants' responses, but enabling the same standard questions to be asked. In addition, this approach gave me an opportunity to follow up with questions about participants' experiences of interest. This protocol was piloted, prior to its use with the 25 students, with 10 students at the participating university outside of teaching sessions. I conducted the pilot phase through one-to-one, semi-structured interviews, and each interview lasted for 50-65 minutes. The feedback from pilot participants was used to refine the core interview questions. Based on the pilot interviews, I discovered that it is often a good idea to follow questions with a simple example which explains the question and clarifies the meaning and angle that I want to communicate to the participants. I also learnt how to be more explicit when asking questions. It was also noted from the pilot interviews that the interview questions for the study were extensive enough for interviewees to narrate their experiences.

The interviews were semi-structured and undertaken face-to-face; they lasted approximately 45–60 minutes and were audio-recorded on an individual basis. The interviews involved a series of questions to study the first-year experiences of STEM students broadly. Each interview was centred on educational experiences such as resources,

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quality of teaching and learning, peer influence, family influence and relationship between staff and students, all of which are known to have the potential to affect the ability, interest, self-efficacy and motivation of students to pursue STEM degrees [15]. For example, I asked the participants to (a) explain the factors that influenced their decisions to go onto a STEM course; (b) describe any activities, resources, programmes, teaching sessions, lecturers or specific experiences that help to make them feel a part of their course; (c) think of a time, as a STEM student, when they did not feel they belonged to STEM; (d) describe what they like most about their course so far; (e) describe what they like least about their course so far; and (f) to tell me what encourages them to continue as a STEM student. There were additional probing questions to elucidate information or provide further details based on participants' responses. Generally, the participants provided reflections on their own experiences. All the interviews were audio-recorded after I obtained the consent of the students.

3.2. Data Analysis

Each of the 25 interviews was transcribed verbatim. I listened to each interview recording once before beginning the transcription of that particular recording. Each interview was manually transcribed by myself after active-listen playback. I imported the interview transcripts and my handwritten observations into Word files and imported these as memos into NVivo (a qualitative data analysis software package) for coding analysis of factors relating to the retention and achievement of undergraduate students on STEM courses.

After the completion of the initial transcription, I read through each transcript carefully numerous times. I came up with a list of possible themes by which the interviews could be coded. I reviewed the codes, and I collapsed multiple codes that shared a similar feature or concept of the data into a single code. I went back to the transcripts and started coding the interviews using descriptive coding based on the emergent themes, drawing on inferential analysis. After that, I examined my codes and looked at how different codes might be combined to form a key theme. I aggregated the codes into themes and then grouped in a hierarchical manner. I revised the themes carefully to ensure that they were meaningful, capturing the data, and obtaining helpful themes.

Lastly, I developed a template of key themes and re-examined the transcripts to note their presence or absence in each of the interviews. I made sure that there was consistency in the classification of a participant's responses across the whole interview and not just centred on a small section of the coded interview.

4. Research Findings

After the coding process, ten main themes emerged from the data. I undertook the coding based partly on the literature review of the factors that have previously been found to influence retention and achievement of students on STEM courses and partly on what struck me in the data that might additionally be relevant for my study. In the following sub-sections, I describe the themes and highlight representative responses from the student data.

4.1. Intrinsic value

The most frequent theme, 'intrinsic value', reflects the inherent satisfaction an individual experiences from engaging in a task for its own sake. It is the extent to which the person gains enjoyment from performing an activity. It can also be referred to as perceived enjoyment and pertains to student beliefs that the task is interesting [16]. All students stated factors for continuing to study STEM that fall under this category. For example: "Do what you like. You must have a passion for your course. If you like your course, no matter the challenges you would be able to complete the course and come out in flying colours". Another participant stated: "I always loved Chemistry as a secondary school student. I always fascinated about chemicals and other things related to it and I decided to study Chemistry".

4.2. Expectancy of success

The second most frequent theme is the expectancy of success which refers to students' beliefs about how well they would perform in STEM. Twenty three of the 25 students stated factors that fall under this category. For example, one stated: "I look forward to maintaining my current CGPA – First class". Another stated: "I expect to move higher to second class upper".

