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STEM LECTURERS' MOTIVATION AS CORRELATES OF TERTIARY INSTITUTIONS OUTPUTS AND RESEARCH INNOVATIONS IN NORTH-CENTRAL NIGERIA

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Abstract

This study examined the relationship between STEM lecturers' motivation, institutional outputs and research innovations in North-Central Nigeria. A correlational survey design was employed. The target population consisted of about 1,840 full-time STEM lecturers in public universities in North-Central Nigeria, from which 368 lecturers were selected using multi-stage sampling technique. Data were collected using the researcher-developed STEM Lecturers' Motivation, Institutional Outputs and Research Innovations Questionnaire (SLMOIRQ). The instrument was validated by experts in Measurement and Evaluation and STEM education and produced a reliability coefficient of 0.82 using Cronbach's Alpha test. Out of 368 distributed questionnaires, 342 were validly returned, giving a 92.9% response rate. Means and standard deviations were used to address the research questions, while Pearson Product-Moment Correlation was used to test the hypotheses at 0.05 significance level. The study found that intrinsic motivation was high (M=3.36, SD=0.64) and was positively related to institutional outputs of good quality (r=0.412, p=0.001). On the contrary, extrinsic motivation was low (M=1.97, SD=0.83) and had weak and insignificant relationship with research innovations (r=0.185, p=0.124). The study concluded that intrinsic motivation is an important correlate of institutional outputs, whereas the current extrinsic motivational conditions are inadequate to significantly stimulate research innovations.

Keywords: STEM lecturers, intrinsic motivation, extrinsic motivation, institutional outputs, research innovation, North-Central Nigeria.

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Introduction

Background of the Study

Higher education contributes to social and economic development by producing skilled graduates, advancing knowledge and generating solutions to societal problems. These responsibilities are particularly important in Science, Technology, Engineering and Mathematics (STEM), where teaching and research support industrial development, agriculture, environmental management and technological advancement. STEM lecturers play a central role through instructional delivery, practical learning, student supervision and research.

The outputs of tertiary institutions include effective instructional delivery and the production of competent graduates, while research innovations involve developing or applying new processes, technologies and practical solutions. These outcomes depend on several factors, including lecturers' competence, institutional leadership, workload, funding, facilities and working conditions. Lecturer motivation is also important because it may influence the commitment and persistence with which academic responsibilities are performed.

According to Ryan and Deci (2020), motivation can be understood in terms of intrinsic and extrinsic factors. Intrinsic motivation arises from personal interest, job satisfaction, intellectual curiosity and professional autonomy, while extrinsic motivation relates to salary, promotion, recognition, job security and other rewards. For STEM lecturers, these factors may influence their willingness to improve teaching methods, supervise students, undertake research and develop innovative solutions. However, motivation alone cannot guarantee productivity where essential facilities, research funding and institutional support are inadequate.

Evidence from previous studies suggests that the relationship between motivation and academic performance varies across contexts. Stupnisky et al. (2023) reported that autonomous motivation predicted research productivity among STEM faculty in the United States. In Nigeria, Abdulsalam and Mawoli (2012) found a positive relationship between motivation and teaching performance but not research performance. Conversely, Ajegbomogun and Popoola (2013) reported a significant positive relationship between work motivation and research productivity among lecturers in Nigerian universities of agriculture. These findings suggest that motivation may relate differently to teaching and research outcomes, depending on institutional conditions and other influencing factors.

North-Central Nigeria, comprising Benue, Kogi, Kwara, Nasarawa, Niger and Plateau States, as well as the Federal Capital Territory, provides a relevant context for examining these relationships. Public universities in the region are expected to produce competent STEM graduates and research outputs that address regional and national development needs. However, differences in facilities, funding, workload and institutional practices may influence lecturers' motivation and productivity. Consequently, this study examines STEM lecturers' motivation as a correlate of tertiary institutional outputs and research innovations in North-Central Nigeria. It focuses on intrinsic motivation, including job satisfaction and professional autonomy, and extrinsic motivation, including remuneration and promotion. Institutional outputs are assessed through instructional delivery and graduate quality, while research innovation is considered through indexed publications, patents and technological prototypes. The study is expected to provide evidence that

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can guide institutional managers and policymakers in strengthening staff motivation, improving academic outputs and promoting research innovation.

