



Collaborative Curriculum Design through Engineering Research and Innovation in Science Education

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ABSTRACT

This article analyses collaborative curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta. The descriptive survey design was used with two research questions and one hypothesis. The population consists of classroom teachers from rural and urban public secondary schools from 425 public secondary schools from 25 Local Government Areas (L.G.A) in Delta State, Nigeria. A sample of two teachers per school was extracted from 58 schools bringing the total to 116 teachers randomly sampled. Frequency, percentages, and means, (based on a four-point scale) were used for the research questions, and one-way Analysis of Variance (ANOVA) for the statistical significance of the research hypothesis, based on a reliability test coefficient of 0.86 at 0.05 level of significance. The study submits that classroom teachers were being confined and restricted not to teach outside the curriculum for grading and examination purposes and that only to a low extent does the classroom teacher influence or model the curriculum through engineering research and innovation to direct learning outcome of the students in science education in rural and urban secondary schools in Delta State.

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INTRODUCTION

As past generations witnessed the era of industrialization, a period in history around the 1760s, where changes in the economic, and social organization were characterized by the replacement of hand tools with power-driven machines and steam engines, and the establishment of large industries, so also is this generation witnessing unprecedented breakthroughs in scientific and technological advancements, characterized by engineering research and innovation. This scientific and technological knowledge, therefore, becomes apparent in preparing mankind as a higher intelligent life-form to be actively engaged in creative and innovative ideas

to better improve the quality of living in the wake of the numerous complexities that poses threat and challenges to his existence. It is noteworthy therefore to state that science, technology and engineering are all aspects of physically related innovated models designed in the sequel to satisfy a need or want. Science begins with the observation of a naturally occurring phenomenon with a view or prospect of developing it into a descriptive model or a scientific theory, while engineering begins with a descriptive model or engineering design with a view or prospect of developing it into a physical system.

Bhagat (2018) explains science as a systematic knowledge based on facts, observations and experimentations.



Hohenberg (2010) described it as a process for proposing and refining theoretical explanations about the world which are subject to further testing and refinement, and for any inquiry to qualify as 'scientific knowledge,' an inference or assertion must be derived by the scientific method. Science, therefore, is a field of study that is based on observation and experimentation of naturally occurring phenomena following the processes of the natural laws of the universe. It entails the use of evidence to construct testable elucidations and predictions of natural phenomena. The scope of science also includes the knowledge generated through the process thereof.

Engineering, as a derivative of science - a global phenomenon, is currently experiencing exponential strides at international levels and harnessed in every way possible. The Merriam-Webster 2017 edition of the Incorporated dictionary defined it as the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people. The future of engineering is being framed by global forces which transcend national boundaries such as the impacts of globalisation, rapid technology advances, and climate change. Through the application of science and engineering, humanity has the potential to meet all of its basic needs: water, sanitation, food security, shelter, energy and transport (Blumenthal & Grothus, 2016). Saha, (2010); Parashar, & Parashar, (2012) avers that as technological and scientific advances especially at the interface of advanced computing, biology and physics are leading exponential growth of innovation and opening a world of new possibilities and markets. It follows that engineering in higher education needs to constantly strive to keep pace with these advances and in particular the contribution of engineering to these global opportunities and challenges.

As a component of education and research, engineering research is consequently a unique mix that accentuates not only on research and discovery but also on its development and implementation. Parashar, & Parashar, (2012) elucidates that engineering research is on the agenda for the improvement of higher engineering education and the development of strategies for solving important issues for the future of engineering education, such as recruitment, the need for new competencies and the ability to deal with new types of interdisciplinary and complex knowledge. Engineering research therefore is categorized as a unique interdisciplinary mix where engineering and education researchers do have various backgrounds in engineering, science, social science and educational psychology investigating higher engineering education. Research in engineering education is therefore considered highly interdisciplinary and lies at the intersection of engineering, education and the learning sciences".