4.3. Utility value

The third most frequent theme is utility value which is the usefulness of STEM for other goals [17]. In total, 19 of the 25 students talked about their decisions to continue with STEM as this is aligned with their future academic goals. For instance, "I chose Mathematics as it would give me opportunity to go into other things such as financial mathematics. I want to go into actuarial science" and, from another student, "Firstly, the benefits of standing at a place in future. The economy of Nigeria relies on petroleum. The GDP of Nigeria stands on oil and gas. I am encouraged by the fact

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that in few years, I will be able to support the country's economy".

4.4. Sociocultural factors

The theme of sociocultural factors refers to influences related to having a supportive environment or a social network that students can draw upon to ask for help or to make them feel that they belong to STEM. These factors include peers, friends, family member and others. Belonging is a student's subjective feelings of relatedness or connectedness. It includes feeling supported, valued, and accepted by the university, staff, and other students in the university. In total, 19 out of the 25 interviewees referred to a supportive environment as an important factor for continuing studying STEM. For example, one interviewee stated:

> *Presently, there is a 400 level [final year] student in our department who has been a good motivation in terms of academic excellence and in terms of moral standard. She is a role model. She made me realise that I can make use of this good knowledge that I have. I am inspired by most things that some of our seniors do. Their stories have been my source of inspiration.*

Another interviewee stated:

> *Currently, I have different helps from different family members so that I can complete. I am not dropping out. Personally, I am motivated to continue.*

4.5. Industrial action

The theme of industrial action refers to factors related to strikes of the academic union of universities in Nigeria which have disrupted the educational planning and development in Nigeria's public university system. This has resulted in the interruption of academic programmes, delays in the year of graduation and poor academic performance [12]. In total, comments from 15 of the 25 students indicated that their decisions to remain on STEM courses are influenced negatively by one or more of these factors. For example, one student stated:

> *I think that this strike may affect me. Although I am planning to be a pharmacist in future, there is a chance of not completing this course if the strike action continues. Nevertheless, I hope to be a pharmacist when I complete the course. Strike is something that affects every student , but I think it should not continue.*

Another student stated:

> *This is my second year and we have not started the academic session because of The Academic Staff Union of Universities (ASUU) strike. Throughout my first year, I did not enjoy the dividend of education in Nigeria. It is not about sitting in the class.*

4.6. Self-efficacy

Self-efficacy is defined as an individual's belief in his or her ability to succeed at a specific task or in a specific situation [18, 19]. It can also be considered as a person's confidence in their ability to be successful in carrying out academic tasks at a designated level). The root of self-efficacy is the core belief that an individual has the power to produce wanted effects [18]. In total, 14 out of the 25 students identified factors that fall under this theme. For example, one participant reported:

> *You must have self-belief. You must believe in yourself. People may tell you that it is difficult. Do not let their words discourage you. Do not be discouraged by the people around you. Put in the dedication and time and you will see the results in no time.*

Another participant stated:

> I *was good in maths. I sat some exams. Scoring good results in first semester but making mistakes in some exams in second semester and I got B. I always getting A. Not used to B. That affected me for a long time! I was thinking I should just leave engineering. Just because of the grades in maths courses.*

4.7. Difficulty

The theme of difficulty reflects the perceived obstacle of STEM as a subject. This theme is distinct from Expectancy of success because the fact that the subject is perceived as difficult does not always mean that it will determine someone's expectation of success. Furthermore, expectation of success may be influenced by factors other than the difficulty of the subject. In total, 14 of the 25 students mentioned that the course is challenging and requires determination to succeed. However, this factor rarely discourages them from continuing to study a STEM course. For instance, one participant stated:

> *My advice is that do not come into STEM because your mates are in STEM. Do not come to STEM because you are friends in it to it. You should come because you actually have problems to solve. That is what will give you the motivation. Come what be, it will give you energy to continue. When the challenges come such a setback, you will understand that I need*

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to continue because I have a problem to solve. Once you have it at the back of your mind that you have problems to solve, you will stand irrespective of the situation.

