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A spectrum analysis of an objective-oriented English vocabulary for the technological and vocational college/university programmes

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ABSTRACT: The purpose of this study is to design systematically tan English course in school-based curricula in technological and vocational college/university (TVCU) programmes so that graduates can communicate fluently with professionals in native English speaking nations. The first step in the systematic design of the English courses is to make a spectrum analysis of an English vocabulary for vocational use in the TVCU programme. The adequate vocabulary for vocational use should be computed and put into the contents of English textbooks to make students learn English more practically. The English abilities in TVCU programmes are based on the 17 occupational specialties according to Taiwan's Ministry of Education; these have been divided into seven occupational groups. Through the spectrum analysis, all vocabulary in TVCU programmes can be organised into common English and the seven occupational groups. Further, textbooks can be based on this vocabulary. The English courses are designed by the objective-oriented principle, which aids in the curriculum design of TVCU programmes planned to be put into practice in 2005. It is envisaged that the globalising pace in Taiwan will be sped up in order to connect with the countries around the world due to the analysis and curriculum design.

INTRODUCTION

Communication in English is one of the essential elements of globalisation. Technologies and the social sciences will influence the non-Native English Speaking Nations (non-NESN) because of these fields' emphasis on English communication. These kinds of communications are very important to such countries, because such information will contribute significantly to the progress of non-NESNs. Furthermore, English has become the default official language of the Internet [1]. The applications of very fast developing information technology (IT) on the Internet provide the dominant knowledge sources in developed and developing countries, that is, the English proficiency level of a country will decide its development in the knowledge-based economy, thereby affecting the level of economic growth [1-4].

In Taiwan, a policy for globalisation has been proposed and stressed for a long time. Because Mandarin and some dialects are widely used in daily life, the general level of English in Taiwan cannot be matched with that found in some Native English Speaking Nations (NESN). Undoubtedly, the rapid changes of technology that started in the 20th Century will accelerate even faster in the 21st Century [5]. Some of these rapid changes stem from international cooperation. From the viewpoints of globalisation, the English proficiency level in Taiwan should be elevated to approach the level of NESNs. The Ministry of Education in Taiwan has planned the design of English courses from elementary schools in order to elevate the English level to bridge this gap. Therefore, English courses should be properly designed and executed during this process of globalisation.

The effectiveness of English teaching affects directly the pace of globalisation. The school-based curricula in the technological and vocational education systems have been developed by the Ministry of Education to cope with the rapid changes in this age of the knowledge-based economy [6][7]. These curricula have been divided into 17 so-called *occupational specialties* (see Appendix 1) [8][9].

It is envisaged that such a new school-based curricula will be put into practice in 2005. Correlations among the school systems in TVCU programmes in Taiwan are shown in Table 1. Current 18 year-old students will work on the 2-year technological and vocational college/university (TVCU) programme, while 16 year-old students will work on the 4-year TVCU programmes. Since students study English at the junior high school level (about 12 years old), their English level could not be sufficient to handle all the elements of globalisation related to English

Table 1: Correlations between the school systems in Taiwanese TVCU programmes.

<table>
<tr><td colspan="3">Technological and Vocational Education Systems</td><td>Age</td></tr>
<tr><td colspan="3">Graduate Schools from TVCU Programmes</td><td>Over 23</td></tr>
<tr><td rowspan="3">4-year Technological and Vocational College/University</td><td colspan="2">2-year Technological and Vocational College/University</td><td>22</td></tr>
<tr><td colspan="2"></td><td>21</td></tr>
<tr><td rowspan="3">2-year Junior College of Technology</td><td rowspan="5">5-year Junior College of Technology</td><td>20</td></tr>
<tr><td rowspan="3">Vocational High School</td><td>19</td></tr>
<tr><td>18</td></tr>
<tr><td></td><td>17</td></tr>
<tr><td></td><td>16</td></tr>
</table>

after they graduate from 2-year or 4-year TVCU programmes. When they study within school-based curricula, instructors cannot teach them in the same way as those in NESNs.

