南台人文社會學報 2013 年 11 月
第十期 頁 77-107

應用英語碩士生統計學能力與學習認知探討

黃大夫*

摘要

了解統計基本觀念與應用以及熟悉統計軟體運用能力是台灣應用英語碩士班學生基本要求之一。然而因為大多學生並無統計學基礎，導致雖然研究生體認到統計學的重要性，但對統計學依然有恐懼感。本研究主要探討應用英語碩士生統計概念理解度與統計概念重要性相關性。本研究另外也探討統計軟體以及統計課程授課與教材使用語言在學習統計過程扮演之角色。52 位應用英語碩士班學生於基礎統計學課程結束後填寫完成一份李克特式六點量表問卷，包含統計概念理解度，統計概念重要性，統計方法理解度，統計方法重要性，統計學習想法等五個部分。藉由相關分析與相依樣本 *t* 檢定等統計分析方法，研究結果包含：一、受試者統計概念理解度與重要性有統計上顯著相關（$r = .41$, $p < .01$），統計方法理解度與重要性也同樣有顯著相關（$r = .45$, $p < .01$）；二、受試者統計概念理解度與重要性有統計上顯著差異（$p < .003$），統計方法理解度與重要性也同樣有顯著差異（$p < .006$）；三、熟悉 SPSS 有助於了解統計之想法與統計方法理解度（$r = .34$, $p < .05$）以及統計學有助於了解國際期刊論文之想法（$r = .37$, $p < .01$）有顯著相關；四、統計課程中，使用英語授課或教材有助於了解統計概念與統計概念理解度（$r = .56$, $p < .01$），統計方法理解度（$r = .49$, $p < .0$），與修過統計課程數（$r = .38$, $p < .01$）有顯著相關。本文復針對研究結果之教學上意涵進一步提出論述，對未來可持續之研究方向提出建議，最後並做出結論。

關鍵詞：統計學能力、SPSS 運用能力、統計英文

* 黃大夫，南臺科技大學應用英語系副教授
電子信箱：dfjhuang@mail.stust.edu.tw
收稿日期：2013 年 09 月 13 日，修改日期：2013 年 11 月 18 日，接受日期：2013 年 11 月 22 日

STUST Journal of Humanities and Social Sciences, November 2013

No. 10 pp.77-107

Applied English MA Students' Statistics Proficiency & Perceptions of Statistics Learning

Da-Fu Huang[*]

Abstract

An understanding of statistics and its application in applied linguistics research, and competence in using statistical analysis software, have always been important requirements for graduate students of MA programs in applied linguistics in Taiwan. Learning statistics, however, can be a daunting task for students, despite their awareness of the importance of the subject. This study, therefore, set out to explore the relationships between competence, perceived values, and performance in the application of statistical software, and investigate the underlying factors that influence the learning achievements and attitudes of students. Fifty-two applied English students of both weekday and weekend MA programs of a technological university in Taiwan participated in the study, by responding to a survey questionnaire with six-point Lickert scale items designed by the researcher. After completion of a graduate course in statistics for applied linguistics research offered by the researcher, two classes of graduate students were requested to self-evaluate their understanding of statistical concepts and tests, specify their perceptions of the importance of statistical concepts and tests in graduate research, and indicate their agreement or disagreement with specific statements about statistics learning. The participants' understanding and their perceptions of the importance of designated statistical concepts were shown to have a statistically significant correlation ($r = .41$, $p < .01$). A statistical correlation ($r = .45$, $p < .01$) was also found between understanding and perceived importance of the designated statistical tests. The participants' perceived understanding was statistically different from their perceived importance of statistical concepts ($p < .003$) and of statistical tests ($p < .006$).

[*] Da-Fu Huang, Associate Professor, Department of Applied English, Southern Taiwan University of Science and Technology
E-mail: dfjhuang@mail.stust.edu.tw
Manuscript: Sept. 13, 2013; Modified: Nov. 18, 2013; Accepted: Nov. 22, 2013

Understanding of statistical tests, moreover, was found to be significantly associated with the belief that familiarity with the use of SPSS facilitates understanding of statistics ($r = .34$, $p < .05$), which correlated significantly with the facilitating role of statistics in understanding international journal papers ($r = .37$, $p < .01$). The use of English instead of Chinese course materials to facilitate comprehension of statistical concepts was furthermore shown to have a statistical association with statistics competence ($r = .56$, $p < .01$), statistical test performance competence ($r = .49$, $p < .01$), and the number of statistics courses previously taken ($r = .38$, $p < .01$), suggesting that using English learning materials and English as a medium of instruction could facilitate statistics learning for applied English majors, along with the provision of more statistics learning experiences. Implications of the research findings are proposed for the development of statistical literacy, and the effective use of English as a medium instruction in applied English MA programs in Taiwan.