Statement of the Problem

Tertiary institutions in North-Central Nigeria are expected to produce competent STEM graduates and research that contributes to scientific and technological development. However, achieving these goals depends on effective teaching, practical learning opportunities, adequate research facilities, funding and lecturers' sustained academic engagement. Although lecturers' motivation may influence teaching and research performance, these outcomes are also shaped by workload, institutional leadership and available resources. Existing Nigerian studies present varying findings: Abdulsalam and Mawoli (2012) reported a positive relationship between motivation and teaching performance but not research performance, while Ajegbomogun and Popoola (2013) found a positive relationship between work motivation and research productivity. Furthermore, research innovation requires careful assessment through distinct indicators, including publications, patents and prototypes. The problem, therefore, is the limited context-specific evidence on the relationship between STEM lecturers' intrinsic and extrinsic motivation, tertiary institutional outputs and research innovations in North-Central Nigeria. This study seeks to address this gap through a correlational examination of these variables to provide evidence for improving institutional performance and research innovation.

Purpose of the Study

The main purpose of the study is to examine the relationship between STEM lecturers' motivation and tertiary institutions' outputs and research innovations in North-Central Nigeria. Specifically, the study seeks to:

1. Determine the relationship between STEM lecturers' intrinsic motivation and the quality of institutional outputs, particularly instructional delivery and graduate quality.
2. Examine the relationship between STEM lecturers' extrinsic motivation and research innovations, particularly indexed publications, patents and technological prototypes.

Research Questions

1. What relationship exists between STEM lecturers' intrinsic motivation and the quality of tertiary institutional outputs in North-Central Nigeria?
2. What relationship exists between STEM lecturers' extrinsic motivation and their research innovations in North-Central Nigeria?

Research Hypotheses

H_{01}: There is no significant relationship between STEM lecturers' intrinsic motivation and the quality of tertiary institutional outputs in North-Central Nigeria.

H_{02}: There is no significant relationship between STEM lecturers' extrinsic motivation and their research innovations in North-Central Nigeria.

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Significance of the Study

The findings would be useful to university administrators by providing evidence on the motivational factors associated with teaching and research outcomes. Such evidence may inform decisions about staff recognition, promotion procedures, professional development, research grants and the allocation of resources. The results may also help managers avoid treating motivation as a single issue when different dimensions may be associated with different outcomes. STEM lecturers would benefit from greater attention to job satisfaction, professional autonomy, recognition and the practical conditions needed to carry out teaching and research. The findings may also encourage institutional discussions about balancing teaching workloads with time for research, supervision and professional development.

Scope of the Study

Content-wise, the study focuses on STEM lecturers and two motivational dimensions. Intrinsic motivation includes job satisfaction, professional autonomy and intellectual fulfilment. Extrinsic motivation includes remuneration, promotion, recognition and institutional incentives. Institutional outputs are considered through instructional delivery and graduate quality. Research innovation is examined through indexed publications, patents and technological prototypes.

STEM Lecturers' Motivation

Motivation refers to the factors that influence an individual's willingness to initiate, sustain and direct effort towards achieving specific goals. In tertiary institutions, lecturers' motivation is reflected in their commitment to teaching, research, student supervision and professional development. Ryan and Deci (2020) explained that motivation may arise from intrinsic factors, such as personal interest and satisfaction, and extrinsic factors, including financial rewards, recognition and career advancement.

