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The Ability of Taiwanese College Freshmen to Read and Interpret Graphics in English

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Abstract
This study is intended to assess the ability of Taiwanese college freshmen to read and understand English graphics, and at the same time evaluate the quality of English text-usage training dispensed in the high schools in Taiwan. The subjects, 211 freshmen, were drawn from a medical university in central Taiwan. They represented a group of above average students among the Taiwanese college freshmen majoring in sciences and engineering. The research instrument was the criterion-referenced graphics test, *GASS*. The data show that the pass rate is 13.27%. The survey of reading difficulty and the *t*-test, t (177) = 5.933, $p<.001$, suggest that in reading graphics, the ability to read English itself is a major cause of difficulty. The study concludes with suggestions for further studies and various recommendations for improving the teaching and learning of graphics in both high school and freshman college English classes.
Keywords: EFL Graphic Literacy; Graphic Literacy Assessment; Content Area Reading; Text Aids

Introduction

In Taiwan and in many southeastern Asian countries, academic excellence in English is pursued for higher status and as a means to keep abreast of globalization. Moreover, it is a popular practice in the academic world in many Asian countries to acquire English reading skills to study scholarly works in English, and to write texts and publish papers in English. One special feature of these academic texts is their extensive use of text aids to facilitate the comprehension and learning of their contents. Such learning and comprehension aids include a broad variety of graphs as shown below (Hunter, Crismore & Pearson, 1987):

1. Sequential graphs such as flowcharts, time lines and process charts;
2. Quantitative graphs such as bar graphs, line graphs, pie charts, bar charts;
3. Pictographs such as maps for physical, political and special purposes;
4. Tables and charts such as schedules, time tables and comparison charts.

These visual-spatial text adjuncts help communicate information and support thinking or learning processes (Schnotz, 2002). However, in the English native setting, text-usage skills instruction is often neglected. Equally, there are no studies exploring the current status of graphic literacy instruction in high school and college freshman English classes in Taiwan. Given the dearth of such related research, the objective of this paper is to determine the extent to which high school graduates in Taiwan are adequately prepared for reading and interpreting graphics in academic English.

In this study, the broad rationale is first presented along with references to past research as regards the functions of text aids. Following is the case study of this question, carried out among a group of Taiwanese college students. It is hoped that this preliminary research will lead the way to more large-group studies. The findings of this study may be of interest to those who are involved in EFL/ESP programs in Asia.

Literature Review

"A good graphic representation can force us to discover things without knowing in advance what we are looking for" (Wainer, 1994, p.14). Graphs present concepts in a concise manner, distill a great deal of descriptive writing into a small amount of space, restate the information, and illustrate the author's ideas (Askov & Kamm, 1982; Weintraub, 1967). Fry (1981) states that graphs are an important communication tool and often communicate better than words. They are concrete and direct, but truncated, and they require interpretation. Schnotz (2002, p.107) points out, "…verbal information and pictorial information can be kept simultaneously in working memory and, accordingly, it is easier for the learner to make cross-connections between the two different codes and later retrieval information." As a result, he continues, if the subject matter is complex and/or if learners have low prior knowledge, then graphic representations increase comprehension.

The idea of using text adjuncts dates back to the seventeenth century, when Comenius in his 'Didacta Magna' suggested that envisioning information is extremely important for effective learning. However, it is only since the 1970s that research on comprehension of visual displays has been investigated systematically (Schnotz, 2002). Empirical results have documented that graphics facilitate comprehension and learning from the texts (Arnold & Dewyer, 1975; Bodemer, Ploetzner, Bruchmuller & Hacker, 2005; Booher, 1975). Booher (1975) found that the mixture of pictorial information and verbal instructions facilitates perceptual-motor tasks. Arnold and Dewyer (1975) reported that the pictorial supplementation of verbal information, such as the use of diagrams, resulted in better performance and comprehension. Bodemer, Ploetzner, Bruchmuller and Hacker (2005) investigated the benefit of an instructional support method during learning with multiple representations, simulations, and animations. Three types of information integration were compared in two consecutive experiments: (1) presentation of non-integrated information, (2) presentation of pre-integrated information, and (3) active integration of information. They found that the integration of static representations before processing dynamic visualizations yielded better performance, and can provide a basis for a more systematic and goal-oriented behavior during simulation-based discovery learning.

