Teachers' Pedagogical knowledge in Effective Education and Curriculum in Ghana

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Abstract
This present study used a sequential mixed approach to investigate teachers' pedagogical knowledge in effective education and curriculum in integrated science and mathematics. To test the consistency of the outcome, a triangulation technique was utilized in the context of diverse instruments. A semi-structured questionnaire and interview were used as research instruments for the data collection where 17 items (questions) were used on a five-point Likert scale. The study's setting surrounds integrated science and mathematics teachers in senior high schools; hence the study's population. However, the Ashanti region was used as the study area; therefore, 187 teachers were sampled for the study from 30 different senior high schools. The sampling method used is the non-probability method; thus, purposive and convenience sampling approach for selecting respondents from the various schools and districts in which their schools are situated. In a nutshell, it is obvious from the findings in that majority of teachers perceive integrated science and mathematics as: amalgamation of all science disciplines, methods of teaching, and basis of STEM (science, technology, engineering, and mathematics). It is evidential that almost all of the respondents have pedagogical knowledge concering their field of teaching. Moreover, there is a significant relationship between teachers' pedagogical knowledge and integrated science and mathematics education and curriculum in senior high schools, specifically Ashanti region of Ghana. However, to achieve greater strides in the field of integrated science and mathematics, the curriculum and contents used should be backed by modern practices of pedagogy.

Keywords: *Pedagogial Knowledge; Integrated Science; Mathematics; Curriculum; Pedagogy perception*

1. Introduction

In reality, the growth of any nation or society is largely dependent on the quality of educational opportunities to its people. Centered on this rationale, the United Nations (UN) introduced the Free Compulsory Universal Basic Education (FCUBE) to fill the human capital gap and ensure the upward social mobility of citizens of member states (Akyeampong, 2009). The Millennium Development Goals (MDGs), where the second objective states that all children, boys and girls alike are required to go through the entire program of basic education by 2015, has made a further step for the need for education " for all " (Adediran, 2014). Justifiably, education is a powerful agent in the accomplishment of this vision and, more importantly, in fostering citizenship growth through educating every school-age child (Akunu, 2014). On the connection between education and growth, Kakar et al. (2011) show that schooling has a long relationship with fiscal progress and human development in human endeavour. Cohen et al. (2000) believes that education is the formal training and training that is provided in preparation for life, especially to young people. Education is perhaps the knowledge, training and skills that one acquires through teaching at school, college, university or community. It can also be said to be a method or training that has an outcome or intent that involves the learning of skills, the improvement of mental capacity, emotional wellbeing and the social health of the person. Aziz (2012) maintains that quality of education has a significant linkage to the quality of instruction that students learn. Likewise, Châu (1996) shares Aziz (2012)'s views and maintains that the quality of education relies on the effectiveness of teachers, especially in the early stages of education where learners are at an early age. In reality, as far as teaching for learners is concerned, the standard of teachers who are both academic and professional can not be overemphasized.

The capacity and skills of learners to learn about problems and issues about themselves, their relative and remote domestic society and the global community are the global consensus among scholars in this contemporary world (Idowu, 2001). It is arguable that learners need a specific and distinctive kind of education that will create an enabling environment in life effectively. In its wake, the 1987 educational reforms in Ghana brought the introduction of integrated science at the Junior Secondary School as a core subject. In 1997, at Senior Secondary School, it became a core subject. Mensah (2009) asserts that it is

important to review and structure the pedagogical skills that teachers use at all levels of education so that the perspectives, expertise and skills of teachers in the related field are integrated to make the students understand, maintain and move on to others. Ankomah et al. (2005) hypothesize that the standard of teacher readiness for teaching, which is validated in their preparation of the job scheme, lesson notes and the pedagogical skills they use during instruction, is a fundamental predictor of teacher effectiveness.