Keywords: Statistics competence, SPSS proficiency, Statistics English

Introduction

With applied linguistics having come of age as a discipline or as a research base, competence of statistics and its application in research were brought into the foreground as an essential ability for doing applied linguistics, particularly quantitative, research. Growing emphasis was made by applied linguists on the importance and necessity of statistical knowledge for conducting empirical or statistically based research (Dunkel, 1986; Flynn, 1985; Henning, 1986). Flynn (1985) and Lazaraton, Riggenbach, and Ediger (1987) called furthermore for the basic literacy of research design and statistical concepts for those involved in the teaching and research in applied linguistics fields. Lazaraton et al (1987), among others, surveyed the degree to which applied linguistics professionals were familiar with statistical knowledge and use, and how they perceived the role of statistics in the empirical studies and language teaching. Rumsey (2002) defined statistical literacy and discussed how to promote it in the introductory statistics course by emphasizing not just the "what' of statistics but the "how" and "why" of statistics. Zieffler, Park, Garfield, delMas, and Bjornsdottir (2012) reported on the development of the instrument, Statistics Teaching Inventory (STI), to assess the beliefs and practices of the instructors of introductory statistics courses across different disciplines. Useful resources on research design and statistics such as Brown (1988), Fowler (1983), Hatch and Farhady (1982), Johnson (1992), Lazaraton (2005), Nunan (1992), and Woods, Fletcher, and Hughes (1986) were available to help inform the statistics literacy. The study of Lazaraton (2000) on the actual use of research methods and statistical procedures in the publications of four major applied linguistic journals, however, raised concerns about whether applied linguists used statistical procedures appropriately in compliance with specific

assumptions.

The call for the statistics literacy in applied linguistics research is also significant and relevant in applied linguistics teaching. The graduate curriculum on applied linguistics, for example, should include as one of the essential courses fundamental statistics, which should be able to equip graduate students with a basic literacy of statistical knowledge and use of statistics in their own research. Very few attempts, unfortunately, have been made to understand students' perception of statistical learning and competence, and the nature and content of the statistics literacy from students' learning as well as teachers' practical perspectives. The results of such studies would help work out the core knowledge of statistics serving as a basic literacy of applied linguistics statistics.

More important, prior research seemed to neglect the important role of the statistics software in the learning and teaching of statistics. The application of statistical concepts and performance of statistical procedures would not be accomplished without sufficient proficiency of the statistical software package, such as SPSS, to generate desired output for interpretation and analysis. The software package, however, would mostly strike learners or teachers as daunting and hard to use, and the phobia of the software might in turn lower the learners' confidence in learning statistics. Studies on students' statistics learning attitudes and achievement should hence incorporate the variable of the statistics software into the research hypotheses.

From the pedagogical perspective, still another critical but previously unexplored factor with a likely association with statistics learning attitude and achievement seems to be the medium of instruction and course learning materials. Since a part of the statistics learning materials used in graduate courses in applied foreign language related subjects derived from Chinese

translation, understanding of statistical concepts could be a problem arising from the translation from English to Chinese. It thus requires investigation whether the linguistic medium, English or Mandarin, of the material content and the lecture presentation, has an impact on the comprehension of statistical concepts by applied foreign language MA students with supposedly higher English proficiency. For MA students of applied English in Taiwan, therefore, whether delivery of statistical concepts in English instead of Mandarin would facilitate or hinder understanding of the concepts and whether the course learning materials should be written in English, Mandarin, or in both to best facilitate statistics learning are issues worth empirical investigation, particularly in the EFL context.

This study was thus aimed to explore the three factors and their interrelations with respect to statistics learning of applied English MA students in Taiwan; namely, perceived statistics competence, perceived importance of statistical concepts and methods, and attitudes toward the statistical analysis tool and the language mode of learning materials. The results of the study generated significant implications for the graduate curriculum design on applied linguistics statistics and effective teaching and learning of statistics English for better learning outcome in applied linguistics statistics.

Method

Instrument

A survey on statistical learning and perceived understanding was designed by the researcher based on the instructional content of the MA course of fundamental statistics in applied linguistic research. The questionnaire consisted of six major components (see Appendix 1). The first part asked about the respondents' biodata. The second component

asked the respondents to self-rate their degree of understanding of statistical terms based on a 6-point Likert scale ranging from "Not understand at all" to "Completely understand." The participants rated in the third component degree of importance of statistical terms in their own research using a 6-point Likert scale ranging from "Not important at all" to "extremely important." In components 4 and 5, respondents rated their understanding of statistical methods or tests and assigned degree of importance to these methods respectively on a 6-point Likert scale. Component 6 asked about participants' perception about statistics learning, including their attitudes toward the effect of statistical analysis software on statistics learning, the instruction of statistics in English vs. Mandarin, and English vs. Chinese course learning materials. The Chinese version of the questionnaire was administered with the participants.