English is one of the core courses of the 17 occupational specialties. It is needless to say that English plays a very important role in this age of the knowledge-based economy [10]. Therefore, English courses should be systematically designed utilising the objective-oriented method. The purpose of this study is to design systematically school-based curricula for students in TVCU programmes. After graduating, they can operate using several occupational specialties to communicate with professionals in NESNs smoothly, thereby speeding up the pace of globalisation.

SYSTEMATIC DESIGN OF ENGLISH COURSES USING A SPECTRUM ANALYSIS

The first step in the systematic design of English courses is to undertake a spectrum analysis of an English vocabulary in TVCU programmes. The vocabulary is the basic element of English courses. The adequate vocabulary for vocational use should be computed and then put into the contents of English textbooks in order to make students learn English more practically.

The English vocabulary in TVCU programmes could be based on the 17 occupational specialties, before dividing it into seven occupational groups. The vectors of a spectrum analysis in this regard are shown in Figure 1. Through the spectrum analysis, all vocabulary in TVCU programmes can be organised into common English and, from there, into seven occupational groups. Therefore, English textbooks of the seven occupational groups should be redesigned according to the respective vocabulary of each of the seven occupational groups, including common phrases and grammar. English courses should then be designed utilising the objective-oriented principle in this study.

Figure 2 illustrates the concept of objective-oriented principle: an electronic product engineer (EPE) in a NESN wants to communicate with another EPE in a non-NESN. English is naturally to be the means of communication. Generally speaking, the EPE in the NESN uses common English, as well as professional English including ECE, MEC, MBH and DSN, in order to communicate with the EPE in the non-NESN. In this case, how should the English courses for the EPE be designed in Taiwan?

There are two ways to achieve this goal. The first one is to design electives depending on the vectors of the spectrum, such as ECE occupational group English, MBH occupational group English, etc. Full-time students who seek to become an EPE, or those part-time students who are EPEs, can just take the electives designed, thereby elevating their English level rapidly and effectively.

The other option is for those full-time electronic engineering students who do not know what kind of job they will take; they can take the common English courses and their professional ECE English. If they want to be EPEs after they graduate, their English may not be good enough to work with EPEs in NESNs. Therefore, they should cooperate with some people who have abilities in the MEC, MBH, and DSN occupational groups to work with EPEs in NESNs.

OVERVIEW OF THE ENGLISH CURRICULUM IN THE TECHNOLOGICAL AND VOCATIONAL EDUCATION SYSTEM

Figure 3 displays the English curriculum overview developed from the spectrum in Figure 1 for technological and vocational education systems. The technological and vocational vocabulary and terminologies have been added, little by little, to the curricula in TVCU programmes. Common English is being taught at high schools (HS) and vocational high schools (VHS).

AG	MF	WF	MP	NS	FD	CHE	EE	ME	PME	CAE	ICD	ART	MB	HE	HM	FL
AGF			MED		CHE		ECE	MEC			DSN		MBH			
CE																

Figure 1: The vectors of the spectrum analysis of English for school-based curricula for TVCU programmes. The occupational groups are as follows: AGF: Agriculture and Fishery; MED: Medicine; CHE: Chemistry; ECE: Electrical and Computer Engineering; MEC: Mechanics; DSN: Design; MBH: Management, Business, and Hotel; and CE: Common English.

