Technical and Vocational Education and Training– Curricula Reform Demand in Bangladesh. An Empirical Study of the Curricula of the Diploma-in-Engineering Programme in Bangladesh and the German Initial Vocational Training in the Dual System and the Curricular Effects

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ABSTRACT

This case study investigates the Diploma-in-Engineering (Electronics Technology) curriculum in Bangladesh. It includes student assessment approach and learning/ teaching outcomes, and compares them with Germany's initial vocational training in the Dual System. The required data was collected through a self-designed test and a questionnaire. The test measured mainly students' technical competencies, particularly in the case of practical relevant tasks. Both quantitative and qualitative methodologies were used to analyze the data. A comparison between the polytechnic students and vocational school trainees in Germany at different cognitive levels was made. The findings show that the polytechnic students in Bangladesh perform poorly. It was found that the differences in the categories of Apply and Understand were bigger than the difference in the category of Remember. Furthermore, this study investigated and found that the student assessment approaches in Bangladesh and Germany differ greatly regarding their theoretical requirements and practical relevance. The Diploma curriculum mainly focuses on theoretical matters. Germany's learning field based curriculum in vocational schools focuses on practice oriented learning and teaching, and fosters the trainees' knowledge transfer capability. The current TVET reform in Bangladesh that introduces CBT&A, among others, may address these issues and help Bangladeshi TVET graduates to compete in an international labour market.

Keywords: TVET, VET, German Dual System, Curricula Reform, International Comparison, VET-PISA, Curricular Effect.

1. INTRODUCTION

Technical and Vocational Education and Training (TVET) has been expanding for the last decades in Bangladesh. The *Diploma-in-Engineering* programme of TVET in Bangladesh is offered through polytechnics and leads to a mid-level technical/vocational qualification for technicians (*Diploma engineers, middle level managers*) [13]. There has been a growing consensus that the quality of *Diploma engineers* needs to be improved to international level standards. Therefore, the duration of this programme has been increased from three years to four years in 1999, and the curriculum has been reviewed. However, an assessment of students' competency in the TVET sub-sector and a comparison at intercontinental or regional level has not been made yet. In this study the authors investigate the curriculum of the *Diploma-in-Engineering (Electronics Technology)* program and assess learning/teaching outcomes of the program. The main objective of this study is to compare the competency level of the polytechnic students in Bangladesh (particularly in practical related tasks) on an international level. This should help polytechnic graduates to secure their jobs (or to study) abroad. The research was guided by the following questions: Is the focus of Bangladeshi *Diploma-in-Engineering* curriculum more on practical/ workplace relevant skills and knowledge, or on theoretical knowledge? Are the competences acquired by Bangladeshi polytechnic graduates comparable to those of a developed country, for example Germany? More specifically, how good are Bangladeshi polytechnic students at different cognitive levels (reproduction through transfer) compared to vocational school trainees in Germany? What makes Bangladesh different from Germany particularly in student assessment approaches?

2. SCOPE AND METHODOLOGY OF THE RESEARCH

This empirical study investigates the Diploma-*in-Engineering (Electronics Technology)* curriculum of the Bangladesh Technical Education Board (BTEB) including an approach towards student assessment, assessing learning/teaching outcomes of the program. In order to compare this qualification at an international level the curriculum of German Initial Vocational Training in the *Dual System* was studied, similar occupations (*Electronics Technician for Devices and Systems*

and *Electronics Technician for Industrial Engineering*) were considered as the control group. The German qualification for these occupations corresponds to the International Standard Classification of Education (ISCED) level 3B [11]. The qualification for the *Diploma-in-Engineering (Electronics Technology)* is aligned at level 6 of the Bangladesh National Technical & Vocational Qualifications Framework (NTVQF) (draft) [13]. The entry qualification for both programs of these two countries is ISCED Level 2A/2B.

The required data was collected through a self-designed test and a questionnaire. Consultation with experts, senior teachers, key persons and some students was made too. The survey (data collection) was conducted in vocational schools (*Berufsschulen*) in Baden-Württemberg, Germany (N = 160) and in polytechnic institutes in Bangladesh (N = 160) within the period from July 2009 to February 2010. The competence test measured mainly students' technical competencies, particularly in the case of practical relevant tasks. Both quantitative and qualitative methodologies were used to analyze the data.