It is useful to discover what it means to know something prior to considering the knowledge base for teaching. Based on their study of many disciplinary and epistemological knowledge classification systems, Deng and Luke (2008) suggest three conceptions of knowledge. First, canonical knowledge in the developed disciplines is defined by the disciplinary definition of knowledge. Second, from the wisdom of practice comes the realistic conception of knowledge embodied by procedural knowledge. The third type of knowledge is the experience - based conception of knowledge based on the notion of Cooper (1993) that knowledge is rooted in human experience and based on it. Although there are other ways of knowing, such as empirical or esthetic ways of knowing (Deng & Luke, 2008), these three distinct ways of knowing offer a helpful explanatory context for conceptualizing the origins of knowledge of integrated science and mathematics teachers in secondary school. Mutwiri et al. (2017) indicate that productive teaching is generally a combination of the faculty's inner drive to learning process for students and equip them with the knowledge of subject matter and the competence of teachers to use effective pedagogical skills. In essence, in a balanced education environment, the proper application of the pedagogical skills of teachers in integrated science and mathematics education is important (Government of Ghana, 2018). Tactlessly, Ankomah et al (2005) found that a significant number of Ghanaian secondary school teachers lack sufficient academic qualifications, using incorrect pedagogical skills that endanger the realistic performance of students. Moreover, Addai-Tuffour et al. (2020) contend that students' ability to perform satisfactorily depends on the pedagogical skills and competence of teachers. To buttress their point, Eshun and Mensah (2013) studied whether pedagogical knowledge influences the content of social studies teachers in the Westetrn region of Ghana. In their findings, they reiterated the importance of pedagogical skills and knowledge for academic excellence of students. On this backdrop, this present study aims to investigate teachers' pedagogical knowledge in effective education and curriculum in Ghana to critically understand this phenomenon and further provide policy direction.

2. Method

This present study used a sequential mixed approach to investigate teachers' pedagogical knowledge in effective education and curriculum in integrated science and mathematics. To test the consistency of the outcome, a triangulation technique was utilized in the context of diverse instruments. Moreover, employing one method with the utilization of another for clarification of complementarity and illustration of results. A semi-structured questionnaire and interview were used as research instruments for the data collection where 17 items (questions) were used on a five-point Likert scale. The study's setting surrounds integrated science and mathematics teachers in senior high schools; hence the study's population. However, the Ashanti region was used as the study area; therefore, 187 teachers were sampled for the study from 30 different senior high schools. The sampling method used is the non-probability method; thus, purposive and convenience sampling approach for selecting respondents from the various schools and districts in which their schools are situated (see Table 1 for statistics of the respondents). The analytical method used in this study is the Pearson chi-square statistics to test for significance with the aid of SPSS.

In essence, 250 questionnaires were distributed but at the end of the survey 187 questionnaires were gathered representing 74.8% which shows satisfactory response rate. Moreover, based on the respondents demographic information, 141 (75.5%) were males and 46(24.5%) were females.

Table 1 Descriptive statistics of respondents

Schools	No. of Respondents (Teachers)	Percentage of total respondents %

Akrofuom Secondary	5	2.67
T.I. Ahmadiyya Senior High School	9	4.81
Obuasi Secondary	5	2.67
Christ the King Catholic Senior High School	6	3.21
Adu Gyamfi Secondary	4	2.14
Agona Secondary	5	2.67
Maabang Secondary	4	2.14
Tepa Secondary	5	2.67
Jacobu Secondary	3	1.63
SDA Secondary	7	3.74
Manso-Adubia Secondary	4	2.14
Konongo Odumase Secondary	4	2.14
Juaso Secondary	5	2.67
Nkawie Senior High Technical School	6	3.21
Osei Tutu Secondary	9	4.81
Toase Secondary	9	4.81
Afia Kobi Ampem Girls Secondary	8	4.28
Jachie Pramso Senior High School	5	2.67
Adventist Senior High School	6	3.21
Ghana Armed Forces Senior High School	8	4.28
Anglican Secondary School	8	4.28
Asanteman Secondary School	7	3.74
Kumasi Academy	6	3.21
Kumasi Girls Secondary School	8	4.28
Kumasi High School	7	3.74
Osei Kyeretwie Secondary School	6	3.21
Prempeh College	9	4.81
Opoku Ware School	8	4.28
St. Louis Secondary School	6	3.21
KNUST Senior High School	5	2.67
Total	187	100
Gender	Frequency	%
Male	141	75.5
Female	46	24.5
Total	187	100

3. Findings

3.1 Assessing the perception of teachers on integrated science and mathematics

The study tend to critically understand the perception of teachers in the field of integrated science and mathematics considering their pedagogical knowledge in education and curriculum structure in their sphere of career. In that regard, some specific question were posed to participants of this study who were specifically integrated and mathematics teachers in the senior high schools in Ashanti region, Ghana.