Other studies have also documented that among readers of different ability levels, visual displays can have a supporting function for understanding and learning difficult materials (DeStefano & LeFevre, 2007; Montali & Lewandowski, 1996; Schnotz, 2002). In Montali and Lewandowski's study (1996), less skilled readers performed at a level commensurate with average readers when science and social studies passages were highlighted on computer screen while being voiced. DeStefano and LeFevre (2007), reviewing the cognitive load in hypertext reading, found that readers with low working memory and low prior knowledge were usually disadvantaged in hypertext. However, if the hypertext structure was hierarchical and consistent with that of the knowledge domain, learners with low prior knowledge were benefited. Schnotz (2002), in a review of the supportive function of visual-spatial text adjuncts, concluded that visual-spatial adjuncts seems to be especially evident with learners of low prior knowledge and low verbal skills: The more difficult a learning content is, the higher the learner's frequency of looking at adjunct visual displays.

Despite the strengths of graphic displays on reading comprehension, some experts in graphic literacy warn that the very strength of graphs can create a problem (Lowe, 1993; Schnotz, 2002; Weintraub, 1967). Weintraub (1967) points out that graphic displays condense information; they are frequently difficult to interpret. In addition, Schnotz (2002) suggests that visual displays do not support communication, thinking, and learning automatically. The learner requires specific graphic schemata in order to be able to read off information from the visual-spatial configuration (Lowe, 1993). Nevertheless, learners often underestimate the informational content of pictures and believe that a glimpse would be enough for understanding and for extracting the relevant information (Mokros & Tinker, 1987; Schnotz, 2002; Weidenmann, 1989). Consequently, the informational content of pictures may be overlooked by students who do not have experience in reading them (Askov & Kamm, 1982).

Effective learning with visual-spatial text adjuncts can be fostered through instructional design by the teacher or instructional material and through adequate processing strategies by the learner (Schnotz, 2002). In an English-as-mother-tongue setting, students can learn graphic reading skills from their courses in mathematics, social studies, science, and reading from elementary school through to high school. However, Heilman, Blair and Rupley (1981) point out that teachers are not teaching text-usage skills and that these skills are often neglected. Studies have also found that secondary students reading at or below grade level experience confusion about the purpose and function of textbook aids (Mateja & Wood, 1982), and students tend to make inadequate use of these text aids while using textbooks (Dillner & Olson, 1982). Thomas and Moorman (1983) traced the causes and concluded that elementary teachers may skip lessons on study skills in the hope that secondary school teachers will compensate. Meanwhile, junior and senior high instructors assume students in their classrooms have already been taught how to utilize the graphic representations in textbooks.

As an antidote to existing deficiencies in graphic literacy and to ensure that high school graduates are able to use graphic and text-usage skills, the Georgia Curriculum Guide for Social Studies outlined its own objectives for graphic instruction. In the core courses and college preparatory courses such as World History, Citizenship, and Economics, the objectives include enabling students to make a table of contents; to develop charts, tables, graphs, and grids to appropriately convey information; to use features of books for information; to interpret keys or legends for map reading; and to infer from data on a map or combination of maps (Gillespie, 1988).