3. DESIGN AND DEVELOPMENT OF THE TEST

Only the technical competence was measured under this work. This is because it is very time consuming to measure all the components of occupational competence. On top of that technical knowledge/competence is the strongest predictor of the ability to solve technical problems [8, 14, 15]. It has been proved that domain-specific knowledge (e.g. knowledge about constituent elements of the upcoming learning fields) is usually the largest contributor to the explanation of variance of the learning success, or to the predicted future development of individuals [9, p. 128]. Therefore, the test integrated enough easy questions, as well as some test elements that have middle level requirements, and some test elements that demand a relatively higher level of knowledge.

As this work concentrates on a particular field, e.g. electronics technology, the test was designed to capture students' electro-technical knowledge and competences in core areas and also in areas of specialisation. They are to be mastered by the learners in principle and represent the basis for the development of vocational competence. Furthermore, as the main objective of this study was to measure students' competencies in workplace relevant situations, the emphasis was to design questions predominantly as "practical" and "real-world" situation tasks.

In Germany it is common that students use a handbook/ an Engineers' data reference book (Tabellenbuch) in the classroom and also in the examination. This is not the casein Bangladesh. Here a student must recall all the factual information he/she requires to solve a problem in the examination, if not supplied as data sheet together with a question paper. The questionnaire was designed in such a way that students are able to answer the questions without such a reference book. Necessary data sheets were supplied.

All students (Bangladeshi and German) were presented the same questions (vollstaendige Aufgabendarbietung; [16, p. 79], however, for Bangladeshi students the language of the testwas English. A translated Bengali version of the test was also supplemented. The language of the test was German for the trainees in Germany.

4. VALIDITY OF THE TEST

To validate the test, a questionnaire regarding the test items was presented to the experts/ teachers both in Bangladesh and Germany. These teachers/ experts have a long teaching and/or industry experience in the field of electronic technology. They were asked whether the subject content/ topic regarding a particular task was taught in the classroom, in the in-company training or whether it was part of the syllabus (Lehrplan) at all. Furthermore, this questionnaire asked about: the probability that the students can solve the task, the degree of complexity, comprehensibility and the workplace relevancy for the occupation *Electronic Technician*. The teachers/experts have assessed the test items on the basis of a five-point rating scale.

5. RESULTS

The results of the test show that the competency level, *in the case of application-oriented tasks*, achieved by the polytechnic students/graduates in Bangladesh at the end of the four year Diploma-in-Engineering course is lower than that of the vocational school (Berufsschule) trainees in Germany at the end of the three-and-a-half-year Apprenticeship Training in the Dual System. In other words, Bangladeshi polytechnic students lag clearly behind the German apprentice trainees. The students of polytechnic institutes in Bangladesh obtained only 9.27 points out of a total 100, while the trainees of vocational schools in Germany obtained 36.42 points, on average. That means the polytechnic students in Bangladesh obtained only a fourth of the points that the German vocational school trainees obtained in the competence test. Figure 1 and 2 show the histogram of points obtained by polytechnic students and vocational school trainees.

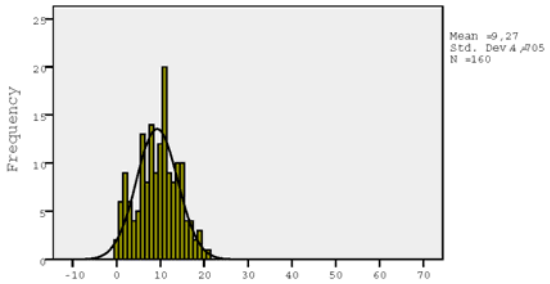

Figure 1: Histogram of points obtained by polytechnic students in Bangladesh

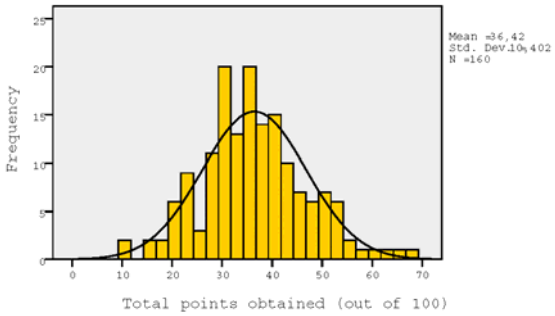

Figure 2: Histogram of points obtained by vocational school trainees in Germany

The "two-sample t-test" was carried out. The findings of this "t-test" are given in table 1.

Table 1: Comparison of student achievement (overall) in competency test: results oft-test and measures of effect size.