In particular, under this section, the study with the aid of semi-structured questionnaire and interview asked the participants to share their view, opinion or perception on the subjects "integrated science and mathematics". Therefore, they were particularly asked three (3) questions pertaining to their perception on the knowledge of pedagogy in their subject areas – questions asked can be found in table 2.

From the outcome presented in Table 2, question (1) sought to understand the perception of the participants regarding "integrated science and mathematics are amalgamation of all science disciplines". However, it was observed that 89(47.59%) of the respondents strongly agreed, 62(33.16%) disagreed, but 15(8.02%) agreed to the assertion. Also, 19(10.16) neither agree or disagreed, hence responded neutral while 2(1.07) strongly disagreed. That notwithstanding, the revelation suggests that majority of the respondents perceived science and mathematics as an amalgamation of all science disciplines; thus, 104 (55.58%). In view of the second question regarding the perception of teachers' pedagogical knowledge on science and mathematics, respondents were asked to whether "integrated science and mathematics are methods of teaching" and from the feedbacks, it was observed that 93(49.73%), and 29(15.51%) strongly agreed and agreed respectively to the assertion – representing about 65.24% of the totatl respondents. However, 11(5.88%), 53(28.34%), and 1(0.53%) were explicitly neutral, disagreed, and strongly disagreed, simultaneously. The final question under this section sought to fish out the perception of the participants as to whether integrated science and mathematics are the basis of STEM. In that context, 87(46.52%), and 89(47.59%) strongly agreed and agreed respectively, representing 94.11% of the participants.

For profound understanding and clarification, interviews were conducted and 10 of the teachers' participated. However, 9 out of the 10 interviewees share the view that integrated science and mathematics are interconnected to social sciences hence embodies every sphere of life – therefore, considered as the amalgamation of the science disciplines. The only interviewee who opposed to the question shared that integrated science and mathematics are theoretical and natural which usually do not represent social dealings, hence social science can not be regarded as part of natural science. Subsequently, the interviewees were asked what is the opinion could be regarded as the ultimate goal and objective of integrated science and mathematics. In their responses, it was observed that majority of them are of the view that the two are stepping stone for logic and reasoning more so understanding the genesis and revelation of creature for discovery.

In a nutshell, it is obvious from the findings in this section that majority of teachers perceive integrated science and mathematics as: amalgamation of all science disciplines, methods of teaching, and basis of STEM (science, technology, engineering, and mathematics).

Table 2 Teachers' perception on integrated science and mathematics

	Teachers' perception on integrated science and mathematics						
	Items	SD (%)	D (%)	N (%)	A (%)	SA (%)	Total (%)
1	Integrated science and mathematics are an amalgamation of all science disciplines	2(1.07)	62(33.16)	19(10.16)	15(8.02)	89(47.59)	187(100)
2	Integrated science and mathematics are methods of teaching	1(0.53)	53(28.34)	11(5.88)	29(15.51)	93(49.73)	187(100)
3	Integrated science and mathematics are the basis of STEM	5(2.67)	3(1.60)	3(1.60)	89(47.59)	87(46.52)	187(100)

Note: SD=Strongly disagree, D=Disagree, N-Neutral, A=Agree, SA=Strongly Agree

3.2 Teachers' knowledge on education and curriculum

In pursuit to gather the views of respondents of their knowledge on education and curriculum in their pedagogical practice, eight (8) questions were asked in that regard. Question one sought to find out where integrated science and mathematics curriculum ensures higher level of thinking and problem solving skills. In their responses, 128(68.45%), and 56(29.95% strongly agreed and agreed to the assertion. This suggests that about 98.4% of the total respondents understand that integrated science and mathematics ensure higher level of thinking and problem solving skills – therefore, the teaching of these subjects are essential to the

thinking capacity of students. It was also observed that all the respondents were of the view that integrated science and mathematics are stimuli for creativity as 78(41.71%), and 109(58.29%) agreed and strongly agreed to the assertion, respectively.