With the swift emergence of new technologies, the use of graphic information in learning and instruction has become a specific challenge for educators (Schnotz, 2002). The effective supportive function of graphics on comprehension and learning has been well evidenced in the United States (Arnold & Dewyer, 1975; Bodemer, Ploetzner, Bruchmuller & Hacker, 2005; Booher, 1975; DeStefano & LeFevre, 2007; Montali & Lewandowski, 1996; Gillespie, 1988; Schnotz, 2002; Weintraub, 1967). To the contrary, studies concerning EFL learners' ability to read and interpret graphics in English do not exist in Taiwan. An analysis of the Mandarin content textbooks used in elementary schools and junior and senior high schools shows that instruction in graphic literacy also takes place in courses such as mathematics, science, and social studies. Do the teachers, like their counterparts in the United States, skip the instruction and assume that their students have mastered the skills in the lower grades? Furthermore, no empirical studies have documented that the learning of Mandarin graphic reading skills could be transferred to the reading of English graphics. Equally, there are no studies exploring the current status of graphic literacy instruction in high school and college freshman English classes in Taiwan.

As graphics facilitate comprehension and the learning of information, the possession of graphic reading skills may compensate for the deficiencies in students' comprehension of the college discipline-specific texts. Accordingly, this study proposes to assess the ability of college freshmen in Taiwan to read and interpret graphics in English-language texts, especially these static text adjuncts found in college content area textbooks. This study was designed to answer the following four questions:

1. Are college freshmen ready to use the text aids and graphics used in English-language text books to facilitate comprehension?
2. Which of these graphics--graphs, tables of contents, tables and charts, index, time lines, and maps--are college freshmen most likely to interpret correctly?
3. Did college freshmen have any experience reading the graphics in English at high school?
4. Is an insufficient grasp of English a cause of difficulties in reading and interpreting graphics?

Method

Participants

The subjects consisted of 211 freshmen students at a medical university in central Taiwan. These participants came from five departments. They were selected to represent a group of above-average students regarding their overall school achievement among Taiwanese college freshmen majoring in sciences and engineering. The criteria used to define the ability of the participants are based on the results of the July Joint College Entrance Examination held annually in Taiwan (CEEC, 2008).

Taiwanese high school students, at the end of Grade 10, are required to choose a track of study between humanities and sciences which include engineering and life sciences. Usually students proficient in mathematics choose the science track. In the examination, students in the science track are required to take five or six subjects: Mandarin Chinese, English, mathematics for science, biology, chemistry, and physics. Students in humanities are required to take five subjects: Mandarin Chinese, English, mathematics for humanities, history and geography. Both tracks take the same Mandarin and English tests as they read and use the same learning materials. The results of the tests are weighted on a scale of zero to 100. In 2007, 100,117 high school graduates registered for the examination. Among them, 49,788 students took the examination for the science track (CEEC, 2008).

In estimating the standing of the participants' overall school achievements among the nation's high school graduates, the following steps were followed:

1. The researcher listed the respective raw "minimum college department admittance score" (MCDAS) of the five departments in 2007: 320.97, 318.81, 280.70, 275.73, and 251.95. Then, the researcher averaged the MCDAS of the departments by the six required test subjects, which yielded the following mean MCDAS: 53.495, 53.135, 46.783, 45.955, and 41.991.
2. Next, the researcher computed the national mean MCDAS for the examinees in the science track by following this formula (sum of the national mean of each test subject × the examinees taking each subject) ÷ (sum of the examinees in the six subjects): [Mandarin (54.46 × 100,070) + English (31.12 × 100,059) + mathematics for science (36.09 × 49,788) + biology (56.94 × 30,002) + chemistry

(43.55 × 46,236) + physics (32.81 × 46,092)] ÷ (100,070 + 100,059 + 49,788 + 30,002 + 46,236 + 46,092). The computations yielded a national mean MCDAS of 41.893, which is lower than any of the five departments by a range from 11.602 to 0.098 points.

Research Instrument

Graphics Assessment for Social Studies (GASS) was the measure for this study (Gillespie, 1988). GASS is a criterion-referenced test. It was designed to measure the ability of high school students to read and interpret graphics commonly found in social studies textbooks. The test is an untimed test and consists of 72 questions. The questions are grouped into six sections with twelve questions each. Each section measures the ability to read and interpret one of six graphic representations or images: graphs, tables and charts, time lines, a table of contents, an index, and maps.