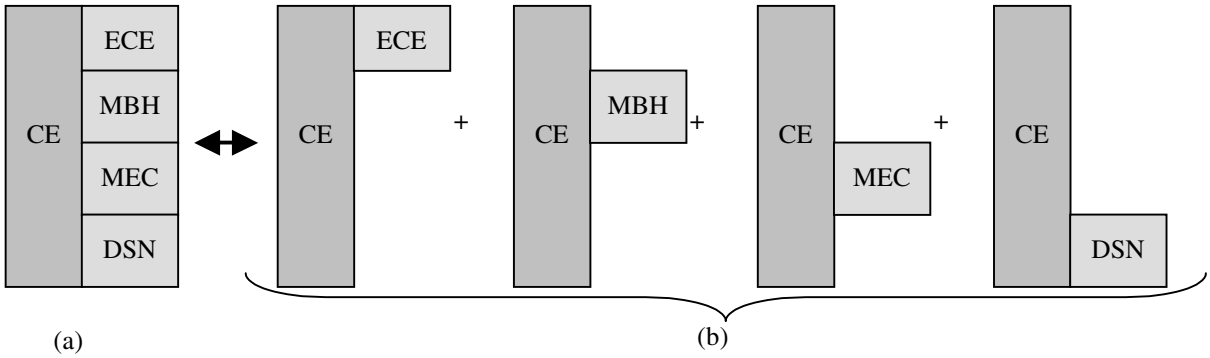

Figure 2: An illustration of the systematic design for English courses - (a) The abilities of the electronic product engineer in an NESN; (b) The systematic design of the English courses in a non-NESN to combine students' English abilities of the four occupational specialties to communicate with the electronic product engineer in (a).

System	Year	Courses																
TVCU	1-4	AG	MF	WF	MP	NS	FD	CHE	EE	ME	PME	CAE	ICD	ART	MB	HE	HM	FL
	2	TVE(AGF)			TVE(MED)		TVE(CHE)		TVE(ECE)	TVE(MEC)			TVE(DSN)		TVE(MBH)			
	1	CE(added ADF, MED, CHE, ECE, MEC, DSN, MBH)																
HS/VHS	3	CE																
	2																	
	1																	

Figure 3: The English curriculum overview is developed from the spectrum for technology and vocational education systems (HS/VHS: High School/Vocational High School, TVCU: Technological and Vocational College/University). The technical and vocational vocabulary and terminologies are added gradually to the curricula in TVCU programmes.

Common English courses should have some technical and vocational materials added that are related to several occupational groups in TVCU programmes, especially simple professional terminologies. Due to this kind of curriculum design, the common English curriculum links between HS, VHS and TVCU will be very helpful. Some electives in technical and vocational English, depending on individual occupational groups (TVE(OG)), are designed for the 2nd year of TVCU programmes in order to elevate students' English in their respective fields. Some basic professional courses in English textbooks, handouts and multimedia are selected each semester.

For example, the vocabulary classification according to the spectrum is shown in Table 2. The vectors of the spectrum comprise the seven occupational groups. All of the vocabulary in TVCU programmes should be designed for common English and the seven occupational groups. The column called *Common Professional Vocabulary* shows that some of the words are simple. In fact, the real meanings of the professional vocabulary are difficult for the students. These vocabularies should be taught in their respective professional courses or electives, such as ECE English, and MBH English. This kind of design would help facilitate communication between professionals in NESNs and those in non-NESNs. Applying the combinations of the spectrum in non-NESNs can also help in communication with people in NESNs, as shown in Figure 4. Teamwork in non-NESNs for professional English communication is very important. It is expected that the design of English courses in TVCU programmes should speed up the pace of globalisation and increase the prosperity in Taiwan.

FREQUENTLY USED VOCABULARY IS DEPENDENT ON STUDY FIELDS

English is a language of social empowerment, as knowledge of English is a passport to gaining a better job. Conversely, the inability to speak and write in English is a disadvantage; millions of young people spend thousands of hours trying to improve their English abilities. However, some researchers warn that the majority of these people waste their time learning English because they will not have the chance to use it in their future careers [11]. There are many books in non-NESNs that are concerned about daily-used vocabularies. Many students in non-ENSNs work hard studying them, but most students forget much of these vocabularies because they use their native language in their daily life.

A popular textbook by Stallings in departments of ECE is titled *Computer Organisation and Architecture* [12]. A recent study found that this has 112,508 words, but that the number of the vocabulary in this book is only 6,695 [13]. This means a lot of vocabulary is repeatedly used in this textbook. In fact, most of the technological and vocational documents have the aforementioned characteristics because simple and clear writings are the requirements of technological documents. The number of individual vocabulary in this textbook can be found that the top-sorted 700 vocabulary have been presented in 80% of the total 112,508 words in the textbook. The statistical results are shown in Figure 5 and Table 3. Given these results, the concept of a vocabulary spectrum is verified.

