

Mathematics as a Tool for Enhancing Competitiveness and Employability of Vocational Training Institutions in Ghana

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Abstract

The study investigated the extent to which the Mathematics content and curriculum of Vocational Institutions in Ghana could be restructured to enhance the competitiveness and employability of those graduates. The seemingly low level of Mathematical competence and skills has hampered their pursuits for further studies and favourable competition with their counterparts from the senior high schools and the technical institutes in Ghana. This study sampled about 400 students from four Vocational Training Institutes in the Upper East and Central Regions of Ghana to reflect the poor geographical locations and low economic viabilities of these products. The results discovered that students were willing to accept restructuring and study Mathematics in the Vocational Institutions. Therefore, to revamp the Technical and Vocational Education and Training in Ghana, the Government of Ghana, through the Ministry of Education and the bodies responsible for these Institutions should reconsider inculcating Mathematics into their curricula of Vocational Institutes.

Keywords: Employability, Job, Mathematics, Skills and Tools

Technical and Vocational Education and Training System in Ghana

The African Union(AU--2014) opines that the Technical and Vocational Education and Training(TVET) systems in Africa differ from country to country and are delivered at technical institutes, vocational centres, polytechnics, universities, enterprises, and apprenticeship training centres. In West Africa, traditional apprenticeship offers the largest opportunity for the acquisition of employable skills in the informal sector. In Ghana, the informal sector accounts for more than 90 percent of all skills training.

The UN Educational, Scientific and Cultural Organization (UNESCO- 2014) and National Vocational Training Institutes (NVTI--2009) observe that the TVET system in Ghana is even provided through several ministries; with the Ministries of Education and Employment and Labour Relations being the most prominent. Bortei-Doku Aryeetey, Doh and Andoh (2011) gives the statistics of both the public and private TVET institutions recorded by the Ministry of Education, as 27% Integrated Community Centres for Employable Skills, 21% Ghana Education Service (GES) Technical Institutes, 19% NVTI centres, 16% Community Development Centres, 10% Social Welfare Centres, 6% Leadership Training Institutes, 1% Opportunities Industrialization Centres and 1% Agricultural Training Institutes.

Bortei-Doku Aryeetey, Doh and Andoh (2011) agree that the Government of Ghana established a legal framework for TVET and formed the Council for Technical and Vocational Education and Training (COTVET) in 2006 to co-coordinate, formulate national policies and oversee all aspects of TVET in the country. The COTVET has also formed three sub-committees for industry advisory, qualifications/quality assurance and traditional apprenticeship. While the different ministries are responsible for implementing the policies within their TVET institutions, the overall goals of the Council are to ensure that the unemployed particularly, the youth, Junior High School (JHS), Senior High School (SHS), secondary technical schools or technical institutes are given competitive, employable and entrepreneurial skills nationally and globally within the formal and informal sectors. The SHS and technical school graduates can opt progress to universities and polytechnics or apprenticeships including those who not these schools. However, no such opportunities have been accorded to the vocational school graduates.

Statement of the Problem

The researchers observed that problems of vocational training and education in Ghana emerge from the requirements of the curriculum, the types of examinations and the challenges the institutions still face in meeting their mandate. The various TVET institutions develop and administer their own different curricula to vocational students. They also conduct different examinations for their trainees. However, the fragmented natures of the mathematics content, pedagogy and examinations lack quality, competency and reliability of results and the graduates. The study also observed that there are many challenges still bedeviling vocational education in Ghana. These challenges spine from infrastructure to managerial as compared to the traditional liberal schools. If these challenges are left unaddressed, the quests to boost vocational education and imbibe the youth with employable skills still remain a mirage.

Literature review

Programme Requirements of Vocational Training Institutions in Ghana

The Ministry of Education, Youth and Sports (MoEYS--2004); MOEYS (2007); and, Anarfi and Appiah (2012) opine that the JHS programme is the basic entry requirements which equip students to move into the diversified system of SHS comprising options in Vocational, Technical, Agricultural and General Education or simply two parallel streams of the SHS and TVET or an apprenticeship scheme. All the JHS students offer Mathematics alongside English Language, Social Studies and Integrated Science as core subjects. These core courses are continued to the SHS, technical institutes and beyond. It is however, regrettable that the vocational school students do not offer core Mathematics.