Another student stated:

… it will be quite challenging for you as it is challenging for us. Therefore, you need to be focussed. You need to be disciplined to any length so that you will become the best. Make sure that you are able to convert the ideas and practical into solutions.

4.8. The quality of teaching and learning

The theme of the quality of teaching and learning refers to factors related to the appropriateness of teaching and learning, including lecturers and facilities. It sums up how a student's academic and social experiences during their studies influence their view of themselves, the campus, the community, and the world as a whole.

In total, comments from 13 of the 25 students indicated that one or more of these factors have impacted their experience of succeeding on STEM courses. For example, one student stated:

There should be a close relationship with teacher. That is not happening. The quality of teaching is not good as I expected. I am paying for my studies, and I think that I should get a better quality of teaching. I felt that I should have a close relationship with my teacher in to have a good support. I must go and watch some of the sessions online again after the teaching to have deeper understanding of the concept. That seems to have affected my expected grade.

Another stated:

I am in year 2. Based on what I have learnt so far, I love the programming aspect more because I love to think of a way to do something. I do not like being given a directive on how to do something. I prefer to be given an example and I think my own way to solve the problem. In programming, they will only show you an example of what is expected of you to do and ask you to use your own way or your own language to do it. My best experience is programming.

4.9. Cost

The cost theme reflects how a respondent's decision to continue with STEM limited access to other activities or required a lot of time and emotional effort. According to
Umarji et al. [17] the cost of engaging in an activity can be psychological, financial, or time- and energy-related. In total, 12 out of the 25 students reported factors related to the cost of engaging with STEM. One participant reported:

To be steadfast. Do not relent in your effort. It is not going to be easy. Be ready to face challenges. It will be easy if you work hard. Work hard or work smart. Explore. Watch videos in your field, it will help you. For example, watching videos on animation how flows work, it gives you an idea of what is really like. Ask questions if you do not understand.

Another participant stated:

To count the cost. STEM course is not for the lazy people. It is for diligent individuals. Be ready for the emotional, physical, and mental stability for all you will go through. Willingness to learn is important before you are going into it.

5. Limitations

Regarding qualitative research, the issue of generalizability arises on account of the limited sampling and representation of the population. This relatively small group of STEM undergraduates from a single public university in Nigeria is not sufficient as a representative sample for making informed decisions about all STEM undergraduates in the country. The sample, institution and other factors should be considered to evaluate the transferability of the findings to other settings. This study was undertaken in one university located in one state in Nigeria. There are thirty-six states in Nigeria, excluding Abuja the capital, with significant differences between them in funding, governance and culture. The thirty-six states in the country have been politically classified into six geopolitical zones, namely, the North-Eastern Zone (NE), the North-Central Zone (NC), the Middle-Belt Zone (MB), the South-East Zone (SE), the South-West Zone (SW), and South-South Zone (SS). Research findings may be different if the same study is carried out elsewhere in the country because of cultural differences. In addition, I only undertook interviews in this study rather than combining them with observations.

6. Discussion

The present study investigated the factors that influence students to persist and achieve on STEM courses in Nigerian public universities by analysing participants' responses to individual interviews using thematic analysis. The study provides a greater understanding of student experiences that can improve persistence and achievement of undergraduates studying STEM courses in public universities in Nigeria. During the study, 9 different

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themes emerged, based on students' perspectives expressed in their responses. These 9 themes are intrinsic value, expectancy of success, utility value, sociocultural factors, industrial action, self-efficacy, difficulty, the quality of teaching and learning, and cost.

Previous studies have demonstrated that factors related to student motivation, such as students' interest, perceived value, and feelings of competence in STEM disciplines, are important for explaining persistence and achievement in STEM. The results from this study support the ideas of the expectancy–value theory of motivation [20] that emphasises that individuals' choice, persistence, and performance can be explained by their beliefs about how well they will do on an activity and the extent to which they value the activity. In other words, it is assumed that expectancies and values have direct influence on achievement choices. In addition, they have influence on performance, effort, and persistence. Advocates of the theory presume that the expectations of succeeding in a task (i.e., ability beliefs, such as self-efficacy, individuals' goals, self-schema, and affective memories and self-concept of ability) and the subjective task value associated with the task compared to other tasks, have direct effect on achievement-related intentions and behaviours. In turn, individuals' perceptions of their own previous experiences and a variety of socialization influences have direct influence on these social cognitive variables. The subjective task value is considered as the subjective aspects of a task that can increase or decrease the chance that an individual will select and complete it [20]. The subjective aspects of a task result from attainment value, intrinsic value, utility value and the cost of engaging in the activity, which can be psychological, financial, or the expenditure of time and energy. The theory is centred on two essential motivational questions that individuals will ask themselves (consciously or subconscioiusly) before they engage in a specific task.: "Can I do this?" and "Why do I want to do this?"