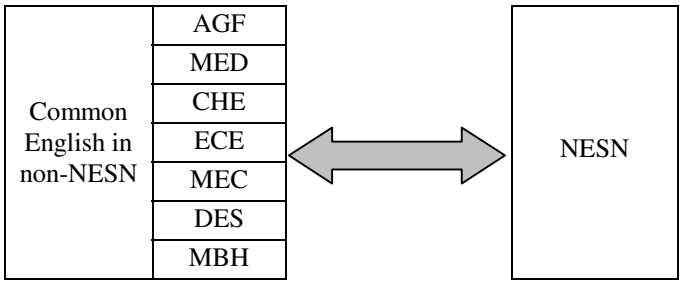

Figure 4: Application of spectrum combinations to aid communication with people from NESNs.

Table 2: Correlations between the school systems in TVCU programmes.

Occupational Group	Common Vocabulary	Common Professional Vocabulary
AGF	growth, vegetable, culture	*soil amelioration*, fertility
MED	medicine, clinics, doctor	*action potentials*, transcription
CHE	atom, silicon, pollution	*fused ring*, *chemical affinity*
ECE	system, signal, communication	algorithm, synchronous
MEC	force, architecture, design	strain, *ball screw*, rigidity
DES	view, picture, drawing	mould, *depth of the field*, landscape
MBH	statistics, management, secretary	*diffusion index*, *earnings yield*

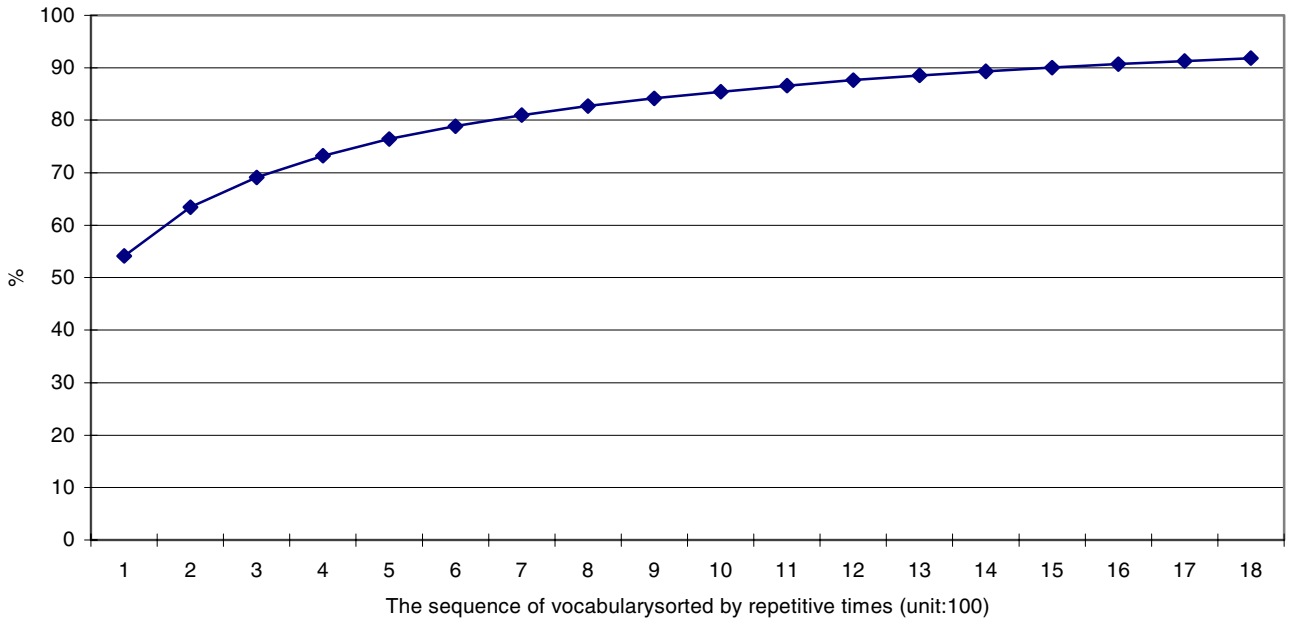

Figure 5: The accumulation of the presented percentage of the top 1,800 sorted vocabulary in the textbook [13].