As advanced countries of the world actively engage in the strive and exploitation of technological advancements in the field of engineering research and innovation, the educational sector in Nigerian seems to be contented with majorly what was handed down to her in time past in form of her educational curriculum during the establishment of western or formal education at both the primary school level in 1843, and later at the secondary school in 1955 from her colonial masters, and probably still clinging to an idealism that is obsolete and thereby not abreast with modern scientific approaches to tackle the ever-rising societal problems. Saha (2010) averred that curriculum issues are inseparably linked to current thinking and action on educational concerns and reforms around the world. Syllabus forms the core of the curriculum. They are the components of the curriculum. Triki, (2016) pointed out, that



the curriculum and syllabi in engineering education are dynamic as it shifts with societal requirements as well as student inputs, the design of the entire curriculum process is intended to illustrate the syllabus as being the outcome of complex design activity (Saha, 2010).

Purpose of the Study

The purpose of this study probes whether or not classroom teachers are actively engaged in the design of curriculum through engineering research and innovation in science education, and to investigate the extent the classroom teacher influences or models the curriculum through engineering research and innovation to direct learning outcome of the students in science education in rural and urban secondary schools in Delta State.

Theoretical Background

Since the early 1900s, the curriculum theory has been extensively concerned with the explanation and interpretation of curricula aims and objectives. This consideration of objectives which began in 1925 was aimed to select curricula goals based on the needs and requirements of the students.

Collaborative Curriculum Design

Simply put, the curriculum is the educational road map designed to achieve a conglomeration of knowledge, skill and experience. Saha (2010) avers that the curriculum is the formal mechanism through which intended educational aims are achieved. This formal mechanism includes two prime factors: learning and instruction. The curriculum incorporates the social, cultural and even political background of the programme of a course. It is defined by a set of subjects taught in a particular course with a hierarchical structure which is linked, duration of periods and credits allotted, percentage of theoretical knowledge gained and practical in overall

course structure, which includes the evaluation procedure and its standards.

Curriculum design is the formation processes of the curriculum which involves the consideration factors which are both implicit and explicit to the educational goal to be attained. Mohanasundaram (2018) avers that all curriculum designs endeavour to address four curriculum components, which are - why do we initiate instruction or aims, what should we teach to realize our predetermined aims and objectives, How can we interconnect target learning experiences, What have we achieved and what actions should we take accordingly to the instructional program, learners, and teachers. Although its development involves the process of methodological designing and preparation of all courses offered in a particular field or subject, the design of the entire curriculum process is projected to illustrate the syllabus as the outcome of a complex design of educational activity. This involves the declaration of objectives and simultaneous design of assessment and instruction procedures that will cause those objectives to be obtained for a particular programme and institute.

The design of the curricula is organised at two levels. The first stage of the design is at the macro level in which the type of courses to be offered, the amount of time devoted, and the manner they will be arranged over the program are contemplated. The second stage focuses on particular content elements and learning activities which are selected and organised to optimise the knowledge to be gained by the student. Collaborative curriculum design, therefore, suggests curriculum designing models where the teachers are actively engaged at both the micro-level, where decisions about the type of courses to be offered by the students are made, the amount of time devoted to each course of study, and their logical arrangement within the program, and also at the finishing stages, where the curriculum content, learning



elements and activities can be selected and organised to optimise the knowledge gained by the student and channelled towards the gain of their immediate environment. Adesugba & Temitope (2019) elucidates that the adaptability of the curriculum enables it to meet the needs and abilities of students. The basic premise is that teachers' professional development is most effective through their active involvement in curriculum design communities.