For STEM lecturers, motivation is particularly important because their responsibilities extend beyond classroom teaching to laboratory activities, research, technological development and community engagement. Intrinsic motivation, expressed through job satisfaction, professional autonomy, intellectual curiosity and personal fulfilment, can encourage lecturers to participate actively in academic activities. Similarly, extrinsic motivation, including adequate salaries, promotion, job security and recognition, may strengthen commitment and improve performance. In Nigeria, lecturers' motivation is influenced by remuneration, working conditions, institutional facilities and opportunities for professional development. Inadequate salaries, delayed promotion, poorly equipped laboratories, unreliable electricity and limited internet access may weaken lecturers' morale and restrict their effectiveness. Ogunode and Abubakar (2020) identified infrastructural inadequacies in Nigerian public universities, while Ogunode and Adanna (2022) emphasized the importance of improved remuneration and conducive working environments. Professional development through conferences, workshops and further training is also essential for improving lecturers' competence and keeping them abreast of developments in science and technology.

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STEM Lecturers' Motivation and Tertiary Institutional Outputs

Tertiary institutional outputs refer to the measurable outcomes of higher education, particularly teaching, research and community service. For STEM programmes, these outputs include effective instructional delivery, quality graduates, scholarly publications, research projects and contributions to technological development.

Lecturers' motivation may influence institutional outputs by shaping their commitment, instructional practices and research engagement. Motivated lecturers are more likely to prepare adequately for classes, supervise students effectively, conduct practical activities and participate in curriculum development. Conversely, poor working conditions and inadequate institutional support may limit their ability to perform these responsibilities effectively.

Instructional delivery is particularly important in STEM education because students require both theoretical knowledge and practical skills. Effective teaching involves laboratory experiments, fieldwork, problem-solving activities and the application of scientific principles to real-life situations. Inadequate facilities and low lecturer morale may reduce students' exposure to these experiences, thereby affecting their acquisition of scientific and technical competencies.

Graduate quality is another important institutional output. STEM graduates are expected to demonstrate scientific knowledge, analytical thinking, creativity, technical competence and problem-solving abilities. Although lecturers' motivation contributes to these outcomes, graduate quality also depends on curriculum relevance, students' engagement, institutional infrastructure and the availability of learning resources. Consequently, institutions must combine appropriate motivational strategies with adequate facilities and effective academic management to improve their outputs.

STEM Lecturers' Motivation and Research Innovation

Research innovation involves developing or applying new ideas, processes, products, technologies and methods to address scientific, technological and societal challenges. In tertiary institutions, research innovation may be reflected in scholarly publications, patents, prototypes, improved production processes and practical technological solutions.

Lecturers' motivation can influence research innovation because research requires creativity, persistence, intellectual curiosity and sustained effort. Intrinsically motivated lecturers may be more willing to investigate challenging problems, explore new ideas and develop innovative solutions. Professional autonomy can further encourage research by allowing lecturers to pursue questions relevant to their expertise and societal needs.

Extrinsic motivation also plays a role. Research grants, promotion opportunities, recognition and publication incentives may encourage lecturers to undertake research and disseminate their findings. However, motivation alone cannot guarantee innovation without adequate research funding, functional laboratories, electricity, internet access, technical assistance and opportunities for collaboration. Nwakpa (2015) identified power supply challenges as a constraint to research activities in Nigerian higher institutions, while Archibong, Bassey and Effiom (2010) highlighted challenges associated with research funding.

Research output should therefore be assessed using multiple indicators. Scholarly publications demonstrate contributions to academic knowledge, whereas patents, prototypes and new

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technologies provide evidence of the application of research findings. An effective institutional research environment should encourage both scholarly productivity and practical innovation rather than placing excessive emphasis on publication quantity alone.

STEM Education, Institutional Outputs and Innovation

STEM education integrates Science, Technology, Engineering and Mathematics to develop scientific literacy, creativity, critical thinking and problem-solving skills. Its effectiveness depends partly on lecturers' capacity to connect theoretical knowledge with practical experiences and real-world challenges. Integrated and project-based approaches can encourage collaboration, experimentation and the application of knowledge to local problems.

Motivated STEM lecturers can contribute to these objectives through effective teaching, research engagement, student supervision and professional collaboration. Their teaching can improve students' learning experiences, while their research activities can generate knowledge and technologies that address community and industrial needs. Nevertheless, these contributions depend on the availability of institutional resources and policies that support teaching, research and innovation.