Table 3: The top sorted 104 vocabulary of the textbook by Stallings (ref. [12]) and their frequency of appearance [13].

Rank	Vocabulary	Frequency of Appearance	Rank	Vocabulary	Frequency of Appearance	Rank	Vocabulary	Frequency of Appearance
1	the	8,827	35	each	409	70	then	220
2	of	3,935	36	registers	387	71	when	219
3	A	3,369	37	if	381	72	2	217
4	is	2,916	38	figure	367	73	access	217
5	to	2,821	39	which	363	74	addressing	217
6	and	2,425	40	number	356	75	4	213
7	in	2,249	41	at	353	76	table	212
8	that	1,200	42	two	352	77	other	200
9	are	1,132	43	bits	344	78	main	199
10	for	1,120	44	time	333	79	only	193
11	be	1,100	45	1	321	80	branch	189
12	this	964	46	there	317	81	process	189
13	memory	958	47	we	317	82	line	187
14	as	898	48	not	316	83	example	185
15	instruction	862	49	use	314	84	also	181
16	an	800	50	more	282	85	bus	181
17	data	746	51	operation	269	86	operating	176
18	0	740	52	computer	259	87	operations	173
19	with	734	53	set	259	88	because	170
20	or	716	54	all	258	89	chapter	167
21	on	623	55	control	257	90	same	166
22	can	595	56	may	257	91	12	165
23	it	552	57	these	256	92	interrupt	165
24	register	496	58	must	245	94	module	165
25	one	489	59	bit	244	95	word	165
26	by	487	60	into	237	96	thus	163
27	processor	481	61	program	237	97	3	154
28	address	470	63	will	235	98	so	153
29	used	434	64	have	234	99	result	151
30	instructions	428	65	has	232	100	execution	150
31	from	423	66	some	227	101	organization	150
32	system	421	67	disk	226	102	between	149
33	cache	412	68	than	223	103	performance	147
34	I/O	411	69	most	220	104	8	146

As listed in Table 3, some terms, such as *register* (rank: 24; frequency: 496) and *cache* (33; 412), are not words that are used daily, yet they have a high-ranked weight in the technical textbook. Therefore, technical and vocational vocabulary and their terminologies can be gradually added to the curricula in TVCU programmes, utilising the objective-oriented principle. Although the English courses may be repeated in technological and vocational courses, it should nevertheless make students learn technical and vocational English effectively in order to arouse their interests in English studies.

The spectrum identifies the pathway of self-study. For example, the junior EPE mentioned above, whose English level may not be sufficient to work with an EPE in an NESN, should, therefore, cooperate with some persons who have abilities in MEC, MBH and DSN in order to work with EPEs in NESNs. However, Figure 3 and Table 2 indicate that they can study the MEC, MBH and DSN English vocabularies by themselves. Furthermore, this spectrum helps part-time students, who are studying school-based curricula of TVCU programmes, to elevate their English proficiency levels on their jobs.

This curriculum design is based on a spectrum analysis of the vocabulary. The teaching materials of the seven occupational groups are made up of the classified vocabulary, grammar and phrases. Therefore, the teaching contents are suited to the seven occupational groups, respectively. From students' viewpoint, it makes them learn directly and effectively. One method to determine the vocabulary for vocational use is to build vocabulary databases. In this way, the frequency of vocabulary for vocational use can be computed and words classified into the seven occupational groups, respectively [8]. The source can be professional textbooks, documents, manuals, user guides, Web sites, technical notes and others. After computing a frequency, grades can be allocated to each vocabulary. Moreover, the higher frequency words in this vocabulary database should be presented in first year English for individual occupational groups. Further research will take much time and requires additional experts to take part in the programme.