On the othe hand, it was observed that majority of the respondents perceive that the scope of integrated science and mathematics should focus on solutions that are reliant on recent societal issues as well as the solutions should be focused on human centered initiatives. Moreover, majority of the respondents understand that the development of socio-cultural and personal behaviours should be based on the teachings of integrated science and mathematics.

Conversely, it was observed majority of the respondents opinionate that natural sciences and social science do not differ significantly – hence, they co-exist. In line with that, 89(47.59%), and 56(29.95%) strongly disagreed and disagreed to the assertion that the content of natural science and science education differ significantly. Contratry to this, majority of the respondents shared that mathematics and science contents differ significantly. More importantly, the respondents understand that the content of integrated science and mathematics should be centered on training critical thinkers and robust decision makers

Table 3 Teachers' knowledge on education and curriculum

	Teachers' knowledge on education and curriculum						
	Items	SD (%)	D (%)	N (%)	A (%)	SA (%)	Total (%)
1	Integrated science and mathematics curriculum ensures higher level of thinking and problem solving skills	0(0)	1(0.53)	2(1.07)	56(29.95)	128(68.45)	187(100)
2	integrated science and mathematics eduction should offer creativity	0(0)	0(0)	0(0)	78(41.71)	109(58.29)	187(100)
3	the scope of integrated science and mathematics should be reliant on recent societal issues	1(0.53)	0(0)	1(0.53)	78(41.71)	96(51.34)	187(100)
4	the scope of studies regarding integrated science and mathematics should focus on solutions regarding human lives	1(0.53)	2(1.07)	0(0)	78(41.71)	99(52.94)	187(100)
5	the development of socio-cultural and personal behavious should be based on integrated science and mathematics	1(0.53)	1(0.53)	0(0)	78(41.71)	107(57.22)	187(100)
6	the content of natural science and science education differ significantly	89(47.59)	56(29.95)	30(16.04)	78(41.71)	1(0.53)	187(100)
7	mathematics and science contents differ significantly	2(1.07)	5(2.67)	15(8.02)	78(41.71)	90(48.13)	187(100)
8	the content of integrated science and mathematics should be centered on training critical thinkers and robust decision makers	2(1.07)	7(3.74)	2(1.07)	78(41.71)	87(46.52)	187(100)

Note: SD=Strongly disagree, D=Disagree, N-Neutral, A=Agree, SA=Strongly Agree

3.3 Teachers' pedagogical knowledge of integrated science and mathematics

In this section, the aim of the study is to understand the pedagogical knowledge of the teachers sampled for the study – the outcome of the study can be found in table 4. It is evidential that almost all of the respondents have pedagogical knowledge concering their field of teaching. In particular, 98.93% are of the view that integrated science and mathematics are purposefully used to prepare learners for their future lives. Also, 89.84% responded that one benefit of integrated science and mathematics is to have a positive attitudinal transformation. Again, 98.4% shared that the development of relevant knowledge, values, attitudes, logic and reasoning, and practical skills are the major role of integrated science and mathematics teachers. Eventually, the study on integrated science and mathematics stress on learning and teaching of skills rather than learning and teaching of factual content being expressed by 100% of the respondents. Moreover, majority are of the view that integrated science and mathematics should emphasise on logic and reasoning, and problem solving skills; thus 94.65% of the respondents asserting. Considering the practicality

aspect of the subjects, 100% of the respondents strongly agreed and agreed that integrated science and mathematics should be taught practically but not only theoretical.