Examinations and Certifications of Vocational Training Institutions in Ghana

Kitaev, Glover, Melomey, Coleman and Kaluba (2003), and NVTI (2010) observe that the vocational institutions hold three types of examinations administered by the Ghana Education Service, NVTI and Social Welfare examinations. The NVTI in particular, operates under the Ministry of Employment and Labour Relations to provide demand-driven employable skills and enhance the income generating capacities of all students through competency-based Apprenticeship, Master craftsmanship, Testing, Certification and Career Development. The

National Trade Test Committee is in charge of curriculum development and examination for the students of vocational schools. It provides the Grade 1 Certificate, the Grade 2 Certificate and the National Craftsman Certificate (NCC). Each candidate then receives a performance grade in Distinction, Credit, Pass, Referred or Fail. Even though students may perform creditably well, they cannot progress to any higher institution just because they did not write Mathematics.

Challenges and Prospects of Vocational Training Programmes in Ghana

According to Ghana News Agency (2008), Mr. George Aboagye Okyere, the Head of Monitoring and Supervision Department of NVTI, observes that about 60% of the vocational institutions are operating below the required standards. Also, Kitaev, Glover, Melomey, Coleman and Kaluba (2003) and, Fu and Tu (2013) also bemoan the fragmented, uncoordinated and inconsistent TVET legislation that has plagued the vocational institutions. TVET institutions may choose to register with the GES, the General Department of Registration, the Ghana National Association of Private Schools, the NVTI, the District Assemblies, the Ministry of Works and Housing, Ministry of Local Government or any other bodies. The majority of private TVET institutions has however, registered with the GES and uses the standard NVTI curriculum. Bortei-Doku Aryeetey, Doh and Andoh (2011), and The AU (2014) bemoan that TVET is perceived across Africa as a route for those who are not able to function within an academic setting.

In order to revamp this sector of education and training, stakeholders need to inculcate TVET curricula with modern science, mathematics and technology to wipe out negative perceptions, enhance sustainable development and provide linkages to higher education and the labour market. It was incumbent that the Government of Ghana, through the Ministry of Education and other stakeholders should consider restructuring the mathematics-based skills to enhance the competitiveness and employability of vocational graduates in this globally competitive labour environment.

Purpose of the Study

The study investigated the effectiveness of restructuring the Mathematics content and curriculum into the Vocational Institutions in Ghana

Objectives of the study

1. To assess the basic entry requirements into the vocational institutions.
2. To assess the competency-based skills and interests of vocational students.
3. To recommend for the restructure of Mathematics curriculum the Institutions.

Hypotheses

1. Null hypothesis 1: All students were endowed with the mathematical competency and pedagogical skills in the vocational institutions.
2. Null hypothesis 2: At least, one student lacked those skills and competency in Mathematics in the vocational institutions.

Significance level: 5%

Tests statistics: Binomial at 50% proportion, Runs tests and Chi-square

Rejection criteria: p-values more than the test statistics

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Research Method

The study selected 400 students from two regions of the country 2 public and 2 private. A structured questionnaire for the study, consisting mainly of a five -point rating scale, ranging from (a) to (e) was employed in the data collection. The decision on the sample size was taken based on economic viability of the two regions. The choice of regions was discussed thoroughly to represent the profiles of the poor prevailing conditions of these vocational institutions. Principals or representatives of the four institutions were contacted and briefed on the contents of the questionnaire. The Principals in turn briefed the students on how to complete the questionnaire carefully. Copies of the questionnaire were then distributed to the students to answer and return them.

The researchers implored the SPSS software for the data processing and reporting of the findings. The software was used in vetting and coding of the completed questionnaire. Two charts and three nonparametric data analyses were implored for the analyses. The charts were used to visualize the demographic compositions and aims of studying Mathematics in these vocational institutions. The nonparametric tests were the Binomial, the Runs (based on the central tendencies) and the Chi-square Analysis of Variance (based on gender as independent variable) was implored.