This research suggests that STEM undergraduates who feel competent in their courses (competence beliefs) and perceive their STEM courses as important, interesting, and useful (task value) are more likely to persist and achieve on their STEM degrees.

Intrinsic value pertains to student beliefs that the task is interesting and is the most frequent theme in this study. Interest in the subject area is important to mastery learners' persistence in a field. STEM undergraduates may drop out of their courses due to lack of interest in the area. Poor retention and achievement on STEM courses are attributed to different reasons, including poor instruction, impersonal classes, and objections to lifestyles they had witnessed in laboratories [15]. One of the indicators of motivation is persistence. Without motivation and the effort, it engenders, students are unlikely to persist in their studies. Students' motivation to study may be influenced positively or negatively by their experiences in the university. Educators in the STEM area should be attentive to the types of experiences which influence student motivation to persist and achieve on STEM degree courses. Efficacy expectation is the belief of individuals in their ability to perform the behaviours required to produce the outcome they need. The greater the efficacy expectation, the stronger and more persistent the effort will be to obtain the desired outcome.

The results from the present study indicate the importance of intrinsic value, expectancy of success, utility value, sociocultural factors, industrial action, self-efficacy, difficulty, the quality of teaching and learning, and cost on the persistence and achievement of STEM undergraduates. Themes that emerged from interview responses throw more light on what universities can do to improve the likelihood of their STEM undergraduates manifesting the persistence they need to complete their degree courses. Apart from universities supporting their undergraduates to acquire the academic skills they need and clarify their goals, they should have a strategic plan on how to address issues of intrinsic value, expectancy of success, utility value, sociocultural factors, industrial action, self-efficacy, difficulty, the quality of teaching and learning, and cost [19, 20].

A university cannot assume that the self-efficacies of its STEM undergraduates do not change over the course of the first year. The university must build, reinforce, and maintain students' beliefs throughout their journey through the institution. While this may be particularly right among students whose previous educational experiences have been challenging, it is also applicable to students who, despite their preceding success in high school, struggle to adapt to the academic pressures of the university.

Without the right support to improve their performance, many students will lose their motivation to persist, and later drop out. It is essential that university management monitors and frequently assesses the performance of the STEM undergraduates in their first year. These undergraduates should be provided with both academic and social support to succeed when required, especially in the classroom. The results of this study indicate that the motivation of STEM undergraduates in their first year to persist and achieve on their degree courses can be influenced by their positive personal experiences on their courses. Students with positive experiences on their courses are more likely to feel positively about the subject they are studying, which can lead to persistence to succeed on the programme. Educators need to be mindful of this and expedite opportunities for

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increasing positive perceptions of undergraduates towards persistence to achieve on their STEM degrees.

7. Recommendations and Future Work

Universities need to consider the teaching and learning approaches that can have positive impact on students' perspectives toward STEM courses. Lecturers need to employ engaging STEM activities that may encourage students to develop positive personal perspectives related to the present study's themes of intrinsic value, expectancy of success, utility value, sociocultural factors, self-efficacy, and the quality of teaching and learning. University managers need urgently to resolve the ongoing industrial action in order to minimise its negative impacts on students.

The findings from this study could be extended so as to apply to a larger sample from which more reliable generalization could be made. Transferability to other Nigerian public universities may be possible but this needs further investigation and testing. This could then help to add to existing academic literature and to contribute to future research and theory. Future work could also examine the academic experiences of the STEM graduates once they have completed their degree courses in Nigerian public universities.

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