Procedures

Two MA fundamental classes of one weekday and one weekend program instructed by the researcher participated in this study. Over a period of 18 learning weeks, the two classes were taught the identical content on the fundamental concepts of parametric statistics. The course was conducted in a way that all of the statistics terms and tests contained in the survey were covered and explained during course lectures and hands-on SPSS practice sessions. The course learning of the two classes proceeded according to the same syllabus and the teaching schedule, and the participants of the two classes revealed no significant variation in terms of class attendance and learning achievement. Only during the final class meeting were the students notified and invited to complete the survey voluntarily within one class period. A total of 52 questionnaires were completed and returned.

The statistical concepts contained in the survey included the following: *p-value, confidence interval, standard deviation, effect size, power, hypothesis testing, ,categorical vs. continuous variables, independent vs. dependent variables, score vs. frequency data, α or Type-I errors, normal distribution, statistical significance, degree of freedom, sample size, r-squared, interaction , variables vs. levels, standard scores, β or Type-II errors, and statistic.*

The statistical methods or tests contained in the survey included the following: *Pearson correlation, regression, Chi-square, independent samples t-test, paired samples t-test, one-way ANOVA, factorial ANOVA, and repeated measures ANOVA.*

The statistical tests and concepts selected for the survey were meant to represent the learning objectives of the fundamental statistics course, or the core statistics knowledge the participants should acquire at the end of the semester in order to obtain a minimal literacy of statistics in applied linguistics.

Results

Perceived Understanding of Statistical Concepts

In terms of understanding of statistical concepts, the results of descriptive statistics (cf. Table 1) showed that the five most understood statistical terms in descending order are *dependent vs. independent variables, sample size, statistical significance, p-value, and score vs. frequency data*, while the five least understood concepts, *Type II error, Type I error, confidence interval, R-squared, and degree of freedom*.

Table 1
Descriptive Statistics of Perceived Understanding & Importance of Statistical Concepts

	Perceived Understanding			Perceived Importance		
Term	**M**	**SD**	**Rank**	**M**	**SD**	**Rank**
1. P-value	3.83	1.37	3	4.87	1.1	1
2. Confidence Interval	3.35	1.37	13	4.56	1.0	8
3. Standard deviation	3.67	1.42	6	4.62	.9	6
4. Effect size	3.60	1.45	8	4.62	1.1	7
5. Power	3.75	1.43	5	4.63	1.1	4
6. Hypothesis testing	3.54	1.49	10	4.31	1.1	17
7. Categorical vs. continuous variables	3.65	1.63	7	4.52	1.1	9
8. Independent vs. dependent variables	4.13	1.48	1	4.75	1.1	3
9. Score vs. frequency data	3.81	1.56	4	4.50	.9	11
10. α or Type-I errors	3.35	1.47	13	4.21	1.2	20
11. Normal distribution	3.67	1.52	6	4.48	1.0	12
12. Statistical significance	3.83	1.42	3	4.83	1.1	2
13. Degree of freedom	3.42	1.54	12	4.27	1.1	18
14. Sample size	4.02	1.53	2	4.63	1.1	5
15. R-squared	3.42	1.55	12	4.33	1.1	16
16. Interaction	3.44	1.41	11	4.35	1.0	15
17. Variables vs. levels	3.65	1.38	8	4.50	.9	10
18. Standard scores	3.58	1.39	9	4.40	1.0	14
19. β or Type-II errors	3.33	1.52	14	4.21	.9	19
20. Statistic	3.44	1.45	11	4.44	1.0	13

Perceived Importance of Statistical Concepts

As to importance of statistical concepts in MA research, the five terms perceived by the participants most important in descending order are *p-value, statistical significance, independent vs. dependent variables, power,* and *sample size*, whereas the least important terms are *Type-I errors, Type-II errors, degree of freedom, hypothesis testing, and R-squared.*

The association between the perceived understanding and perceived importance of the statistical terms was shown to be statistical (r = .41, p < .01) as indicated in Table 2. Performance of Spearman's rho and Kendall's tau-b correlations also indicated significant results (Spearman's r = .41, p < .01; Kendall's r = .34, p < .01), suggesting that the more degree of importance assigned to statistical concepts, the more likely the participants would show their understanding of the concepts. Despite overall significant correlation between the two factors and moderate effect size of the correlation, participants were fairly inconsistent in the relative order of perceived understanding (Rank 13 or bottom-ranked) and that of perceived importance (Rank 8) with respect to the concept of confidence interval, implying that they showed relatively low degree of understanding of confidence interval though it was considered relatively important for their research.

Table 2
Correlations between Understanding & Perceived Importance of Statistical Concepts

Correlation	**Variables**	**Coefficient**	***P*** **value**	***R*-Squared (Effect size)**
Pearson's	Understanding of Statistical Concepts Perceived Importance of Statistical Concepts	.41	< .01	.17 (Mid)
Spearman's Rank-ordering	Understanding of Statistical Concepts Perceived Importance of Statistical Concepts	.41	< .01	.17 (Mid)
Kendall's Concordance	Understanding of Statistical Concepts Perceived Importance of Statistical Concepts	.34	< .01	.12 (Mid)

Gap between Understanding and Perceived Importance of Statistical Concepts

To further examine the gap between understanding and perceived importance of statistical concepts, paired samples t-test was performed.