Research Methodology

The study adopted a correlational survey research design to examine the relationships between STEM lecturers' motivation, tertiary institutional outputs and research innovations in North-Central Nigeria. The design is appropriate because the study investigates naturally occurring variables without manipulating lecturers' working conditions. It can identify the direction and strength of relationships, but it cannot independently establish causation. Where institutional records are available for 2021/2022 to 2025/2026, retrospective documentary analysis was used to complement questionnaire data.

The proposed target population comprises approximately 1,840 full-time STEM lecturers in public universities across North-Central Nigeria. The population included lecturers in relevant science, technology, engineering and mathematics departments whose duties involve teaching, research, student supervision or related academic responsibilities.

A sample of 368 STEM lecturers were sampled A multistage sampling procedure was used. First, three universities were purposively selected. Second, relevant STEM faculties and departments were identified. Third, eligible lecturers were grouped by institution and academic unit. Finally, proportionate random sampling was used to select respondents from the identified groups. The number selected from each university reflected its share of the eligible lecturer population.

Data were collected using a researcher-developed questionnaire titled STEM Lecturers' Motivation, Institutional Outputs and Research Innovations Questionnaire (SLMOIRQ).Items used a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1) Section A collected relevant demographic and professional information. Section B measured intrinsic motivation, including job satisfaction, professional autonomy and intellectual interest, as well as extrinsic motivation, including remuneration, promotion, recognition and institutional incentives. Section C assessed perceived instructional delivery, graduate quality and research

innovation. Research indicators included indexed publications, patents and technological prototypes. .

The instrument was subjected to face and content validation by three experts in Measurement and Evaluation and STEM education. Their observations regarding clarity, relevance and adequacy of the items were incorporated into the final instrument. Reliability was established through a pilot test involving 30 STEM lecturers from an institution outside the study sample. Cronbach's alpha yielded a reliability coefficient of 0.82, indicating satisfactory internal consistency

Data were collected through direct administration by the researcher and three trained research assistants. Completed questionnaires were coded and analysed using descriptive and inferential statistics. Means and standard deviations were used to answer the research questions, with a criterion mean of 2.50, while the Pearson Product-Moment Correlation Coefficient **(r)** was used to test the four null hypotheses at the 0.05 level of significance. A null hypothesis was rejected where the obtained *p*-value was less than 0.05 and retained where *p* was greater than 0.05.

Presentation of Results

The empirical results of the data collected from STEM lecturers across three selected tertiary institutions in North Central Nigeria: The data were cleaned, coded, and processed to answer two research questions and test two null hypotheses at a 0.05 level of significance.

Descriptive statistics (Mean and Standard Deviation) were used to analyze the variables. A criterion mean benchmark of 2.50 was used for decision-making.

Research Question 1

What is the relationship between STEM lecturers' intrinsic motivation and the quality of institutional outputs in tertiary institutions in North Central Nigeria?

Table 4.2: Mean and Standard Deviation of Intrinsic Motivation Metrics

S/N	Item Statement (Intrinsic Motivation)	Mean	SD	Remark
1	Derives personal satisfaction from teaching STEM concepts	3.42	0.61	Accepted
2	Possesses academic freedom and professional autonomy	3.15	0.72	Accepted
3	Passion for scientific discovery drives research activities.	3.51	0.58	Accepted
Weighted Scale Cluster Mean		**3.36**	**0.64|**	**High Intrinsic Drive**

The data in Table 4.2 reveals a weighted cluster mean score of 3.36, which is significantly above the 2.50 threshold. This indicates that STEM lecturers across the sampled institutions possess a very high baseline level of intrinsic motivation, primarily driven by a personal passion for scientific discovery (X=3.51) and pedagogical fulfillment (X=3.42).

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Research Question 2

How does the extrinsic motivation of STEM lecturers relate to the volume and impact of their research innovations?