	Mean	SD	Min	Max	t	df	p	η_p^2	Cohen's d
Bangladesh	9.27	4.71	0.0	21.0	-30.1	221.5	<0.001	0.74	3.60
Germany	36.42	10.40	10.5	68.0					

The various parameters of this test are: t = −30.08 (the negative sign indicates that Bangladeshi polytechnic students lag behind the German vocational school trainees), the degree of freedom, df = 221.45, the significance (two-tailed), p < .001. In this case, the estimated p is very much less than the normally accepted significance level of 0.05 (significant) and/or 0.01 (very significant) [2,3].This proves that the probability of these two average values being equal is strongly rejected.The effect size is estimated and expressed by the partial eta-squared, η_p^2, which is 0.74 and indicates a large effect (>> 0.14). Cohen's d of 3.60also is high compared to 0.80 (large effect) (Bortz, 2005, p. 143).

These findings support experts' and teachers' opinions (who work in the TVET sector in Bangladesh), who are in doubt about the practical competences of the polytechnic graduates. They blame the lack of prior-knowledge and basic competences of students at the entry-stage of the course. They also complain that there is a lack of teachers who regard their profession as a vocation. However, the learning environment that includes, among other determinants, the curriculum and its complexity level, plays a significant role in developing students' competencies. An inadequate curriculum (too complex or too simple or not yet properly tuned) may hinder the development of students' competencies [6, p. 10; cf. 7, p. 123].

This study also examined students' competencies at different levels of cognitive processes. The findings showed that the tasks which require only a reproduction of knowledge (level 1: the cognitive process category of *Remember*) are more likely to be solved than the tasks which require knowledge transfer and/or knowledge production (level 3: the cognitive process category of *Apply*). Students' performances in solving the tasks in the cognitive process category of *Remember* (reproduction) and the category of *Understand* (re-organisation) were found to be almost the same (see Figure 3).It was found that the mean difference between the categories Remember and Understand is only1.1% and is not significant (p = 0.788). The category Apply differs significantly from Remember by −9.8%, p < .001 and from Understand by −10.8%, p < .001.

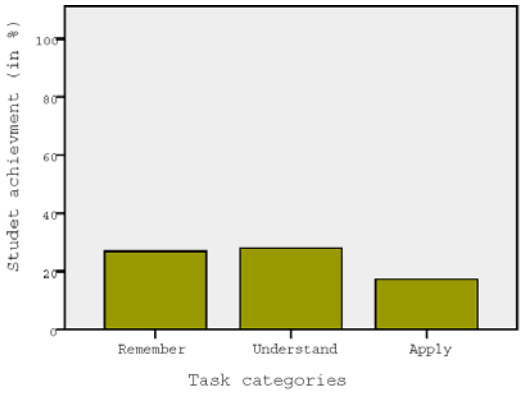

Figure 3: Student performance in different cognitive process categories

Student/trainee performance in the categories of Remember and Understand were almost the same. These can be explained as follows:

1. German trainees are used to using Handbooks (Tabellenbuch) during their exams. Often they do not have to retrieve relevant knowledge (factual information) from long term memory, particularly during the examination or test. However, in this competency test handbooks were not allowed.
2. The situation in Bangladesh is different. Handbooks are not allowed here. A student is to remember/ recall the knowledge (factual information) required to solve a task, unless it is supplied.
3. Item classification (according to Bloom/ Anderson & Krathwohl's Taxonomy of learning objectives)is often difficult (ambiguous). Firstly, a task often requires a combination of two or more knowledge categories which are often not separable and, secondly, the level of complexity of a task highly depends on an individual's prior knowledge and/or proficiency, i.e. if he/she has performed the same or a similar task previously.

The students'/trainees' competence level at the category of Apply was found to be much lower than the competence level at the other two categories – Remember and Understand. The solution of a task at the level of Apply usually requires the student to use his/her abstract (prior) knowledge in a specific situation. The results indicate that most of the students/trainees were unable to transfer their knowledge to the actual situations given in the tasks or they did not have the required prior knowledge.