Generally speaking, the contents of the admission examinations lead the teaching in schools of Asian countries, such as Japan, Korea, China and Taiwan [14]. The English course in the admission examinations for TVCU programmes is the required course in all of the aforementioned countries. As a consequence of the concept of the vocabulary spectrum, it is proposed that the contents of the required course in English in admission examinations should be tested according to the vocabulary spectrum that they have majored in. This will increase students' interest in studying English in non-ENSNs, because of the repetitive use of the vocational vocabulary. The results from a questionnaire show that, in Taiwan, employees' salaries are dependent on their English abilities [15]. English is a passport for obtaining a better job [11]. This means that the better a person's English proficiency is, the higher his/her salary. This phenomenon illustrates how English abilities play an important role in globalisation, and is thought to be very common in most non-NESNs. Therefore, effective English teaching is a shortcut to enhancing globalisation. Classifications from the vocabulary spectrum in Table 1 could be a pathway to help students learn English effectively, thereby augmenting their qualifications and incomes as well.

The four processes of globalisation are mobility, simultaneity, bypass and pluralism [16]. This study helps members of multinational enterprises communicate in a face-to-face manner. This also encourages people to take part more directly in business behaviours in these kinds of companies so as to increase efficiency. The better the English proficiency level of workers, the greater the global acceptance people will gain. Therefore, the language prerequisite of the four aforementioned processes needs to be considered.

Internationalised people have 3C characteristics, namely:

- *Concepts*: people have the ability to acquire advanced concepts, information and knowledge for their jobs;
- *Competence*: people display stiff competitiveness in performing their tasks to a high standard;
- *Connections*: people have the ability to make extensive contacts with the worldwide enterprises and organisations in order to obtain resources in their fields [16].

The strategy of a vocabulary spectrum analysis provides a shortcut in training internationalised professionals. Further, technological globalisation does not imply any need for a change or shift in the fundamental characteristic of engineering as an activity, and does not conflict with engineering practice [17]. Therefore, the applications of the vocabulary spectrum should help entrepreneurs easily gain globalised personnel. The designs of technological and vocational English curricula can be adjusted to suit each individual country.

International and comparative analyses can help provide insight into how to deal with global challenges, and provide national responses for a particular country [18]. Table 4 lists the number of employees hired by industries in Taiwan [19]. It shows that the total percentage for manufacturing (26.97%), trade (17.64%), constructions (7.22%), agriculture, forestry, fishing and animal husbandry (7.18%), and hotel and catering (6.13%) is over 64%. It is expected that the percentage of employees in each individual industry will be stable for several years. Moreover, the major exports and imports for Taiwan, as well as export and import countries that trade with Taiwan, are shown in Figure 6 [20].

Table 4: The number of employees by industry in Taiwan in October 2003 (total: 9,613,000 persons) [19].

Industry	Persons	Percentage
Agriculture, forestry, fishing and animal husbandry	690,000	7.18%
Construction	694,000	7.22%
Culture, sports and recreation	190,000	1.98%
Education	529,000	5.50%
Finance and insurance	370,000	3.85%
Health care and social welfare	288,000	3.00%
Hotel and catering	589,000	6.13%
Manufacturing	2,592,000	26.97%
Mining and quarrying	8,000	0.08%
Profession, science and technology	280,000	2.91%
Public administration	386,000	4.01%
Public utilities	35,000	0.36%
Real estate rental and leasing	73,000	0.76%
Trade	1,696,000	17.64%
Transportation, storage and communication	494,000	5.14%
Other services	699,000	7.27%

Legend	Representation	Major Import Countries	Major Export Countries
	Major Exports	USA 23%, Hong Kong 22%, Japan 10%, Germany 4%, the Netherlands 3%, Singapore 3%	Japan 24%, Hong Kong 17%, USA 17%, South Korea 6%, Germany 4%, Malaysia 4%
	Major Imports		
	Major Imports and Exports		
	Non-Major Imports and Exports		

Figure 6: The major export and import industries for Taiwan, as well as export and import countries trading with Taiwan.

English is the prime communication means for most of the major import and export countries that Taiwan deals with. The major import and export industries are manufacturing (CHE, EE, ME, PME), agriculture, forestry, fishing, animal husbandry (MF, WF), trade, hotel and catering (MB, HE, FL), that is, the major import and export industries are coherent with the major employees of the individual industry. Therefore, it is necessary that employees in major import and export industries are able to emphasise their English abilities.