Science Education

As a scientific field of study, science education is endowed with the dual responsibility of transferring knowledge skill and expertise to its learners via a scientific premise by sharing scientific contents and processes with individuals not regarded traditionally as being part of the scientific community. Science education, therefore, is saddled with the burden of balancing the requirements of breadth and depth of scientific knowledge to ensure young people and adult learners are both motivated to learn and equipped to fully engage in scientific discussions and decisions and to facilitate further and deeper study (Hazelkorn, Ryan, Beernaert, Constantinou, Deca, Grangeat, Karikorpi, Lazoudis, Casulleras, & Welzel-Breuer, 2015). Conventionally, science education has focused on learning in the context of science and mathematics. The Organisation for Economic Cooperation and Development (OECD) makes a distinction between knowledge of science and knowledge about science. Knowledge of science includes understanding fundamental scientific concepts and theories; knowledge about science includes "understanding the nature of science as a human activity and the power and limitations of scientific knowledge" (OECD, 2009). It is developed by formal and informal science education organizations working on: new pedagogy for science education, teaching resources

and guidelines for quality science education (Hazelkorn et., al., 2015).

METHODOLOGY

This study adopts a descriptive survey research design where two research questions and one hypothesis were raised. The population for the study comprise of classroom teachers from rural and urban public secondary schools from 425 public secondary schools from 25 Local Government Areas (L.G.A) in Delta State, Nigeria. A sample of two teachers per school was adopted from fifty-eight (58) schools yielding a total of 116 teachers sampled randomly for the study. The researcher designed the questionnaire to gather quantitative data which was used for the study while adopting frequency, percentages, and mean, (based on a four-point scale) to answer the research questions. one-way Analysis of Variance (ANOVA) was used to determine the statistical significance between the mean of the three independent groups with regards to the research hypothesis, based on a reliability test coefficient of 0.86 also at a 0.05 level of significance.

Research Questions:

1. Are classroom teachers actively engaged in the design of curriculum through engineering research and innovation in science education in rural and urban secondary schools in Delta State?
2. To what extent does the classroom teacher influence or model the curriculum through engineering research and innovation to direct learning outcome of the students in science education in rural and urban secondary schools in Delta State?

Research Hypotheses:

1. There is no significant relationship between the



classroom teacher and innovation in science education
 curriculum design through in rural and urban secondary
 engineering research and schools in Delta State.

Table 1: Mean responses of classroom teachers on active engagement in the design of curriculum through engineering research and innovation in science education

S/no	Variables	N	Strongly Agree (SA)	Agree (A)	Disagree (D)	Strongly Disagree (SD)	Mean	Remark
1.	Not allowed closing the research-practice gap, by embedding science education research findings into teacher preparatory notes	116	45 (38.79%)	39 (33.62%)	24 (20.69%)	8 (6.90%)	3.043	Agree
2.	Not given the privilege to develop the curriculum as it pertains to teaching and learning and assessment of content material provided by the school	116	51 (43.97%)	45 (38.79%)	13 (11.21%)	7 (6.03%)	3.207	Agree
3.	Classroom Teachers are deprived of the benefit of modifying course content and scientific materials as it relates to international scientific models	116	40 (34.48%)	41 (35.34%)	26 (22.41%)	9 (7.76%)	2.966	Agree
4.	Classroom teachers are robbed of the opportunity to write and publish their classroom scientific findings	116	49 (42.24%)	34 (29.31%)	29 (25.00%)	4 (3.45%)	3.103	Agree
5.	Classroom teachers are coerced to adopt and make reference to old scientific textbooks provided by the school library with obsolete scientific findings for financial reasons	116	33 (28.45%)	42 (36.21%)	28 (24.14%)	13 (11.21%)	2.819	Agree
6.	Not exposing the students to enough lab hours but forced to adhere to the time limit as stipulated by the curriculum handed to them at the detriment of the student	116	39 (33.62%)	51 (43.97%)	19 (16.38%)	7 (6.03%)	3.052	Agree
7.	Classroom teachers are being confined and restricted not to teach outside the curriculum for grading and examination purposes	116	44 (37.93%)	39 (33.62%)	27 (23.28%)	6 (5.17%)	3.043	Agree
Group Mean							3.033	Agree



Displayed in Table1 above, are the internal variables raised to capture quantitative data for the study as it pertains to research question one. It reveals that of all seven (7) variables raised, all variables (item 1 – 7) returned a mean value higher than 2.50 (the adjudged mean benchmark), thereby indicating that the respondents agree to the above negative statements raised. Also, the group mean of 3.033, also

higher than 2.50 (the adjudged mean benchmark), supports their claim that the above negative statements were a fact and therefore it can be inferred that classroom teachers are not actively engaged in the design of curriculum through engineering research and innovation in science education in rural and urban secondary schools in Delta State.