Content validity evidence was obtained from four social studies teachers who assessed the item-objective congruence. The consistency was 97.06%. Predictive validity was estimated by comparing the test scores to the students' semester grades. The coefficient for test and grades was .64, and for retest and grades was .70. The internal consistency index for the first test was .95 and was .91 for the retest, using the Kuder-Richardson Formula 21 (Gillespie, 1988).

The standard of performance (cut-off criterion) was set at 85%. As Tyler (1973, p. 105) points out, "A child has demonstrated mastery ... when he has performed correctly 85% of the time. Some small allowance, like 15%, is needed for lapses common to all people." Gronlund (1982) also suggests that the mastery level on a multiple-choice test be set at 85%. Four high school social studies teachers, one test and assessment specialist, and six reading education specialists were invited to rate each item consistently with this criterion. The question "Should every high school graduate be able to answer this item correctly?" was used as a guide to rate the items (Jaeger, 1979). The mean of the responses made by the panel members was 85% and the median was also 85% (Gillespie, 1988).

This test was selected for the study because very few tests that exist now are designed to assess the ability to read and interpret graphics. Frequently-used tests, such as the *California Achievement Test* or the *Test of Academic Progress*, contain very few sub-sections measuring graphic skills, leaving judgments about students' abilities tenuous at best. For five years prior to this study, the researcher administered parts of the instrument as remediation measures for Taiwanese college students attending his English classes. This test, though developed for social studies, was also deemed appropriate for the participants in sciences, as no differentiation of high school EFL instruction is made for students in either sciences or humanities in Taiwan.

Questionnaire

Two questions were formulated to explore whether the participants had been taught how to read graphics in high school EFL classrooms, and to determine whether or not English was a cause of difficulties in understanding the questions on the test. These are the two questions:

1. In your high school EFL classrooms, did your teachers teach you to interpret graphics similar to those in the test? If your answer is yes, write down the page number on which the same graphics appear.
2. Say whether the English in the items A) was difficult; B) was a little bit difficult; C) was not difficult to read and understand.

Test Procedure

The test was administered in four of the researcher's freshman English classes. In two consecutive periods of 50 minutes, the participants responded to the questions. Participants were told about the purposes of the test. They were encouraged to try their best to answer the questions on the test. They were also told that they were free to discontinue the test at any time. No dictionary was allowed.

Grading

Two college English teachers were invited to hand-grade the measure in a two-week period. The first teacher graded all the questions, added up the total scores, and tallied the number of responses to the questionnaire. The second teacher graded the answer sheets again for accuracy. The raw score was then converted to percent by following this formula: (total correct answers÷72) ×100.

Data Analysis

The SPSS version 11.5 was used to organize and analyze the data collected in the study. First reported were the descriptive statistics of the converted scores, and the frequency and percentages using 5% as an interval to depict the passing rates and the general performances. A graph was appended to illustrate the result. Error ratios were then calculated to rank the participants' performances of these graphics: graphs, charts and tables, time lines, table of contents, maps, and indices. Finally, the participants' responses to the questionnaires were reported in percentages. Also reported were the results of a *t*-test comparing the participants who indicated that the English in the items was or was not difficult to read and understand. Tables were also formulated to visually delineate the results.

Results

Pass Rate and the Distribution of Performances

Table 1 presents the pass rate and the distribution by frequency and percentage of the performances of the 211 participants. The results show that 28 or 13.27% of the participants scored above the 85% of the cut-off criterion. Twenty nine or 13.744% of the participants scored near the passing criterion. The table also shows that 88.625% of the participants were able to answer more than 50% of the questions, with only 11.375% of the subjects out of the range.