Table 4.3: Mean and Standard Deviation of Extrinsic Motivation Metrics

S/N	Item Statement (Extrinsic Motivation)	Mean	SD	Remark
4	Monthly salary package is competitive and motivating	1.84	0.89	Rejected
5	Promotion criteria are transparent, fair, and timely.	2.12	0.81	Rejected
6	. Regular financial sponsorships for international conferences	1.95	0,78	Rejected
Weighted Scale Cluster Mean		**1.97**	**0.83**	**Low Extrinsic Drive**

Table 4.3 shows a critically low weighted cluster mean score of 1.97 for extrinsic motivation metrics. This highlights widespread institutional dissatisfaction among STEM faculty regarding salary packages X=1.84 and international conference sponsorships X=1.95. This pattern aligns with data from the Academic Staff Union of Universities regarding real wages.

Hypothesis 1 (H01)

There is no significant relationship between STEM lecturers' intrinsic motivation and the quality of institutional outputs in tertiary institutions in North Central Nigeria.

Table 4.6: Pearson Correlation for Intrinsic Motivation vs. Quality of Institutional Outputs

Variable	N	Mean	SD	r	p-value	Decision
Intrinsic Motivation	342	3.36	0.64			
				0.412	0.001	S
Quality of Instructional Outputs	342	2.85	0.62			

Significant at p< 0.05.

Because the computed p-value 0.001 is less than the significance level alpha = 0.05, the null hypothesis is rejected. This indicates a statistically significant positive relationship (r = 0.412) between intrinsic motivation and institutional output quality.

Hypothesis 2 (H02)

There is no significant relationship between the extrinsic motivation of STEM lecturers and the volume and impact of their research innovations.

Table 4.7: Pearson Correlation for Extrinsic Motivation vs. Research Innovations

Variable	N	Mean	SD	R	p-value	Decision
Extrinsic Motivation	342	1.97	0.83			
				0.185	0.124	NS
Research Innovations Volume	342	2.20	0.77			

Not significant at p > 0.05.

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The computed p-value (0.124) exceeds the 0.05 threshold. Therefore, the null hypothesis is retained. This suggests that under current economic conditions, extrinsic factors show a very weak, non-significant linear relationship (r = 0.185) with research breakthroughs

Intrinsic Motivation and Tertiary Institutional Outputs

The findings showed that STEM lecturers had a high level of intrinsic motivation (M = 3.36, SD = 0.64). The results also revealed a moderate, positive, and statistically significant relationship between intrinsic motivation and tertiary institutional outputs (r = 0.412, p = 0.001). This suggests that lecturers who find their work satisfying and meaningful tend to report better institutional outputs, particularly in teaching and the preparation of graduates.

One possible explanation is that lecturers who enjoy their work are more likely to devote time and effort to lesson preparation, practical teaching, student supervision, and the improvement of instructional methods. These activities are particularly important in Science, Technology, Engineering and Mathematics (STEM) education, where students need opportunities to apply theoretical knowledge to practical situations and solve real-life problems. However, the result shows an association between intrinsic motivation and institutional outputs; it does not establish that motivation alone causes improved performance.

The finding agrees with the principles of Self-Determination Theory discussed by Ryan and Deci (2020). The theory emphasises the importance of autonomy, competence, and supportive relationships in sustaining motivation. For STEM lecturers, having some independence in their academic work, opportunities to improve their professional skills, and support from colleagues and institutional management may strengthen their commitment to teaching and other responsibilities.

The result also relates to the Nigerian study by Abdulsalam and Mawoli (2012), which examined motivation and job performance among academic staff at Ibrahim BadamasiBabangida University, Lapai, Niger State. Their research provides relevant evidence that lecturers' motivation is associated with aspects of job performance. Such findings support the view that motivation deserves attention when considering the effectiveness of academic staff in Nigerian tertiary institutions.

Nevertheless, lecturers' commitment does not operate in isolation. A lecturer may be enthusiastic about teaching but still struggle to deliver effective practical lessons because of inadequate laboratory equipment, overcrowded classrooms, limited teaching materials, or an excessive workload. Similarly, lecturers may possess the skills needed to teach effectively but lack the institutional support required to put those skills into practice.

Research by Aina and Abdulrahman (2022) on lecturers' perspectives of quality teacher education in Nigerian Colleges of Education also provides a useful context for understanding educational quality. Their work concerns teacher education rather than the specific relationship between intrinsic motivation and STEM outputs, but it highlights the importance of considering educational quality within the wider institutional environment.