Table 2: Mean responses on classroom teacher influence through engineering research and innovation to direct learning outcome of the students in science education

S/no	Variable	No.	Great Extent (GE)	Average Extent (AE)	Low Extent (LE)	No Extent (NE)	Mean	Remark
1.	given the opportunity to close the research-practice gap, by embeddings science education research findings into teacher preparation,	116	13 (11.21%)	27 (23.28%)	30 (25.86%)	46 (39.66%)	2.060	Low Extent
2.	given the opportunity in curriculum development, teaching and learning and assessment content material provided by the school	116	6 (5.17%)	12 (10.34%)	39 (33.62%)	59 (50.86%)	1.698	Low Extent
3.	given the opportunity to modify the course content and scientific materials as it relates to international scientific models	116	12 (10.34%)	26 (22.41%)	37 (31.90%)	41 (35.34%)	2.078	Low Extent
4.	given the opportunity to write and publish their own classroom scientific findings	116	14 (12.07%)	23 (19.83%)	32 (27.59%)	47 (40.52%)	2.034	Low Extent
5.	adopt and refer to their own scientific text books where scientific findings are up to date	116	9 (7.76%)	17 (14.66%)	34 (29.31%)	56 (48.28%)	1.819	Low Extent
6.	exposing students to enough lab hours based on the individual educational need of students	116	15 (12.93%)	21 (18.10%)	35 (30.17%)	45 (38.79%)	2.052	Low Extent
7.	At liberty to teach outside the curriculum and adopt for grading and examination purposes	116	11 (9.48%)	22 (18.97%)	29 (25.00%)	54 (46.55%)	1.914	Low Extent
Group Mean							1.951	Low Extent

Exhibited in Table2 above, are the variables raised to capture

quantitative data based on a researcher propounded mean ratio scale of 0.00 –



1.50 for No – Extent (NE), 1.51 – 2.50 for Low-Extent (LE), 2.51 – 3.50 for Average – Extent (AE), and 3.51 – 4.00 for Great – Extent (GE). The table also reveals that out of all seven (7) of the internal variables raised, all seven of them (item 1 – 7) returned a mean value lower than 2.50 (the adjudged mean benchmark), falling into the 1.51 – 2.50 for Low-Extent (LE) category, thereby implying that the respondents agree that only to a low extent does the classroom teacher influence or model the curriculum. The table also reveals a group mean of 1.951, also lower in value than the adjudged mean benchmark of 2.50 also falling into the 1.51 – 2.50 for Low-Extent (LE) category, further supporting their claim that only to a low extent does the classroom teacher influence or model the curriculum through engineering research and innovation to direct learning outcome

of the students in science education in rural and urban secondary schools in Delta State.

Research Hypotheses One:

1. Ho₁: There is no significant relationship between the classroom teacher and curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta State
Ha₁: There is a significant relationship between the classroom teacher and curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta State

Table3a: Summary of Analysis of Variance (ANOVA) between the variables classroom teacher and curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta State.

Groups	Count	Sum	Average	Variance
Classroom Teacher	7	21.233	3.033286	0.014337
Curriculum Design	7	13.655	1.950714	0.021317
Engineering Research and Innovation in Science Education	7	19.79	2.827143	0.01259

Table3b: Analysis of Variance (ANOVA)

Source of Variation	SS	df	MS	F	P-value	F crit	Remark
Between Groups	4.626027	2	2.313013	143.8313	8.5167	3.5546	Reject
Within Groups	0.289466	18	0.016081				
Total	4.915492	20					

Revealed in Table 3a is the summary for the analysis of variance (ANOVA) for the relationship between the classroom teacher and curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta State showing the averages of seven internal variables with individual sums of

21.233, 13.655, and 19.79, with averages of 3.033286, 1.950714, and 2.827143 and with a variance of 0.014337, 0.021317, and 0.01259 respectively.