Table 4 Teachers' pedagogical knowledge of integrated science and mathematics

	Teachers' pedagogical knowledge of integrated science and mathematics						
	Items	SD (%)	D (%)	N (%)	A (%)	SA (%)	Total (%)
1	integrated science and mathematics are purposefully used to prepare learners for their future lives	1(0.53)	1(0.53)	0(0)	78(41.71)	107(57.22)	187(100)
2	one benefit of integrated science and mathematics education is to have a positive attitudinal transformation	2(1.07)	5(2.67)	15(8.02)	78(41.71)	90(48.13)	187(100)
3	the development of relevant knowledge, values, attitudes, logic and reasoning, and practical skills are the major role of integrated science and mathematics teachers	0(0)	1(0.53)	2(1.07)	56(29.95)	128(68.45)	187(100)
4	the study on integrated science and mathematics stress on learning and teaching of skills rather than learning and teaching of factual content	0(0)	0(0)	0(0)	78(41.71)	109(58.29)	187(100)
5	integrated science and mathematics should emphasise on logic and reasoning, and problem solving skills	1(0.53)	2(1.07)	0(0)	78(41.71)	99(52.94)	187(100)
6	integrated science and mathematics should be taught practically but not only theoretical	0(0)	0(0)	0(0)	78(41.71)	109(58.29)	187(100)

Note: SD=Strongly disagree, D=Disagree, N-Neutral, A=Agree, SA=Strongly Agree

3.4 Assessing the impact of pedagogical knowledge of teachers'on integrated science and mathematics education and curriculum

In furtherance, the study assessed the impact of pedagogical knowledge of teachers on integrated science and mathematics education and curriculum – findings are presented in Table 5. According to the outcome, it is obvious that there is a significant relationship between teachers' pedagogical knowledge and integrated science and mathematics education and curriculum in senior high schools, specifically Ashanti region of Ghana. In particular, at a 1% significance level, the alternate hypothesis is accepted and the null hypothesis rejected with a chi-square value of 87.101. The results suggest that in practice, pedagogical knowledge is essential in the teaching of integrated science and mathematics; therefore, much efforts are required in the training of teachers in that fields to significantly impact on the beneficiaries; thus, students. However, to achieve greater strides in the field of integrated science and mathematics, the curriculum and contents used should be backed by modern practices of pedagogy.

Table 5 Pearson chi-square statistics

	Value	**degree of freedom**	**Prob.**
Pearson Chi-square	87.101	65	0.001
Likelihood ratio	42.524	65	0.125
L-L association	13.624	1	0.001

4. Conclusion

This present study used a sequential mixed approach to investigate teachers' pedagogical knowledge in effective education and curriculum in integrated science and mathematics. To test the consistency of the outcome, a triangulation technique was utilized in the context of diverse instruments. Moreover, employing one method with the utilization of another for clarification of complementarity and illustration of results. A semi-structured questionnaire and interview were used as research instruments for the data collection where 17 items (questions) were used on a five-point Likert scale. The study's setting surrounds integrated science and mathematics teachers in senior high schools; hence the study's population. However, the Ashanti region was used as the study area; therefore, 187 teachers were sampled for the study from 30 different senior high schools. The sampling method used is the non-probability method; thus, purposive and convenience

sampling approach for selecting respondents from the various schools and districts in which their schools are situated.

The study tend to critically understand the perception of teachers in the field of integrated science and mathematics considering their pedagogical knowledge in education and curriculum structure in their sphere of career. In a nutshell, it is obvious from the findings in this section that majority of teachers perceive integrated science and mathematics as: amalgamation of all science disciplines, methods of teaching, and basis of STEM (science, technology, engineering, and mathematics) in consistent with Amosa et al. (2015). It is evidential that almost all of the respondents have pedagogical knowledge concering their field of teaching. Moreover, there is a significant relationship between teachers' pedagogical knowledge and integrated science and mathematics education and curriculum in senior high schools, specifically Ashanti region of Ghana. In particular, at a 1% significance level, the alternate hypothesis is accepted and the null hypothesis rejected with a chi-square value of 87.101 – in support of Addai-Tuffour et al. (2020), Ward et al. (2015) and Eshun and Mensah (2013). The results suggest that in practice, pedagogical knowledge is essential in the teaching of integrated science and mathematics; therefore, much efforts are required in the training of teachers in that fields to significantly impact on the beneficiaries; thus, students. However, to achieve greater strides in the field of integrated science and mathematics, the curriculum and contents used should be backed by modern practices of pedagogy.