After performance of the Bonferroni procedure to adjust the alpha level from *.05* to *.003* due to multiple t-tests, the difference between understanding and perceived importance is statistical at *.003* significance level for all of the statistical concepts but Items 8 (*independent vs. dependent variables*), 9 (*score vs. frequency data*), and 14 (*sample size*), as shown in Table 3. This result suggests an overall significant gap between what the participants understand, and how important they think about, the statistical concepts.

Table 3
Paired Samples t-test on the Difference between Understanding and Perceived Importance of Statistical Concepts

Statistical Concepts	Mean Dif	95% Confidence Interval		*t*	Sig
		Lower	Upper		
1. P-value	-1.038	-1.383	-.694	-6.058	.000
2. Confidence Interval	-1.212	-1.583	-.840	-6.552	.000
3. Standard deviation	-.942	-1.330	-.555	-4.881	.000
4. Effect size	-1.019	-1.434	-.605	-4.938	.000
5. Power	-.885	-1.292	-.477	-4.357	.000
6. Hypothesis testing	-.769	-1.198	-.340	-3.598	.001
7. Categorical vs. continuous variables	-.865	-1.293	-.438	-4.067	.000
8. Independent vs. dependent variables	-.615	-1.036	-.195	-2.939	.005
9. Score vs. frequency data	-.692	-1.155	-.229	-3.002	.004
10. α or Type-I errors	-.865	-1.251	-.479	-4.500	.000
11. Normal distribution	-.808	-1.213	-.402	-4.001	.000
12. Statistical significance	-1.000	-1.370	-.630	-5.428	.000
13. Degree of freedom	-.846	-1.249	-.443	-4.217	.000
14. Sample size	-.615	-1.025	-.206	-3.017	.004
15. R-squared	-.904	-1.314	-.494	-4.428	.000
16. Interaction	-.904	-1.279	-.529	-4.839	.000
17. Variables vs. levels	-.846	-1.234	-.459	-4.385	.000
18. Standard scores	-.827	-1.249	-.404	-3.930	.000
19. β or Type-II errors	-.885	-1.265	-.504	-4.666	.000
20. Statistic	-1.000	-1.409	-.591	-4.910	.000

Perceived Understanding of Statistical Tests

As shown in Table 4, the relative degree of understanding of performance of statistical tests in descending order is: *independent samples t-test, one-way ANOVA, paired samples t-test, Pearson correlation, factorial ANOVA, regression, Chi-square, and repeated measures ANOVA.*

Table 4
Descriptive Statistics of Perceived Understanding vs. Importance of Statistical Tests

Statistical methods	Perceived Understanding			Perceived Importance		
	Rank	Mean	SD	Rank	Mean	SD
Pearson correlation	4	3.85	1.35	4	4.37	1.21
Regression	6	3.62	1.36	8	4.12	1.02
Chi-square	7	3.60	1.40	7	4.13	1.25
Independent samples t-test	1	4.13	1.27	1	4.54	1.06
Paired samples t-test	3	3.98	1.26	2	4.44	1.09
One-way ANOVA	2	4.04	1.20	3	4.44	1.11
Factorial ANOVA	5	3.62	1.24	5	4.23	1.13
Repeated measures ANOVA	8	3.52	1.39	6	4.21	1.09

Perceived Importance of Statistical Tests

The relative order of perceived importance in statistical tests was found to be only minimally different from the order of perceived understanding of the statistical tests, with a descending order of importance in the following: *independent samples t-test, paired samples t-test, one-way ANOVA, Pearson correlation, factorial ANOVA, repeated measures ANOVA, Chi-square, and regression.*

As shown in Table 5, statistical correlation (r = .45, p < .01) was found for participants' understanding of performing statistical tests and their perceived importance of appropriate performance of such tests in the graduate study. Spearman's and Kendall's tests also yielded statistical association between the factors of perceived competence and perceived importance of the statistical tests (Spearman's r = .46, p < .01; Kendall's r = .39, p < .01), suggesting that the participants tended to consider a statistical test more important in their own research when the performance of the test received a higher rating of proficiency relative to that of other tests.

Table 5
Correlations between Understanding & Perceived Importance of Statistical Tests

Correlation	Variables	Coefficient	*P* value	*R*-Squared (Effect size)
Pearson's	Understanding of Statistical Tests Perceived Importance of Statistical Tests	.45	< .01	.20 (Mid ~ Large)
Spearman's Rank-ordering	Understanding of Statistical Tests Perceived Importance of Statistical Tests	.46	< .01	.21 (Mid ~ Large)
Kendall's Concordance	Understanding of Statistical Tests Perceived Importance of Statistical Tests	.39	< .01	.15 (Mid)

Gap between Understanding and Perceived Importance of Statistical Tests

Paired samples t-test was performed again to check the difference between participants' understanding and perceived importance of the designated statistical tests. The Bonferroni procedure was performed to adjust the alpha level from *.05* to *.006* due to multiple t-tests. As shown in Table 6, the gap between the participants' understanding and perceived importance of all the designated statistical tests is significant at *.006* level except *regression, independent samples t-test, paired samples t-test, and one-way ANOVA*, suggesting that these tests would pose less learning difficulty than those tests with a significant gap. Among the tests with significant gap between understanding and perceived importance, *repeated measures ANOVA* and *factorial ANOVA*, in particular, shows medium to big effect size with *Cohen's d* ranging between .50 and .80 (King, Rosopa, and

Minium, 2010), indicating where MA students might have learning problems and therefore need more learning assistance.