A comparison between the two countries at different cognitive process levels was made. The findings of this comparison are shown in Figure 4. The statistics are given in Table 2. In the diagram it is seen that the Bangladeshi polytechnic students lag far behind the German vocational school trainees not only on the cognitive process level *Apply* (level 3) but also on the levels of *Understand* and *Remember*. However, the differences between the two countries in the categories of *Apply* and *Understand* are bigger than the difference in the category of Remember. In the category of *Apply* mean difference in performance of Bangladeshi polytechnic students and German vocational school trainees were -29.3% (average points: Bangladesh2.6% and Germany 31.90%), in the category of *Understand* it was -36.2% (Bangladesh 10.0%,Germany 46.2%) and in the category of *Remember* it was -17.7% (Bangladesh18.2%,Germany 35.9%). The variance analysis (ANOVA) confirms these findings with significance, p < .001% (see Table 3).

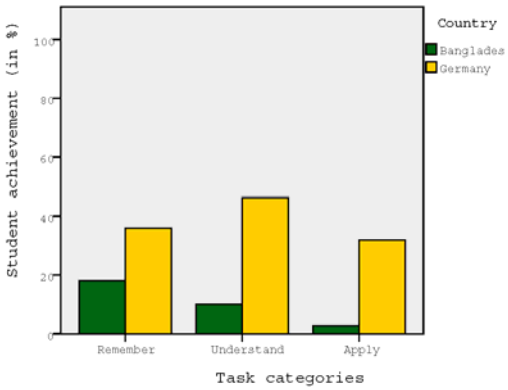

Figure 4: Student performance in different cognitive process levels.

Table 2: Comparison of student achievement on different levels of the cognitve process.BD = Bangladesh, DE = Germany

Cognitive Process Levels	Points (in %)		SD		Med		Mod		Min/Max	
	BD	DE	BD	DE	BD	DE	BD	DE	BD	DE
Apply	2.6	31.9	2.9	13.9	2.2	31.9	0	17.6	0/11.0	2.2/76.9
Understand	10.0	46.2	8.2	16.2	8.9	46.7	4.4	55.6	0/37.8	4.4/86.7
Remember	18.18	35.9	10.1	11.4	18.8	34.4	21.9	43.8	0/51.6	12.5/71.9

Table 3: Effects of within "Task Categories" and between countries

Sources of variation	N	F	df	p	η_p^2
Country	160	891.83	1, 318	$< .001$	0.74
Task category	160	130.76	2, 636	$< .001$	0.29
Task category*Country	160	79.86	2, 636	$< .001$	0.20

6. ANALYSIS OF CURRICUMUM

The analysis of the curricula of both countries shows: the content of the four year *Diploma-in-Engineering* curriculum/syllabus in Bangladesh is inflexible *and* organized according to subjects. It is delivered through polytechnics (full-time schooling) with only 12 weeks of in-company training. The content of the syllabus was categorised as: domain specific/ technical subjects, mathematics and natural science, other related subjects, and the industrial attachment training. The lesson hour and credit distributions are shown in Figure 5. It was found that 56.0% of the total lesson hours and55.4% of the total credit points relate to domain specific/ technical subjects, 16.3% of the total lesson hours and 18.7% of the total credit points cover mathematics and natural science,14.3% of the total lesson hours and 22.2% of the total credit points are attached to other related subjects, 13.3% of the total lesson hours and 3.6% of the total credit points are allocated for the industrial attachment training[1, 3].

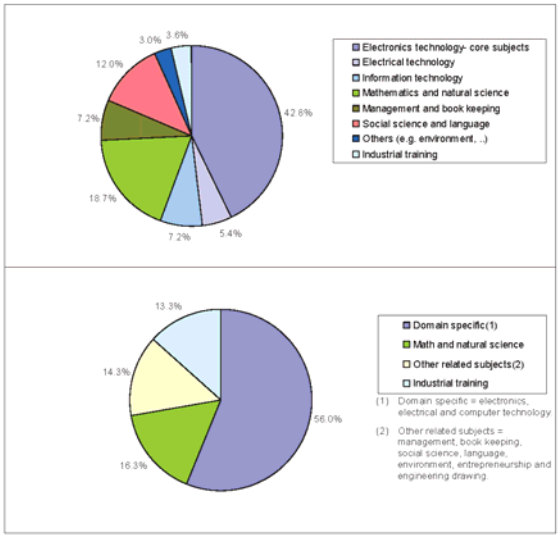

Figure 5: Categories of subjects in the Diploma-in-Engineering (Electronics Technology) syllabus: according to allocated credit points (above), according to allocated lesson hours (below).