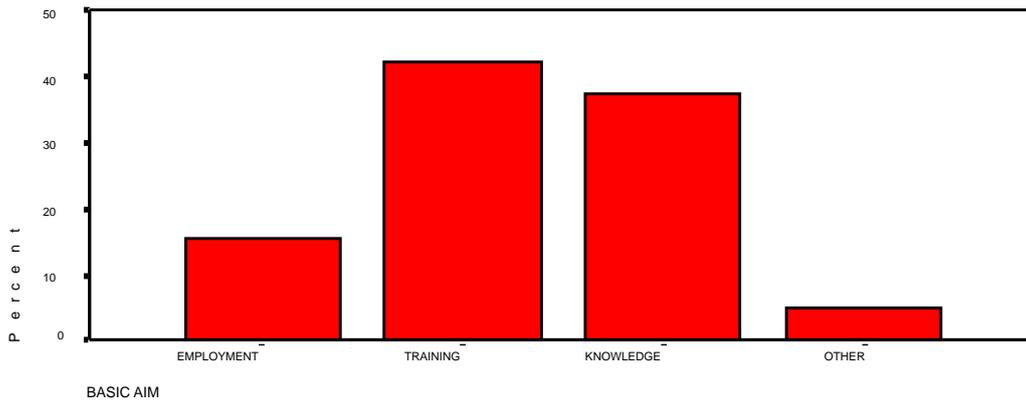
Results

Figure 1: Examinations Students Ever Wrote Before Pursuing Programmes



The chart in figure 1 above simply shows the qualifications of the two genders in the four vocational institutions. It was observed that the females formed the majority of the vocational students across the three levels of examinations encountered before entering the Vocational Institutions. This means that the commonest basic entry requirements of the vocational students are the JHS leavers. These JHS leavers wrote Mathematics and some even obtained good passes. There is no point in exempting them from pursuing and writing further mathematics examinations in the Vocational Institutes.

Figure 2: Aim of Pursuing Vocational Programmes



The chart in figure 2 above simply shows the basic aims of the students in pursuing the vocational programmes in the four vocational institutions. It was observed that the majority of the vocational students went there for intensive training and acquiring academic knowledge. Employment came so closed to these two aims. This means that the students did not only go to Vocational Institutions just to get employed immediately but mainly to pursue liberal and general education. Since they have established these deep rooted aims, it was incumbent upon policy makers to create opportunities for them to pursue higher education.

Binomial Tests on Binary Responses Based on Z Approximation
 Table 1: Binomial Descriptive Statistics of the Binary Responses

Responses	Number	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
Gender	308	1.70	0.46	1	2	1.00	2.00	2.00
Work History	308	1.84	0.37	1	2	2.00	2.00	2.00
Maths Exams	308	1.00	0.00	1	1	1.00	1.00	1.00
Study Maths	308	1.15	0.35	1	2	1.00	1.00	1.00
Willing to Train	308	1.07	0.26	1	2	1.00	1.00	1.00

The table 1 above displays the four items that contained only two options in their rating scales. It was observed that the majority of the vocational students were unanimous in their responses to the female gender, not having any work before embarking on the programme, has ever written mathematics examinations, have studied mathematics and are willing to study mathematics. There is therefore, the need to grant these students the opportunity to study and write competitive mathematics examinations in the Vocational Institutions. This is the surest way to revamp these Vocational Institutions in Ghana.

Table 2: Binomial Test of Significance of the Four Binary Responses

Responses	Category	Number	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)	
Gender	Group 1	Female	216	0.70	0.50	0.000
	Group 2	Male	92	0.300		
	Total		308	1.00		
Work History	Group 1	Yes	50	0.16	0.50	0.000
	Group 2	No	258	0.84		
	Total		308	1.00		
Maths Exams	Group 1	Yes	308	1.00	0.50	0.000
	Total		308	1.00		
Study Maths	Group 1	Yes	263	0.85	0.50	0.000
	Group 2	No	45	0.15		
	Total		308	1.00		
Willing to Train	Group 1	Yes	285	0.93	0.50	0.000
	Group 2	No	23	0.07		
Total			308	1.00		

The Table 2 above shows the Binomial test of significance of the four binary responses. With the test proportion of 0.50, the test was significant at 5%. These tests indicate that the gender, work history, mathematics examinations, mathematics studied and willingness to study mathematics were very important in determining the progress of the students. The privilege, if granted, would enhance fair labour competitiveness and employability of this category of products in the labour market.