Table 6
Paired Samples t-test on the Difference between Understanding and Perceived Importance of Statistical Tests

Statistical Tests	Mean Dif	95% Confidence Interval		*t*	Sig.
		Lower	Upper		
Pearson correlation	-.519	-.838	-.200	-3.267	.002
Regression	-.500	-.855	-.145	-2.826	.007
Chi-square	-.538	-.918	-.159	-2.846	.006
Independent samples t-test	-.404	-.745	-.063	-2.377	.021
Paired samples t-test	-.462	-.799	-.124	-2.746	.008
One-way ANOVA	-.404	-.754	-.054	-2.318	.025
Factorial ANOVA	-.615	-.947	-.284	-3.727	.000
Repeated measures ANOVA	-.692	-1.096	-.289	-3.445	.001

Attitudes toward the Statistical Analysis Tool and the Instructional Medium

The results of the question items on participants' attitudes toward statistics learningwere shown in Table 7. As far as question items on the use of statistical analysis tools areconcerned, around 89% of the participants thought classmate assistance facilitated familiarity with SPSS functions (Item 16), and 87% considered teachers' assistance would also help with proficient use of SPSS (Item 17). Moreover, 86% of the respondents felt that familiar use of SPSS helped reduce fear of statistics (Item 4), and another 86% even believed that familiarity with SPSS functions facilitated understanding of statistical concepts (Item 3). Eighty-five percent of respondents, on the other hand, believed that familiarity with statistical concepts helped better use SPSS (Item 7).

Table 7
Descriptive Statistics of Question Items on Attitudes towards Statistical Learning

Question items	Mean	SD
5. Appropriate selection of stat teaching materials helps to learn statistics effectively	5.50	.61
16. Resorting to classmates for statistical assistance facilitates SPSS operation	5.38	.49
21. Explaining statistical ideas using language learning and teaching related examples facilitates learning statistics	5.37	.74
14. Resorting to classmates for statistical assistance facilitates my understanding of statistical concepts	5.33	.65
20. The extent to which the course instructors assist students in learning will affect their learning effects in statistics	5.33	.68
15. Resorting to teachers for statistical assistance facilitates my understanding of statistical concepts	5.29	.89
19. The teaching approach of the course instructor will affect student learning effects in statistics	5.27	.79
17. Resorting to teachers for statistical assistance facilitates my use of SPSS	5.25	.90
6. Understanding statistics helps understand international journal papers	5.25	.84
4. Familiarity with SPSS operation reduces anxiety of statistics	5.21	1.07
3. SPSS proficiency facilitates understanding statistical concepts	5.19	.99
7. Understanding statistics facilitates SPSS operation	5.13	.71
1. Chinese stat learning materials helps better understand statistical concepts	5.02	1.00
10. I feel difficulty in reporting statistical results in an academic report	4.54	1.11
11. Understanding statistical concepts helps MA research and thesis writing	4.48	1.21
9. I feel difficulty in analyzing statistical outputs	4.48	1.20
12. I feel difficulty in expressing statistical concepts	4.44	.96
2. English stat learning materials helps better understand statistical concepts	4.17	1.20
13. I feel difficulty in generating statistical results in graphs and tables	4.16	1.16
8. Familiarity with statistical concepts facilitates practical English teaching	4.13	1.25
18. It is difficult for MA students with foreign language backgrounds to learn statistics well	3.88	1.54

As to the items on the language mode of statistics learning materials, respondents considered Chinese statistics learning materials (Item 1, 83%)

more helpful for learning than those written in English (Item 2, 69%). More important, as high as 91% of respondents agreed that appropriate choice of statistics teaching materials would lead to effective learning (Item 5), regardless of the language mode of the materials.

Interrelations among Statistical Concepts, Statistical Tests, and SPSS Use

Correlation analysis was conducted to understand the interrelationship among the perceived understanding of statistical concepts, proficiency in performing statistical tests, and the role of SPSS proficiency. Table 8 suggests that perceived competence in performing statistical tests was found to be significantly associated with the belief that familiarity with use of SPSS facilitates understanding statistics (r = .34, p < .05), indicating that students with better proficiency in performing statistical tests are more likely to believe in the facilitating role of SPSS proficiency in understanding statistical concepts. Similarly, participants believing in the beneficial role of statistics in understanding international journal papers tended to believe in the facilitating influence of SPSS proficiency on understanding statistical concepts (r = .37, p < .01). Moreover, whether English instead of Chinese course materials better facilitate comprehension of statistical concepts was shown to have statistical association with statistics competence (r = .56, p < .01), statistical test performance proficiency (r = .49, p < .01), and the number of statistics courses previously taken (r = .38, p < .01), suggesting that , in contrast to Chinese, English statistics learning material seemed to play a facilitating role in the comprehension of statistical concepts with growing course learning experiences in statistics, better statistics knowledge and increasing proficiency in the use of SPSS.

