MEASURING THE GAPS BETWEEN THE RESEARCH AND STATISTICAL SKILLS AND THE TRAINING NEEDS OF GRADUATE STUDENTS

By

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TABLES OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

MENGUKUR JURANG ANTARA KEMAHIRAN PENYELIDIKAN DAN STATISTIK SERTA KEPERLUAN LATIHAN SISWAZAH

ABSTRAK

Kajian ini dicetuskan atas kekurangan kajian yang memberi maklumat asas yang sah dan boleh dipercayai mengenai keperluan latihan siswazah dalam bidang penyelidikan dan statistik. Tujuan utama kajian ini ialah meneliti status persediaan siswazah dalam melaksana dan menilai kajian penyelidikan, pengetahuan asas serta keperluan latihan siswazah dalam bidang penyelidikan dan statistik. Tujuan seterusnya ialah meneroka peranan pembolehubah demografik dan situasi dalam menjangka keseluruhan keperluan latihan. Kajian ini telah mengubahsuai model Borich (1980) bagi menjana senarai keperluan latihan mengikut keutamaan dan menggunakan analisis kuadran bagi menyediakan senarai-senarai keperluan latihan mengikut keutamaan yang disarankan masing-masing oleh siswazah ijazah dan siswazah ijazah lanjutan. Sasaran populasi kajian ini terdiri daripada para siswazah yang kini mengikuti kursus ijazah atau kursus ijazah lanjutan di keempat-empat universiti awam (i.e., UKM, UM, UPM, and USM). Templat soal selidik telah direka dan data dikumpul melalui langganan tinjauan dalam talian. Sejumlah 240 soal selidik yang lengkap dikembalikan dan dianalisis.

Para siswazah mencatat aras rendah ke serderhana dalam persediaan menilai dan melaksana kajian penyelidkan. Keputusan ini adalah dijangka memandangkan pengetahuan asas mereka dalam bidang penyelidikan dan statistik terhad kepada aras pengenalan sahaja. Para siswazah menilai keperluan latihan yang tinggi dalam topik-topik yang tersenarai dalam peringkat interpretasi data. Topik-topik itu termasuk interpretasi hasilan statistik, interpretasi nilai-nilai p, interpretasi signifikan statistik dan signifikan praktikal, dan membuat generalisasi. Tambahan pula, topik-topik pengukuran seperti membina instrumen, menentukan

bukti kesahan dan kebolehpercayaan, serta analisis faktor juga mencatat keperluan latihan yang tinggi. Oleh itu, topik-topik atau kemahiran tersebut perlu menjadi asas untuk membangun, melaksana, menilai, dan mempertingkatkan program latihan penyelidikan dan statistik. Siswazah yang mempunyai pendedahan kepada pakej statistik mencatatkan tahap persediaan keseluruhan yang lebih tinggi semasa menilai dan melaksana kajian penyelidikan. Mereka ini juga mencatat pengetahuan keseluruhan dan pencapaian keseluruhan yang lebih tinggi dalam topik-topik penyelidikan dan statistik. Satu pemerhatian dalam kajian ini ialah selain daripada pendedahan kepada pakej statistik, tiada pembulehubah demografik dan situasi lain yang dapat menyumbang secara signifikan kepada jangkaan keseluruhan keperluan latihan. Sumbangan varian oleh pendedahan kepada pakej statistik yang rendah menunjukkan kekurangan pendedahan para siswazah kepada pakej statistik dan ia perlu dipertimbangkan semasa menstruktur dan membangunkan kurikulum. Akhir sekali, kajian ini juga mengesahkan penggunaan model Borich dalam menetukan keperluan latihan berdasarkan min pemberat skor diskrepensi (mean weighted discrepancy score).