Table1: Passing Rate and Distribution by Frequency and Percentage

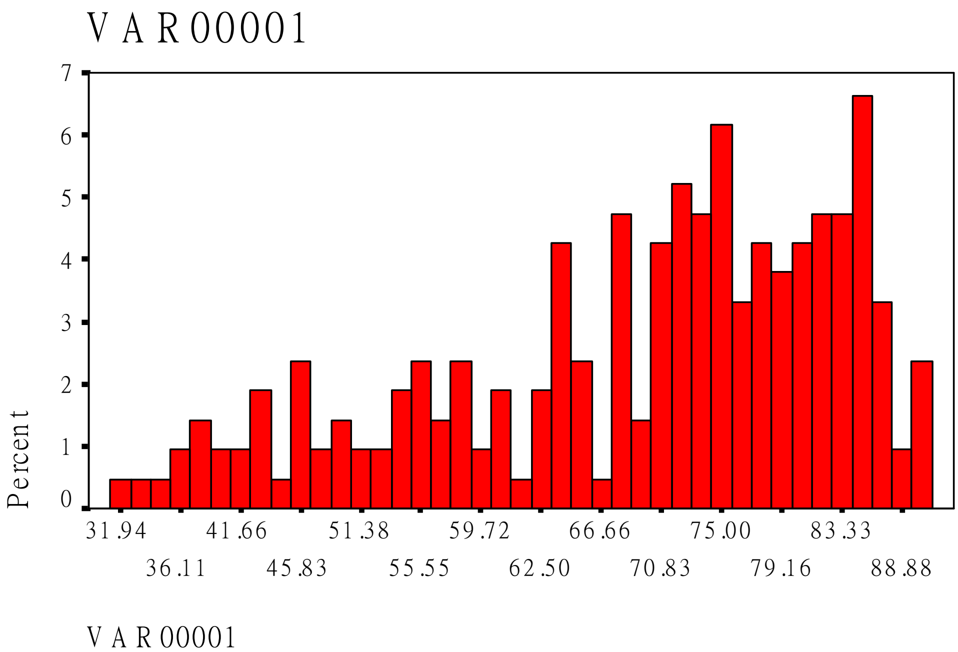
Exact Range by 5%	Frequency	Percent	Cumulative Percent
95.00~100.0	00	00	00
90.27~90.27	05	02.370	02.370
86.11~88.88	23	10.900	13.270
80.55~83.33	29	13.744	27.014
75.00~79.16	37	17.536	44.550
70.83~73.61	30	14.218	58.768
65.27~69.44	19	09.004	67.772
61.11~63.88	18	08.531	76.303
55.55~59.72	15	07.109	83.412
50.00~54.16	11	05.213	88.625
45.83~48.61	07	03.318	91.943
40.27~44.44	09	04.265	96.208
36.11~38.88	05	02.370	98.578
31.94~34.72	03	01.422	01.422
Total	211	100.0	100.0

Table 2 lists the mean, median, mode, range, minimum, maximum and percentiles of the results. The range is 58.33 from the highest score, 90.27, to the lowest score, 31.94. A score above 80.55% is in the upper 75 percentile while a score lower than 60.11% shows a performance in the lower 25 percentile. The table also indicates a negatively skewed distribution, as the mean (69.56%) is smaller that the median (72.22%) which is also smaller than the mode (86.11%). Graph 1 visually displays the negatively skewed distribution of the overall performance of the 211 participants. The distribution spreads out in a bell shaped curve showing that 50% of the student subjects were able to answer above 72.22% of the questions.

Table 2: Mean, Median, Mode, Range, Minimum, Maximum and Percentiles

N	Valid	211
Mean		69.56
Median		72.22
Mode		86.11
Std. Deviation		14.11
Range		58.33
Minimum		31.94
Maximum		90.27
Percentiles	25	61.11
	50	72.22
	75	80.55

Figure 1: Distributions by Percent



Ranking the Ability to Use and Interpret Graphics

These six types of graphics were used in this test: Graphs, Tables and Charts, Time Lines, Tables of Contents, Index, and Maps. To determine which types of graphics the participants were able or unable to use, the error responses to the questions in each of the six categories were tallied and computed separately by this formula: (total number of errors ÷ total number of questions)/100. Table 3 lists the results in descending order. The results show that the participants failed to answer more than 1/3 of the Graph questions, which include bar graphs, pie graphs, and line graphs. In addition, the participants also failed to answer nearly 1/3 of the questions on the following graphics: Index, Table of Contents, Charts and Tables, and Maps. The subjects were able to answer approximately 79% of the time line questions.