References

i *Addai-Tuffour, P., Mwisukha, A., Nasibi, M. W. (2020). Influence Of Teachers' Pedagogical Skills On Students' Ability To Perform Motor Appropriate Skills During P.E Instruction In Kumasi Metropolis, Ghana. African Journal of Emerging Issues (AJOEI), 2(3), 75-88.*

ii *Adediran, A. A. (2014). Students- centred teaching methods and utilization of instructional strategies for effective social studies teaching, paper presented at the 58thWorld Assembly of the international council on Education for teaching (ICET) at the university of Ontario institute of technology, Oshacma, Ontanio, Canada between 1 5th-20th June, 2014.*

iii *Akunu J.A (2014). Influence of Teaching and Learning Resources on Students' performance in Kenya Certificate of Secondary Education in Free Day Secondary Education in Embakasi District, Kenya.*

iv *Akyeampong, K. (2009). Revisiting Free Compulsory Universal Basic Education (FCUBE) in Ghana. Comparative Education, 45 (2). pp. 175-195. ISSN 0305-0068.*

v *Amosa, A.A., Folasayob, O.A. & Oluwatoyinc, A. E. (2015). Instructional strategies foreffective teaching and learning in Nigeria secondary schools, First Asia Pacific Conference on Advanced Research, 146-155.*

vi *Ankomah Y, Koomson J, Bosu R & Oduro G. K.T. (2005). Implementing Quality Education in Low income Countries (Equal Project-Ghana), Institute for Educational Planning & Administration (IEPA), University of Cape Coast. December. pp 1-31.*

vii *Aziz, M.A. (2012). Effects of demographic factors & teachers' competencies on the achievement of secondary school students in Punjab. Islamabad: Allama Iqbal Open University.*

viii *Chau, P. Y. (1996). An empirical assessment of a modified technology acceptance model. Journal of management information systems, 13(2), 185-204.*

ix *Cohen, L., Manion, L., & Morrison, K. (2000). Research methods in education (3rd ed.). London: Routledge. Curriculum Research and Development Division (CRDD). (2007). Social Studies teaching syllabus for Senior*

x *Cooper, J. C. (1993). Logistics strategies for global businesses. International journal of physical distribution & logistics management.*

xi *High Schools. Accra: Ministry of Education.*

xii *Deng, Z., & Luke, A. (2008). Subject matter: Defining and theorizing school subjects. In F. M. Connelly, M. F. He, & J. Phillion (Eds.), The Sage Handbook of Curriculum and Instruction. Thousand Oaks, CA: Sage Publications.*

xiii *Government of Ghana. (2018). Education strategic plan 2018 - 2030. 1–154.*

xiv *Idowu, S. O. (2001). Basic issues in social studies for students of higher institutions. Ijebu-Ode: Fembo Integra Publication.*

xv *Kakar, Z. K., Khilji, B. A., & Khan, M. J. (2011). Relationship between education and economic growth in Pakistan: A time series analysis. Journal of International Academic Research, 11(1), 27-32.*

xvi *Mensah, F. M. (2009). Confronting assumptions, biases, and stereotypes in preservice teachers' conceptualizations of science teaching through the use of book club. Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 46(9), 1041-1066.*

xvii *Mutwiri, L. M., Kafwa, V. N., & Kyalo, M. M. (2017). Integration of Information and Communication Technology in Teaching and Learning: Assessments of Public Secondary Schools in Meru County. African Journal of Education, Science and Technology, 4(2), 102-118.*

xviii *Ward, P., Kim, I., Ko, B., & Li, W. (2015). Effects of improving teachers' content knowledge on teaching and student learning in physical education. Research Quarterly for Exercise and Sport, 86, 130–139.doi:10.1080/02701367.2014.987908*