Table 8
Correlation among SPSS Proficiency, English Learning Materials, and Other Factors

Pearson correlation	Understanding stat concepts	Understanding stat tests	Understanding statistics helps understand international journal papers (Item #6)	Number of stat courses taken previously
SPSS proficiency facilitates understanding statistical concepts (Item #3)		$r = .34$, $p < .05$	$r = .37$, $p < .01$	
English stat learning materials helps better understand statistical concepts (Item #2)	$r = .56$, $p < .01$	$r = .49$, $p < .01$		$r = .38$, $p < .01$

Discussion

There arise special considerations for the statistics course offered for MA students of applied foreign language majors, in contrast to the other social science majors. First of all, most of the applied foreign language MA students had liberal art undergraduate backgrounds and had hardly any foundation in statistics. The students taking the statistics course tended to have learning anxiety over the subject. The statistics textbooks available on the market, unfortunately, are mostly unsuitable for applied foreign language majors due to use of irrelevant examples, theory-driven rather than application oriented content, inadequate coverage of the statistical analysis tool use, and conceptual confusion of statistical terms arising from Chinese translation from English counterparts. Understanding to what extent applied

English MA students comprehend statistical concepts and methods and how they perceive the statistics learning per se and the statistics analytical tool would thus become vital to help improve the design of applied foreign language graduate courses on statistics and lay out the preliminary statistics literacy for applied linguistics majors.

The results of this study showed that the participants had weak spots in learning the statistical concepts concerning indicators of effect size (e.g. *R-squared*) or those related to hypothesis testing, such as *Type-I* and *Type-II errors*. The concepts of hypothesis testing involve higher levels of abstraction and require more explanation through illustration and exemplification, while different statistical tests use specific indicators of effect size (e.g. *R-squared* for correlation, *Phi/Cramer's V* for Chi-square, *Percentage Variance/Cohen's d/Partial eta-squared* for ANOVA, etc.) and efforts should be made to differentiate various effect size indicators along with clarification of its meaning. In addition, despite their realization of its importance, the participants tended to have difficulty comprehending the concept of confidence interval, which indicates the necessity to reinforce its clarification and exemplification on the part of the course instructor. The importance of comprehending confidence interval lies in its advantages over *p-value* in providing the information needed for judging not only statistical significance, but for determining the effect size and precision of estimate as well. Larson-Hall (2010) therefore held that the information of confidence interval as well as degree of freedom and power be reported in the research findings of an academic publication. Still another term likely to confound students via its eluding meaning is degree of freedom, which can be better approached and understood by focusing on its functions in determining the critical value for statistical significance as well as its relation to sample size.

As to the learning of statistic tests, participants were found to be less

proficient in the application of repeated measures ANOVA, factorial ANOVA, Pearson correlation, and Chi-square. The less familiarity with and lower confidence in the use of repeated measures ANOVA, in contrast to more manageable *t*-test and other ANOVA models, is associated with its complicated involvement of both within-group and between-group variables and its rare inclusion into the research design of previous literature in applied linguistics. Relevant empirical studies employing repeated measures ANOVA, if any, can therefore be drawn on to help students understand when to use this test properly in the research context of foreign language teaching and learning. The learning problem with factorial ANOVA, moreover, involves the complication arising from requiring more than two independent variables in the design and the accompanying interaction. Interaction effects would also be tested as well as the main effects of several IVs. The learning problems with Chi-square, on the other hand, were apparently associated with its being the only non-parametric test, with different statistical assumptions from those adopted in parametric statistics, of the surveyed repertoire and with its requirement of all independent variables to be nominal or categorical in nature. Unlike repeated measure ANOVA and Chi-square learning problems, the difficulty in learning Pearson correlation, arose from its distinction from other types of correlation which involve use of different categories of data than the continuous type. Other likely learning difficulties stem from students' problems with interpreting the correlation not a causal relationship and with the meaning of the covariance between two variables as represented in the R-squared value. As a commonly used statistical test, Pearson correlation should be presented to students in a way that they realize why, when, and how to apply the test properly in their own research through exemplification of its actual use in previous applied linguistics literature.

One important finding of this study concerning the role of the statistical analytical software such as SPSS was that it was instrumental in facilitating learning of statistics via reducing statistics phobia. The clear implication for better pedagogical effects is to highlight in class the hands-on practices of SPSS, for example, to familiarize students with the use, application, and output interpretation, of the software so that solid and apt linkage between theoretical and practical perspectives of statistics can be established to inspire confidence in students and accomplish learning objectives successfully.