MEASURING THE GAPS BETWEEN THE RESEARCH AND STATISTICAL SKILLS AND THE TRAINING NEEDS OF GRADUATE STUDENTS

ABSTRACT

This study was initiated by the lack of research-based study to provide reliable and valid information regarding graduate students' training needs in the area of research and statistics. The primary purpose of this study was to examine the graduate students' state of preparedness in conducting and evaluating research literature, their knowledge base and their training needs in the area of research and statistics. The secondary purpose was to identify the graduate students' demographic and situational variables that may explain or predict the overall training needs. This study modified the Borich (1980) model to prioritize graduate students' training needs and utilized quadrant analysis to provide informative list of training for master students and doctoral students respectively. The target population was graduate students who currently pursuing their master degree or doctoral degree in the four public universities (i.e., UKM, UM, UPM, & USM). The questionnaire template was designed and data collection was accomplished through the subscription of web-based survey. A total of 240 fully completed surveys were returned and analyzed.

Graduate students reported low to moderate preparedness level in evaluating and conducting research. This result was not surprising since their knowledge base were confined to introductory level research and statistics. Graduate students rated high training needs in the topics listed in data interpretation stage which included interpret statistical output, interpret p-values, interpret statistical and practical significance, and make generalization. In addition, the measurement topics such as construct instruments, establishing validity evidence and reliability estimates, and factor analysis were also reported as having

high training needs. Therefore, it is crucial that these topics or skills should form the basis for developing, implementing, evaluating, and improving research and statistics training program. Graduate students who have exposure to statistical software packages rated significantly higher overall preparedness level in evaluating and conducting research, higher overall knowledge and overall performance in research and statistics topics/skills. A worth noting area is that none of the selected demographic and situational variables except exposure to statistical package(s) found to be significant predictor of graduate students' overall training needs. The low variance explained by the exposure to statistical package(s) indicated the insufficiency of students' exposure to statistical package(s) and needed to be considered when training curriculum is structured and developed. Finally, the use of Borich model in determining training needs based on the mean weighted discrepancy score (MWDS) was further validated.

CHAPTER 1

INTRODUCTION

The Malaysian higher education sector undergone profound changes during the past one decade. The central part of the change is the increased accessibility of education through both public and private universities which admit an increasing cohort of school leavers, adult learners and generally a more diverse set of students than in the past. The increase in students' enrolment was staggering, rising from about 35,000 in 1990, to about 250,000 in 2005, and an estimated 942,000 students in which included 50, 000 international students (Ministry of Higher Education Malaysia, 2010). Besides 485 private colleges, Malaysia now has 20 public universities, 32 private universities and four foreign university branch campuses. In "Strategic Plan for Higher Education: Laying the Foundation Beyond 2020" (Ministry of Higher Education Malaysia, 2007) the measures and strategies that will make Malaysia an International centre of education excellence were outlined. To propel towards this goal, four of the 20 public universities (Universiti Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM), and Universiti Sains Malaysia (USM)) have been assigned research university status with additional funding for Research and Development and commercialization of research in 2006. The ministry also plans to identify one or two APEX (Accelerated Programme For Excellence) universities within the period of the Ninth Malaysian Plan. In 3rd September 2008, Universiti Sains Malaysia has been declared as first APEX University by the Ministry of Higher Education.

In the quest to achieve world class standards, all universities (public and private) strive for excellence in all their activities, one of which is academic

excellence. The academic excellence was measured partly by the quality of research works (theses and academic publications) done by the graduate students (Mahmud & Zainol, 2008). In an effort to upgrade the quality of research, the graduate students' competencies in research related tasks would be of main concern. Research related tasks are wide range in nature and they vary depending on the disciplines and the majors of study. This study will however focus on competency in statistical data analysis and research methodology among graduate students in the field of education.