Table 3: Ranking of the Ability to Use and Interpret Graphics

Types	Percentage of Error
Graph	35.51
Index	32.74
Table of contents	31.67
Chart & Table	30.25
Map	30.21
Time line	21.33

Experience in Reading Graphics in English in High School

Of the 211 participants, 202 responded to the first survey question. Among these, 112 participants expressed that they had been taught how to use or interpret at least one or more than one of the six graphics in high school EFL classrooms, while the other 90 participants said they had never been taught how to use or interpret the graphics.

This formula was used to tally the percentage for each of the graphics:

(total number indicated as having been taught ÷ 202)/100. The data show that among the six graphics, the Graph was the most frequently taught, with a percentage of 31.28; while the Index was the least taught, with a percentage of 6.16. The data also reveal that the least taught graphics were the following: Time Line (18.01%), Charts and Tables (12.32%), Maps (11.37%), and Table of Contents (10.43%). Table 4 shows the percentage of the graphics which participants said had been taught in high school EFL classrooms.

Table 4: Percent of the Graphics Taught in High School EFL Classes

Types	Total Percent of Being Taught
Graph	31.28
Time line	18.01
Chart & Table	12.32
Map	11.37
Table of contents	10.43
Index	06.16

Performances of Participants Rating Levels of English Language Difficulty

Of the 211 participants, 190 responded to the second survey question. The tally of the responses showed the following results: Difficult (78 participants), Somewhat Difficult (11 participants), and Not Difficult (101 participants). The data from the 11 participants were eliminated from the study as the number was small. The two categories, Difficult and Not Difficult, were used for computing whether or not a significant difference existed between the performances of the participants who found the level of English used in the test difficult and the performances of those who said the English was not difficult.

Table 5 shows that the mean performance of the group who considered the language level difficult is 62.05%; whereas the mean for the group who found the language level not difficult is 74.86%. Again, to bring out possible significant differences in the performances, a simple *t*-test was administered. A significant difference was found, t (177) = 5.933, $p < .001$, favoring the Not Difficult Group. Table 6 presents the result of the *t*-test.

Table 5: Mean, Median, Mode, Range, Minimum, Maximum and Percentiles

		Difficult	Not Difficult
N	Valid	78	101
Mean		62.05	74.86
Median		63.88	76.38
Mode		63.88	86.11
Std. Deviation		14.719	11.848
Range		54.17	58.33
Minimum		33.33	31.94
Maximum		87.50	90.27
Percentiles	25	50.00	70.83
	50	63.88	76.38
	75	73.96	83.33

Table 6: Result of the *t*-test by Difficulty × No Difficulty

English	N	Mean	Std. Deviation	*t*	df	Sig. (2-tailed)
Not difficult	101	74.86	11.848	5.933	177	< .001
Difficult	78	62.05	14.719			
Total	179					

Discussion

A feature of college textbooks is the abundant use of graphics. Graphics facilitate comprehension and the learning of information; therefore, the ability to read and interpret graphics compensates for the difficulties encountered by students in comprehending discipline-specific college texts. In Taiwan, however, there exist no studies that explore the current status of graphic literacy instruction in either high school or college freshman English classrooms. In this study, the ability to read and interpret graphics is measured by administering a criterion-referenced graphic test. The goals are fourfold: 1) to determine whether college freshmen are ready to use text aids and graphics to facilitate text comprehension, 2) to find out which graphics college freshmen are most likely to interpret correctly, 3) to discover whether college freshmen learned to read the graphics in English in high school, and 4) to evaluate to what extent English is a cause of the difficulties experienced by students in reading graphics.