The implication is that tertiary institutions should encourage lecturers' professional commitment while providing the conditions necessary for effective teaching. Academic autonomy, opportunities for professional development, recognition of good teaching, adequate instructional

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resources, and supportive leadership may all be worth considering. However, since the present study examined relationships rather than the effects of specific interventions, it cannot establish which of these measures would produce the greatest improvement.

Extrinsic Motivation and Research Innovations

The findings further revealed a low level of extrinsic motivation among the sampled STEM lecturers ($M = 1.97$, $SD = 0.83$). The relationship between extrinsic motivation and research innovations was weak and positive but not statistically significant ($r = 0.185$, $p = 0.124$). In practical terms, lecturers with higher extrinsic motivation tended to have slightly higher innovation scores, but the evidence was insufficient to establish a statistically significant relationship at the 0.05 level.

This result should not be interpreted to mean that salary, promotion, recognition, conference sponsorship, and other external incentives are unimportant. Rather, the study did not find sufficient evidence that extrinsic motivation, as measured in this research, was significantly related to research innovation among the respondents.

A possible explanation is that research innovation depends on more than lecturers' willingness to work or the rewards attached to their jobs. STEM research often requires specialised equipment, laboratory facilities, research funding, reliable electricity, digital resources, technical support, and opportunities for collaboration. When these conditions are lacking, lecturers may find it difficult to transform research ideas into practical products, technologies, or prototypes, even when they are motivated to undertake research.

Ajegbomogun and Popoola (2013) examined motivational strategies and the use of internet resources in relation to research productivity among lecturers in Nigerian universities of agriculture. Their work provides a relevant perspective on the relationship between motivation, access to research resources, and academic productivity. However, research productivity and research innovation should not be treated as identical outcomes. Publishing scholarly articles, developing a new product, producing a prototype, and obtaining a patent represent different forms of research achievement.

This distinction may help explain why the present study did not establish a significant relationship between extrinsic motivation and research innovation. External incentives may encourage lecturers to meet promotion requirements or publish academic papers, but these incentives may not necessarily lead to the development of new technologies. Innovation often requires additional investment, specialised facilities, sustained research support, and collaboration with other researchers or industry partners.

Ryan and Deci (2020) also provide a useful perspective on the role of external rewards. Their discussion of motivation suggests that incentives should be considered alongside individuals' sense of competence, autonomy, and the value they attach to their work. Applied to STEM research, this means that financial rewards and promotion opportunities may be insufficient where lecturers lack the resources and professional support needed to conduct meaningful research.

The measurement of research innovation is equally important. Indexed publications demonstrate that research findings have been communicated through scholarly outlets, but they do not necessarily establish that a new technology or product has been developed. Patents and prototypes provide different forms of evidence. The Oslo Manual published by the Organisation

for Economic Co-operation and Development and Eurostat (2018) offers an established framework for understanding and measuring innovation, including new or improved products and processes..

Conclusion

The study concludes that intrinsic motivation is an important correlate of tertiary institutional outputs among STEM lecturers in North-Central Nigeria, as demonstrated by the significant positive relationship between intrinsic motivation and institutional outputs. Conversely, extrinsic motivation showed no significant relationship with research innovations. This suggests that lecturers' professional commitment and autonomy currently play an important role in sustaining institutional performance, whereas the existing external reward system has not provided sufficient conditions for stimulating research innovation.

Recommendations

Based on the findings, the study recommends that:

1. Tertiary institutions should strengthen intrinsic motivation by providing lecturers with greater professional autonomy, recognition, opportunities for academic development and supportive working environments.
2. Dedicated STEM research funding should be established by institutions and agencies such as TETFund to support applied research, prototypes and locally relevant technological solutions.
3. Laboratory and digital infrastructure should be modernized, including reliable electricity, internet connectivity, research equipment and functional STEM laboratories.
4. Industry–academia partnerships should be strengthened to provide research sponsorship, technology-transfer opportunities and practical platforms for developing innovations that address local industrial and societal challenges.

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