The study also found that with the more statistics proficiency, the more likely the participants would tend to appreciate not only the benefit of SPSS proficiency, but the English medium learning materials of statistics for better learning effects. Along with the participants' strong agreement with the critical effect of appropriate selection of learning materials on the learning outcome, the criteria of selecting statistics learning content and textbooks should take into account the English medium. The proportion of English medium course readings and/or course books, the extent to which the course lectures are delivered in English, and when in class to use English and when in Chinese, or whether simply the lectures are conducted entirely in English, should be well thought and incorporated into the course design.

Australian Bureau of Statistics (2011) proposed four criteria to evaluate statistical literacy: 1. data awareness, 2. ability to understand statistical concepts, 3. ability to analyze, interpret, and evaluate statistical information, and 4. ability to communicate statistical information and understandings. The findings of this study suggest that the preceding criteria by the ABS can be adjusted by adding the criterion of ability to use statistical software for advancement of statistical literacy of applied English majors. For the same purpose, the fourth criterion should be qualified to refer to the ability to communicate statistical information and understandings in English.

Conclusion

Comprehension of basic statistics concepts and knowledge of appropriate use of statistical tests is one of the essential abilities required of the graduate students of applied linguistics and other fields in social science. The results of this study helped understand the perception of applied foreign language MA students about their competence in statistics and its learning, shedding light on how a fundamental statistics course of the applied foreign language MA program can be better designed and what skills or abilities the statistical literacy in applied linguistics would essentially comprise. As a part of such literacy, MA students of applied foreign languages should be able to comprehend such basic statistic concepts as contribute to their reporting in English of quantitative results required in an academic publication as well as in the theses. Statistical literacy would also include the ability to make statistical inferences through proper application of inferential statistical tests in applied linguistic research design. A complementary ability to these essential qualities of the desired statistical literacy has been found to be the proficiency in using SPSS, the statistics analytical software as a key component of the literacy rubric.

Ongoing research can be done to follow up on several questions. First of all, investigation is needed to understand how well applied English students learn the statistics English taught in class in the form of English taught lectures, English medium learning materials, or English medium statistical analysis tools, and whether MA students' statistics learning achievement is significantly affected by their ESP proficiency in statistics. Studies, moreover, can be undertaken to ascertain the effect of English medium instruction in the introductory statistics course on the statistics learning outcome as compared to the effects of the control Mandarin mode or

the mixed mode.

Limitation

This study is limited in the research sample size and representativeness, and therefore the results may not be generalizable to a larger population. Further replication studies are suggested to better gauge the status of learning statistics in applied foreign language graduate programs in Taiwan and achieve a common understanding of the statistics literacy of applied linguistics.

References

Australian Bureau of Statistics (ABS). (2011). *Statistical literacy*. Retrieved on August 02, 2012 from http://www.abs.gov.au/ausstats/abs@.nsf/Products/1301.6.55.001~Mar+2011~Main+Features~Statistical+Literacy?OpenDocument

Brown, J. D. (1988). *Understanding research in second language learning.* Cambridge: Cambridge University Press.

Dunkel, P. (1986). Review of statistics in linguistics. *TESOL Quarterly, 20,* 549-552.

Flynn, S. (1985). Review of research design and statistics for applied linguistics. *TESOL Quarterly*, *19*, 155-158.

Fowler, F.J. (1983). *Survey research methods.* Beverly Hills, CA: Sage.

Hatch, E., & Farhady, H. (1982). *Research design and statistics for applied linguistics*. Rowley, MA: Newbury House.

Henning, G. (1986). Quantitative methods in language acquisition research. *TESOL Quarterly, 2*0, 701-708.

Johnson, D. M. (1992). *Approaches to research in second language learning.* New York: Longman.

King, B. M., Rosopa, P. J., & Minium, E. W. (2010). *Statistical reasoning in the behavioral sciences* (6th Ed). New Jersey: John Wiley & Sons, Inc.

Larson-Hall, J. (2010). *A guide to doing statistics in second language research using SPSS*. N.Y.: Routledge.

Lazaraton, A. (2005). Quantitative research methods. In E. Hinkel (Ed.), *Handbook of research in second language learning and teaching*

(pp.209-224). New Jersey: Lawrence Erlbaum Associates.

Lazaraton, A. (2000). Current trends in research methodology and statistics in applied linguistics. *TESOL Quarterly, 34*, 175-181.

Lazaraton, A., Riggenbach, H., & Ediger, A. (1987). Forming a discipline: applied linguists' literacy in research methodology and statistics. *TESOL Quarterly, 21*, 263-277.

Nunan, D. (1992). *Research methods in language learning.* Cambridge: Cambridge University Press.

Rumsey, D. J. (2002). Statistical literacy as a goal for introductory statistics courses. *Journal of Statistics Education* [Online], *10*(3). **(**www.amstat.org/publications/jse/v10n3/rumsey2.html**)**

Woods, A., Fletcher, P., & Hughes, A. (1986). *Statistics in language studies.* Cambridge: Cambridge University Press.