Table 3: Runs Descriptive Statistics of the Four Non-Binary Responses

	Number	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50 th -Median	75th
Level Completed	308	2.01	0.33	1	3	2.00	2.00	2.00
Basic Aim	308	2.25	0.89	1	4	2.00	2.00	3.00
Non Basic Aim	308	2.64	1.08	1	4	2.00	3.00	4.00
Area of Maths	308	2.70	1.40	1	5	1.00	3.00	4.00

The table 3 above showcases the four items that contained more than two options in their rating scales. It was observed that the majority of the vocational students completed JHS and was unequivocal in getting the training and knowledge to proceed to the tertiary institutions. It was also discovered that 25% liked Algebra, 50% liked Trigonometry and 75% liked Statistics. The students were actually familiar with the topics in Mathematics at the pre-tertiary levels. Policy makers could therefore, explore this opportunity to restructure Mathematics in the Vocational Institutions.

Table 4: Median Runs Test of Significance

	Level Completed	Basic Aim	Non Basic Aim	Area of Maths
Test Value	2.00	2.00	3.00	3.00
Cases < Test Value	16	72	131	137
Cases >= Test Value	292	236	177	171
Total Cases	308	308	308	308
Number of Runs	12	86	100	134
Z- value	- 11.357	- 4.042	- 6.021	- 2.210
Asymp. Sig. (2 -taile d)	.000	.000	.000	.027

The Table 4 above shows the runs tests of significance on the medians. As regards to the level completed before pursuing the vocational programme, more than 292 of the students completed JHS. Also, more than 236 came for training, more than 177 did not get money to pay for SHS education and more than 171 liked to study Statistics if granted the opportunity. Therefore, the runs tests were significant at 5% level of significance.

Table 5: Mean Runs Test of Significance

	Level Completed	Basic Aim	Nonbasic Aim	Area of Maths
Test Value	2.01	2.25	2.64	2.70
Cases < Test Value	290	180	131	137
Cases >= Test Value	18	128	177	171
Total Cases	308	308	308	308
Number of Runs	31	111	100	134
Z-value	-2.044	-4.654	-6.021	-2.210
Asymp. Sig. (2 -tailed)	.041	.000	.000	.027

The Table 5 above shows the runs tests of significance on the means. The results are quite different from the runs tests. Here now, more than 290 of the students completed JHS and more than 180 came for training. However, less than 177 did not get money to pay for their SHS education and less than 171 liked to study Statistics if granted the opportunity. This split decisions result from the fact that the means were affected by extreme values. On the whole, the runs tests were significant at 5% level of significance.

Table 6: Mode Runs Test of Significance

	Level Completed	Basic Aim	Non Basic Aim	Area of Maths
Test Value	2	3	3	4
Cases < Test Value	16	180	131	173
Cases >= Test Value	292	128	177	135
Total Cases	308	308	308	308
Number of Runs	12	111	100	125
Z- value	- 11.357	- 4.654	- 6.021	- 3.206
Asymp. Sig. (2 -tailed)	.000	.000	.000	.001

The Table 5 above shows the runs tests of significance on the modes. There were multiple modes but the mode with the largest data value was used. It was observed that more than 292 of the students completed JHS and more than 177 did not get money to pay for SHS education. However, less than 180 came for training and less than 173 liked to study Statistics if granted the opportunity. The runs tests of the modes were also significant at 5% level of significance.

Table 7: Chi-Square Descriptive Statistics of the Four Non-Binary Responses

	N	Mean	Std. Deviation	Minimum	Maximum	25th	Percentiles 50th (Median)	75th
Level Completed	308	2.01	0.33	1	3	2.00	2.00	2.00
Basic Aim	308	2.25	0.89	1	4	2.00	2.00	3.00
Nonbasic Aim	308	2.64	1.08	1	4	2.00	3.00	4.00
Area of Maths	308	2.70	1.40	1	5	1.00	3.00	4.00

The table 7 above showcases the chi-square describes of the four. The results are consistent with those on table 3 above. It was observed that over 75% of the students completed JHS. They aimed primarily of getting basic training and academic knowledge to continue to the higher levels.