It is reasonable to consider that more than half of the students currently in school will be employees in major import and export industries, ie some of them will take jobs that are not their majors. Therefore, English courses in TVCU programmes should be designed to include some materials about the major import and export industries of Taiwan in order to meet the needs of enterprises. The concept of a vocabulary spectrum can aid in the design of the contents of an English course curriculum that can meet the technical and vocational English proficiency levels required of employees and current students.

The major exports and import industries for Japans, as well as the export and import countries that Japan deals with, are shown in Figure 7. In comparing Figure 6 with Figure 7, one can ascertain that there are some differences between Japan and Taiwan with regard to their major imports and exports. Therefore, the design of technological and vocational English curricula can be adjusted to suit each individual country. It is proposed that there be an institution established to build a standard of the vocabulary spectrum.

On the other hand, future engineering education provides an encompassing *global* perspective for engineering design that incorporates technical, social, economic, political and environmental considerations [21]. Therefore, important and potential new technologies have to be emphasised, eg IT, MENS and biomedical technology. Naturally, interrelated vocabulary should be integrated into English textbooks.

It is envisaged that the design of VET programmes in respective occupational groups will help students to focus on learning English in order to meet the needs of their future jobs. Generally speaking, students in the technological and vocational education systems prefer technological and vocational courses over English courses. This policy will also help facilitate increased student efforts with regard to English learning so that they may follow the trend of globalisation.

CONCLUSION

Communication in English is one of the essential components of globalisation. In this article, it is proposed that a spectrum analysis of an English vocabulary for professionals be undertaken to facilitate and enhance communication between people from NESNs and non-NESNs.

The English curriculum overview of TVCU programmes is developed from the spectrum given in Figure 1. This method is helpful in the curriculum design of TVCU programmes that are to be implemented in 2005. Due to the analysis and curriculum design, it is anticipated that the pace of globalisation will be accelerated.

Legend	Representation	Major Import Countries	Major Export Countries
	Major Exports	USA 31%, Taiwan 7%, Korea 6%, China 6%, Hong Kong 5%	USA 33%, China 14%, Korea 17%, Australia 4%, Taiwan 4%
	Major Imports		
	Major Imports and Exports		
	Non-Major Imports and Exports		

Figure 7: The major export and import industries for Japan, as well as export and import countries trading with Japan.

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APPENDIX 1

The 17 occupational specialties of the school-based curricula in the technological and vocational education system are listed below [7][8].

Occupational Specialties	Abbreviation
Mechanical Engineering	ME
Power Mechanical Engineering	PME
Electrical and Electronic Engineering	EE
Chemical Engineering	CHE
Civil and Architecture Engineering	CAE
Management and Business	MB
Agriculture	AG
Home Economics	HE
Hotel Management	HM
Marine and Fishery	MF
Water Fowl	WF
Medicine and Pharmacy	MP
Nursing	NS
Arts	ART
Industrial and Commercial Designs	ICD
Food	FD
Foreign Languages	FL

Conference Proceedings of the *6th UICEE Annual Conference on Engineering Education* under the theme: *Educating for the Right Environment*

edited by Zenon J. Pudlowski

The *6th UICEE Annual Conference on Engineering Education*, under the theme of *Educating for the Right Environment*, was organised by the UNESCO International Centre for Engineering Education (UICEE) and was held in Cairns, Australia, between 10 and 14 February 2003. This 6th Annual Conference of the UICEE was an academic activity that, basically, commenced the 10th year of the UICEE's operations.

This volume of Proceedings includes papers submitted to the Conference and offers a strongly assorted collection of highly informative articles that describe various international approaches to engineering education research and development, as well as other specific activities.

The 71 published papers, representing 23 countries, provide an excellent summary of the fundamental issues, concepts and achievements of individual researchers, as well as the concerns of and challenges to engineering and technology education in different cultures. The papers have been organised into the following groups:

- Opening and Keynote addresses
- New trends and approaches to engineering education
- Innovation and alternatives in engineering education
- International examples of engineering education and training
- Multimedia and the Internet in engineering education
- Important issues and challenges in engineering education
- Quality issues and improvements in engineering education
- Case studies
- Specific engineering education programmes
- Course development in engineering education

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