In response to the first research question, the findings of this study reveal that only 13.27% of the participants reached the mastery level. Another 13.74% of the participants scored close to mastery level. The data also show that 50% of the student subjects were able to answer above 72.22% of the questions. The negatively skewed distribution further indicates that the majority of the participants tended to be able to read and interpret the graphics, even though the mastery rate was low.

In response to the second research question, the tally of the error rate reveals that the subjects were able to use, in descending order of competence, the following graphics: Timelines, Maps, Tables and Charts, Index, Table of Contents, and Graphs. In other words, the subjects were more capable of reading and interpreting Timelines than Maps, Tables and Charts, Index, and Table of Contents. They were least competent in reading and interpreting Graphs, which happen to come in greater variety: bar graphs, line graphs, pie charts, bar charts, and pictographs.

In the subjects' identification of the different graphics taught or not taught in high school English classes, the results show that the six graphics tested in the study were generally neglected. Obviously teaching students how to read and interpret graphics is not one of the major foci in high school English classrooms. Scrutinizing the data pertaining to graphics teaching ratio and graphics using error percentages, we observed an interesting incongruity. About 31.28% of the subjects reported that they had read Graphs in high school English classrooms. However, more than 1/3 of the subjects failed to read and interpret the Graph questions correctly. The data further show that the subjects were more successful in answering the Timeline questions, but Timelines were taught much less frequently than Graphs in English classes. Obviously, instruction or the lack of instruction in this case, does not influence the students' ability to read and interpret the graphics. Perhaps the complexity and the types of graphics, as well as the relation between these displays and the task demands and the learner's prior knowledge and cognitive abilities (Schnotz, 2002), do affect the students' success or failure in reading and interpreting graphics. Moreover, as the subjects are EFL learners, it is also possible that the subjects' fluency in English influences their performances.

As regards the last research question, the results show that the subjects who rated English as Not Difficult outperformed those who rated English as Difficult. The gap between the two groups was large, with a mean difference of 12.81 (74.86 vs. 62.05). This result indicates that many more subjects who rated English as Difficult scored at the lower extremity of the normal curve. The significant difference leads to the conclusion that the ability to read English influences the ability to read and interpret graphics in English.

This study reveals that only 13.27% of the participants reached the mastery level in reading and interpreting graphics in English. A dearth of English proficiency and the ineffective high school EFL education in Taiwan may become one of the major causative factors. EFL education in Taiwan has been putting too much emphasis on rote-learning, and students are just asked to remember words and grammar and pass the tests (Gluck, 2007). Ineffective EFL learning and instruction have also been evidenced in many news reports in Taiwan and in international news media such as BBC News. For example, newspapers have reported that Taiwan ranked poorly in the International English Language Testing System (IELTS) given in 2006 and in 2007 (Gluck, 2007; Shieh, 2008). Taiwan ranked 17th in 2006 and 16th in 2007 among the top 20 Asian countries which had the highest number of people taking the language-proficiency test. Besides, Taiwan ranked the last among Mainland China, Korean, and Singapore in the Test of English as a Foreign Language (TOEFL-CBT) conducted from 2004 to 2006 (Shieh, 2008). In 2007, Taiwan again ranked the last among Mainland China, Korean, Hong Kong, and Singapore in the Test of English as a Foreign Language (TOEFL-iBT) (Hu, 2008; Shieh, 2008).

The factors leading to poor performances in reading and interpreting text adjuncts are numerous; for instance, Westelinck, Valcke, Craene and Kirschner (2005) point out that individual differences in learning styles or spatial abilities, the demand of the task, time on task, and the quality of the external graphical representations may influence the graphics reading and interpretation. In addition, the learner's prior knowledge and cognitive abilities also affect the students' success or failure in reading and interpreting graphics (Schnotz, 2002). Moreover, it is possible that gender difference can also be one of the factors. In the current study, gender variations in the ability to read and interpret graphic displays were not the major research foci. However, it was observed that males and females did achieve differently. Among the 82 males and 129 females, it was found that the difference of mean between both sexes was 6.66 points (male: 65.494; female: 72.154). The result of *t*-test revealed that females significantly outperformed males, t (209) = 3.41, p<.001.