Table 7a: Level Completed

	Observed Number	Expected Number	Residual
PRIMARY	16	102.7	- 86.7
JHS	274	102.7	171.3
SHS	18	102.7	- 84.7
Total	308		

Table 7b: Basic Aim

	Observed Number	Expected Number	Residual
Employment	72	77.0	- 5.0
Training	108	77.0	31.0
Knowledge	108	77.0	31.0
Other	20	77.0	- 57.0
Total	308		

Table 7c: Nonbasic Aim

	Observed Number	Expected Number	Residual
Failure	62	77.0	- 15.0
Non Selection	69	77.0	- 8.0
No Money	96	77.0	19.0
Other	81	77.0	4.0
Total	308		

Table 7d: Area of Maths

	Observed Number	Expected Number	Residual
Algebra	104	61.6	42.4
Geometry	33	61.6	- 28.6
Trigonometry	36	61.6	- 25.6
Statistics	120	61.6	58.4
Other	15	61.6	- 46.6
Total	308		

The tables 7a to 7d above subdivide the chi-square analysis of the four items. We have observed that 7a have 0 cells (.0%) expected frequencies less than 5 with the minimum expected cell frequency being 102.7; 7b and 7c have 0 cells (.0%) expected frequencies less than 5 with the minimum expected cell frequency being 77.0. and 7d have 0 cells (.0%) expected frequencies less than 5 with the minimum expected cell frequency is 61.6.

Table 8: Chi-square Test Statistics

	Level Completed	Basic Aim	Non Basic Aim	Area of Maths
Chi - Square	428.909	67.481	8.649	143.721
Degree of freedom	2	3	3	4
Asymp. Sig.	0.000	0.000	0.034	0.000

The Table 8 above shows the Chi-square tests of significance. The tests were unanimously significant with regards to the level completed before pursuing the vocational programme, basic aim for the training, non-basic aim and areas of Mathematics students liked. These four factors were very important in explaining the circumstances surrounding the students' education and training in the vocational institutions.

Discussions

We discovered that the basic entry requirements into the vocational institutions were the JHS. Interestingly, the same entry requirement was also being used for entry into the senior high schools, secondary technical schools and technical institutes. They could therefore, be allowed to study mathematics and write the same examinations with those parallel counterparts. This ensures that the system laid equal opportunities for every second cycle graduate to compete and enhance his/her lifelong fortunes.

The findings also discovered that the top most priorities of the students were to get general education and training. This major purpose was not different from their counterparts who opt for general education. Once they have these relenting pursuits, coupled with their unceasing interest in mathematics, then introducing them to mathematics would not be a misplaced priority.

Coupled with their quest for general education and training were their unanimity and spontaneous reactions to questions of mathematical pedagogy and content. Majority of the students were unequivocal and unanimous to study mathematics in the Vocational Institutions and beyond. Particularly, their topmost choices of subjects were Algebra, Geometry and Statistics. These broad aspects of Mathematics form the bedrock of the course at any level of education. To revamp the high aspirations of setting up the Vocational Institutions in Ghana, it would be prudent to give this category of students the privilege to explore their full mathematical potentials in the Vocational Institutions.

Conclusions

The study investigated how Mathematics could be restructured in the Vocational Institutions in Ghana. The findings revealed that every vocational student would benefit a lot from any restructuring of the Mathematics content and pedagogy to reflect the insurgencies of high labour competition and unemployment of the times. We must concede that this study did not cover many Vocational Institutions in Ghana.

Recommendations

We therefore recommend a much larger sample size across the ten regions of Ghana to make the findings more representative. This will totally ensure the real need assessment of the Vocational Institutions in the globally competitive labour market. Other recommendations are:

1. To assess the various parts of the mathematics curricula, there must be periodic collaborative policy reviews among the Universities, polytechnic and government to enrich the curricula contents.
2. To enrich the competency and pedagogical skills of trainers and trainees, there must be periodic and continuous training and education for staff of these institutions. We suggested that the professional teaching universities should train the teachers on methods of teaching and the polytechnics on the content knowledge of vocational teachers.
3. To ensure academic progression and favourable competition of vocational graduates, the Ghana Education Service and the West African Examinations Council must synchronize the syllabi to sure that vocational students write similar examinations as their senior high schools' counterparts.

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