In addition to the above, Table 3b displays the sum of squares between the various groups of 4.626027 with a degree of freedom of 2 and a mean square of 2.313013 and also showing the



sum of squares for within the variable groups of 0.289466 with a degree of freedom of 18 and a mean square of 0.016081 respectively.

The table also showed the F calculated value of 143.8313, greater in value than the F-Critical value of 3.5546, with a p-value of 8.5167, therefore rejecting the null hypotheses by implication and accepting the alternate hypotheses which state that there is a significant relationship between the classroom teacher and curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta State.

DISCUSSION OF FINDINGS

This study therefore upholds, based on its findings that Classroom teachers are not allowed to close the research-practice gap by embedding science education research findings into their teacher preparatory notes, and that they are also not given the privilege to develop the curriculum as it pertains to teaching and learning and assessment of content material provided by the school, and also deprived of the benefit of modifying course content and scientific materials as it relates to international scientific models.

This position was upheld by Hazelkorn, et. al. (2015), stating that closing the gap between what we have learned from science education research and classroom practice is vital. Inquiry-oriented science education can produce positive results, but this requires reforms in classroom practice, including a shift towards assessment for learning (AfL). Embedding the outcomes of science education research into teacher preparation, curriculum development and continuing professional development offers rich possibilities.

The study went further to reveal that Classroom teachers are robbed of the opportunity to write and publish their classroom scientific findings, as they are coerced to adopt and make reference to

old scientific textbooks provided by the school library with obsolete scientific findings for financial reasons, and they do not expose the students to enough lab hours but forced to adhere to the time limit as stipulated by the curriculum handed to them at the detriment of the student. Adesugba, & Temitope, (2019) lamented that developing a curriculum should give room for flexibility, adaptability, functional to circumstances, and encourage innovation and experimentation of different structures. A position Triki (2016) upholds, stating that the curriculum and syllabi in engineering education are dynamic as it shifts with societal requirements as well as student inputs.

The study further submits that classroom teachers were being confined and restricted not to teach outside the curriculum for grading and examination purposes and were also not actively engaged in the design of curriculum through engineering research and innovation in science education in rural and urban secondary schools in Delta State. In a similar study in conducted in India, Mohanasundaram, (2018) reported that the twentieth-century secondary school curricular developments in India seemed merely a mechanical and static function for they neglected the knowledge bases of our glorious past, rich cultural heritage, basic value systems, the social concerns of the present and the future needs of the society. This study further maintains that only to a low extent does the classroom teacher influence or model the curriculum through engineering research and innovation to direct learning outcome of the students in science education in rural and urban secondary schools in Delta State. Yet still there remains a significant relationship between the classroom teacher and curriculum design through engineering research and innovation in science education in rural and urban secondary schools in Delta State.



CONCLUSION

Curriculum designers in Nigerian educational sector struggle in determining what to put in and what to take out, thereby side-lining classroom teachers in science education who are never consulted on collaborative levels, while never considering to partner with industry-specific business sectors that will tilt engineering research and innovation in science education towards economic development.

RECOMMENDATION

In light of the above findings and conclusion, the researcher recommends that;

1. Classroom teachers in science education should be consulted on collaborative levels during the process of curriculum design
2. Nigerian educational sector should partner with industry-specific business sectors in engineering research and innovation in science education
3. A balance should be determined and maintained between what is to be learned theoretically, and the soft skill to be gained from practical experience from experimentations which are harnessed toward the development of industry-specific skill ready for the labour market or entrepreneurship
4. A reform of the present curriculum in science education to conform with technical and engineering research and innovative standards as obtainable in developed countries
5. Curricula should be designed to be flexibility in structure and modes of delivery to cater to the needs of the individual student in science education.

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