The *Initial Vocational Education and Training in Dual System* in Germany is provided at two learning places: vocational schools (part-time schooling) and companies. The curriculum for vocational schools is flexible and *Learning Field* (Lernfeld) based [8; 9]. The lesson hour distribution of this curriculum is shown in Figure 6. About three-fourth (74.3%) of the total lesson hours are allocated for in-company training, the rest (25.7%) of the time is spent at vocational schools [2, 3].

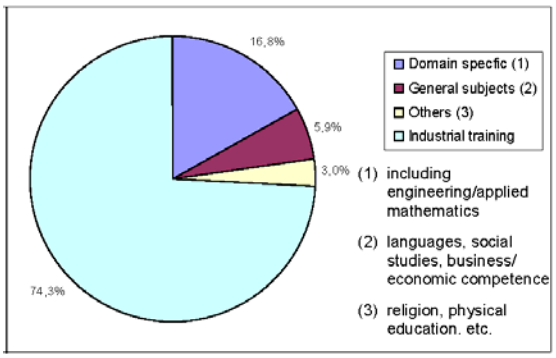

Figure 6: The lesson hour distribution of the curriculum for "Electronics Technician (Devices and Systems)" in Germany.

7. STUDENT ASSESSMENT APPROACHES

Furthermore, we discovered that the student assessment approaches in Bangladesh and Germany differ greatly regarding their theoretical requirements and practical relevance. In Bangladesh question items assess mainly students' theoretical knowledge (knowledge reproduction). That means question items are constructed in such a way that they rarely demand 'transfer' level skills. We categorized the question items of the last three years based on Bloom's Taxonomy of Educational Objectives [5]. The percentage of the test-items in the categories *Remember*, *Understand* and *Apply* were found to be 51%, 43.9% and 5.1%, respectively [3, p. 82 - 83] (see Figure 7).

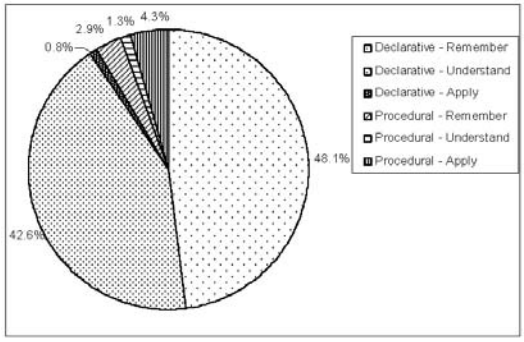

Figure 7: The percentage of items in the final examination question paper in Bangladesh (classified according to Anderson & Krathwohl taxonomy).

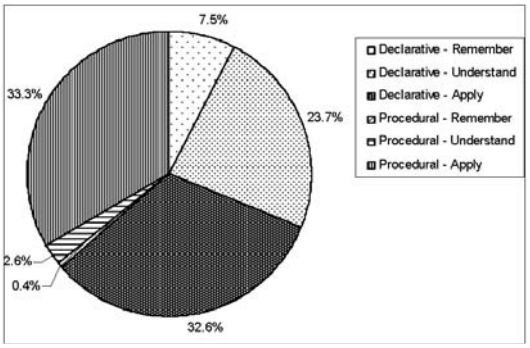

Figure 8: The percentage of items in the final examination papers in Germany (classified according to Anderson & Krathwohl taxonomy).

In Germany the tasks in the examination question papers are practical as well as situation oriented. Mostly, at the beginning of an exam, a project within a learning situation is described. This is followed by a set of questions, mainly regarding this project. Also here we analyzed the questions/ items of the final examinations. Results showed that65.8% of the question items belong to the category *Apply*, 26.3% to the category *Understand*, and only 7.9% to the category *Remember*, according to Bloom's [5] taxonomy.

The findings of the examination questions analysis clearly indicate that little emphasis is placed on transfer-based tasks in Bangladesh compared to Germany.

8. CONCLUSION

The curriculum content analysis, the analysis of student assessment and the competence test results showed that the *Diploma-in-Engineering* curriculum in Bangladesh mainly focuses on theoretical matters. The learning field based curriculum of vocational schools in Germany focuses on practice-oriented learning and teaching, and fosters the trainees' knowledge transfer capability.

Finally, we identified the strengths and weaknesses of the current *Diploma-in-Engineering (Electronics Technology)* curriculum in Bangladesh, and made some suggestions to modernise it accordingly.

However, if the quality of a curriculum is good, then the outcomes depend on the quality of its delivery processes, as well as institutional and individual context factors. We suggest future studies pay more attention to the outlined areas.

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