Zieffler, A., Park, J., Garfield, J., delMas, R., & Bjornsdottir, A. (2012). The statistics teaching inventory: A survey on statistics teachers' classroom practices and beliefs. *Journal of Statistics Education* [Online]. *20*(1), 1-29. (www.amstat.org/publications/jse/v20n1/zieffler.pdf)

Appendix 1

Questionnaire on MA Students' Learning of Statistics

I. Background Information

1. ___ Day MA Program ___ Weekend MA Program

2. Number of statistic courses previously taken

（1）Never （2）One （3）Two （4）More than three

3. In the statistic courses previously taken, the course books used were written in：

（1）Chinese （2）English （3）Both

4. My undergraduate major was:

（1）English （2）liberal arts other than English （3）Engineering

（4）Business & Management （5）Others：____ （Please specify）

5. My current work status：

（1）Jobless （2）With a full-time job （3）With a part-time job

6. （To those with full-time jobs）My work domain：

（1）Civil servant （2）Primary/Secondary school teachers

（3）Cram schools （4）Business （5）Electronics （6）Industrial sector

（7）Others：____ （Please specify）

7. （To those without full-time jobs）My previous work domain：

（1）Hospitality & tourism （2）Primary/Secondary school teachers

（3）Cram schools （4）Business （5）Electronics （6）Industrial sector

（7）Others：____ （Please specify） (8) No work experience

II. Please indicate the degree to which you understand the following statistical concepts, ranging from (1) Not Understand At All to (6) Completely Understand:

1. P-value:

2. Confidence Interval (CI)

3. Standard deviation

4. Effect size

5. Power

6. Hypothesis testing

7. Categorical vs. continuous variables

8. Independent vs. dependent variables

9. Score vs. frequency data

10. α or Type-I errors

11. Normal distribution

12. Statistical significance

13. Degree of freedom

14. Sample size

15. R-squared

16. Interaction

17. Variables vs. levels

18. Standard scores

19. β or Type-II errors

20. Statistic（No -s）

III. Please indicate the degree to which you think the following statistical concepts are important to your research or MA thesis, ranging from (1) Completely Unimportant to (6) Completely Important

1. P-value:

2. Confidence Interval (CI)

3. Standard deviation

4. Effect size

5. Power

6. Hypothesis testing

7. Categorical vs. continuous variables

8. Independent vs. dependent variables

9. Score vs. frequency data

10. α or Type-I errors

11. Normal distribution

12. Statistical significance

13. Degree of freedom

14. Sample size

15. R-squared

16. Interaction

17. Variables vs. levels

18. Standard scores

19. β or Type-II errors

20. Statistic（No -s）

IV. Please indicate the degree to which you understand the following statistical tests, ranging from (1) Not Understand At All to (6) Completely Understand:

1. Pearson correlation

2. Regression

3. Chi-square

4. Independent samples t-test

5. Paired samples t-test

6. One-way ANOVA

7. Factorial ANOVA

8. Repeated measures ANOVA

V. Please indicate the degree to which you think the following statistical tests are important to your research or MA thesis, ranging from (1) Completely Unimportant to (6) Completely Important

1. Pearson correlation

2. Regression

3. Chi-square

4. Independent samples t-test

5. Paired samples t-test

6. One-way ANOVA

7. Factorial ANOVA

8. Repeated measures ANOVA

VI. Please indicate the degree to which you agree with the following statements concerning learning statistics, ranging from (1) Completely Disagree to (6) Completely Agree

1. Chinese stat learning materials helps better understand statistical concepts

2. English stat learning materials helps better understand statistical concepts

3. SPSS proficiency facilitates understanding statistical concepts

4. Familiarity with SPSS operation reduces anxiety of statistics

5. Appropriate selection of stat teaching materials helps to learn statistics effectively

6. Understanding statistics helps understand international journal papers

7. Understanding statistics facilitates SPSS operation

8. Familiarity with statistical concepts facilitates practical English teaching

9. I feel difficulty in analyzing statistical outputs

10. I feel difficulty in reporting statistical results in an academic report

11. Understanding statistical concepts helps MA research and thesis writing

12. I feel difficulty in expressing statistical concepts

13. I feel difficulty in generating statistical results in graphs and tables

14. Resorting to classmates for statistical assistance facilitates my understanding of statistical concepts
15. Resorting to teachers for statistical assistance facilitates my understanding of statistical concepts
16. Resorting to classmates for statistical assistance facilitates SPSS operation
17. Resorting to teachers for statistical assistance facilitates my use of SPSS
18. It is difficult for MA students with foreign language backgrounds to learn statistics well
19. The teaching approach of the course instructor will affect student learning effects in statistics
20. The extent to which the course instructors assist students in learning will affect their learning effects in statistics
21. Explaining statistical ideas using language learning and teaching related examples facilitates learning statistics

VII. Please share additional thoughts on your statistical learning