Conclusions

In Taiwan, it has long been a common practice among college subject teachers to assign English content textbooks to their students (Cheng, 1993; Cheng & Hung, 2002; Hu, Chen & Liu, 2008). These college texts are originally written for English speakers who “ideally” should possess at least a Grade 13 reading ability (Singer & Donlan, 1989). The possession of graphic reading skills, though, may compensate for the deficiencies in students’ comprehension of the college discipline-specific texts. Nevertheless, as this study reveals, inefficient English ability aggravated by a lack of proficiency in graphic reading skills will deprive the reader of this channel to read to learn from the college content texts. As the findings suggest, the efficacy of reading to learn from these college content area texts in the EFL context is questionable among the majority of the college students in Taiwan.

The ability to read and interpret graphs, both static and animated, should be regarded as one of the basic life skills for students of different grade levels. Nearly three decades ago, graphic literacy educators pointed out that “the ability to read graphics is becoming increasingly important because they are more widely used in newspapers, magazines and textbooks than in days past” (Fry, 1981, p.388). Now, with the dramatic development of computers and the proliferation of internet technology, the ability to read and interpret graphic representations has extended far beyond the static textbook graphic displays. Such graphic reading proficiency has become imperative if we are to function in our daily lives.

Implications for Further Studies

As Bintz (1997, p.12) points out, “I am insecure because as an English teacher, somehow I am expected to know about reading, but at the college level I was only trained in English content.” Many studies, moreover, suggest that pre- and in-service teachers in English as native tongue setting might believe that they are not qualified to teach science or social studies reading to their students (Bintz, 1997). In future studies, researchers may want to pay special attention to EFL teachers. As most high school English teachers are majors in English literature or linguistics, their training in instructional strategy for other disciplines may be deficient. Studies might focus on such topics as attitudes towards teaching graphics in English and knowledge of and competency in interpreting graphics.

As this study is based mainly on quantitative data, to flesh out conclusive information regarding college students’ graphic abilities, it is necessary that qualitative studies should also be designed. Insight is needed for examining the frequency, attitudes, and strategies employed by college students beyond the freshman year in reading and interpreting graphics in English subject textbooks. In addition, studies should also be conducted using high school students with regards to their knowledge of graphs and subsequent problems in reading graphs. Indeed, it is more important to train high school students to read and interpret graphics before they enter college. Teaching and learning guides can then be suggested to ready high school graduates to read and interpret graphics in English.

Other than differences in learning styles or spatial abilities, prior knowledge, and cognitive abilities in comprehending text adjuncts, gender differences in the ability to read and interpret text adjuncts may prove to be another area of research interest. The existing studies relating to gender variations have been focused on reading, vocabulary, motivations, reading and learning strategies; text-style preferences, cognition, ability in sciences or mathematics (Chan, 1994; Evans, Schweingruber & Stevenson 2002; Halpern, 2000; Hyde & Linn, 1988; Hyde & McKinley, 1997; Morgan & Douglas, 2007; Poole, 2005; Worrell, Roth, & Gabelko, 2007). However, no studies exist that explore gender difference in graphic comprehension. In future studies, differences in comprehending graphic displays between the two sexes should be first established; then, factors contributing to the differences should be explored and delineated.

Finally, the ability of high school and college students to design graphics should also be considered as one of the important skills in English writing class. In college, students are expected to be effective writers, that is, to be able to produce coherent and elegant academic texts that convey clear meaning. Designing and interpreting graphics are indispensable skills for this purpose. As college students are frequently required to write projects and papers either in Mandarin or in English, studies can be designed to explore how they use graphs in their projects and the quality of the graphs. Graphs used in both languages can be examined as well for differences and proficiency in usage. In addition, a great number of college students are able to design web pages over the internet, though most of them are in Mandarin Chinese. Yet, studies should be developed to compare and contrast the quality of the graphs they design and, more importantly, the problems they meet and the quality of the graphs, tables and indices they design in English.

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