1.1 Background of the study

Research methodology and statistics provide the basic tools in quantitative educational research. Statistics are not to be considered only at the time of data analysis. Rather, the principles of statistics need to be understood and taken into consideration during the planning phase of the research as well. For example, these principles can guide the researchers in obtaining a level of measure that is desired, using an instrument that is valid and reliable, selecting a sample that is representative of the population and that is of sufficient size, and obtaining answers to research questions or testing hypotheses that can be generalized to the population from the sample. Without the understanding of these available tools, it is impossible to design and carry through a sound quantitative educational research. Unfortunately, review of the literature indicates that novice researchers or graduate students are under-prepared or ill-prepared in their quantitative research and methodological training (Faghihi, 1999; Gorard, Rushforth, & Taylor, 2004, Hutchinson & Lovell, 2004, Malaney, 2002). A large number of novice researchers faced with the arduous task of choosing appropriate research methodology and correct statistical analysis

techniques. Perez Lopez, Pedroza, & Luciano (2006) found that students encountered difficulties mainly in their choice of suitable statistical test concerning their objectives of research, the way of interpreting data, selection of the design consistent with their objectives, the comprehension of the meaning of some statistical concepts, and the decision on the use of charts or graphs. These important initial steps in research appear to pose some problems to novice researchers and become a deterrent to their completion of the research (Caplovitz, as cited in Akpanumoh, 1996). Many doctoral students even indicate a sense of frustration, loneliness, self doubt and anxiety which eventually led to their withdrawal from the process. This mainly evolves from inadequate preparation and training in conducting research (Faghihi, 1999).

The quality of quantitative works in educational research also received criticisms. These can be evidenced by empirical studies in which researchers have found that many of the published studies reported in journal articles and unpublished studies (i.e., theses or dissertations) in the field of education are seriously flawed, containing analytical and interpretational errors (Daniel, 1998; Keselman et al., 1998; Onwuegbuzie, 2002; Thompson, 1994, 1998; Vockell & Asher, 1974). Harwell (2001) has stated that a failure to provide the students with the necessary basic foundation knowledge could result in the misapplication and misinterpretation of many powerful statistical tools. Gorard et al. (2004) had attributed a widespread weakness in education research to a shortage of skills in 'quantitative' methods. They raised great concern on the poor quantitative works that have been done and too few researchers who could actually use the sophisticated analysis of complex datasets. There is still a great deal of evidence that educational researchers do not have the necessary understanding of statistical

concepts and process to appreciate the methods which are really appropriate to their needs (Batanero, 2001). Therefore, Hutchinson & Lovell (2004) urged that graduate programs in higher education need to provide research training of sufficient depth and scope to prepare graduates not only to be proficient producers of research but also critical consumers of research literature.

According Capraro & Thompson, 2008, graduate students methodological training informed our expectation regarding the capacity and ability of future scholars to use tools from the complex and ever-expanding array of methods available. Malaney (2002) has observed the deficiency in methodological training among higher education and student affairs professionals, may limit not only the students' ability to read and evaluate research literature but also students' ability to produce research. To ensure the quality and quantity of educational research, graduate program should provide sufficient training to graduate students with sufficient depth of knowledge and skills in conducting and evaluating research literature. In order to provide appropriate and effective training, graduate students' training in the area of research and statistics should be examined.

1.2 Statement of the Problem

More complex research is designed to facilitate more rigorous tests of new theories. Methodologists during the past century have produced a wealth of statistical techniques that can be used to explore and understand research data. With the widespread availability of statistical software (e.g., SPSS, SAS, and Minitab), many different statistical techniques such as factor analysis, multiple regression,

multivariate analyses of variance (MANOVA), structural equation modeling (SEM), canonical correlation, and discriminant analysis can be utilized quite readily. These would appear to be especially important in educational settings where multiple dependent and multiple independent variables are simultaneously analyzed. With the data explosion and ever-increasing need for more analytical capability, more rigorous and sophisticated techniques are required to perform the necessary confirmatory analyses (Hair, Black, Babin, Anderson, & Tatham, 2006). It is expected of graduate students to take advantage of those powerful multivariate available procedures in their research. Furthermore, review of statistical techniques employed in published educational literature indicated that more sophisticated procedures are beginning to appear in the education research literature, requiring knowledge of multivariate procedures including factor analysis, canonical correlation analysis, structural equation modeling, and logistic regression. The widespread use of statistical techniques in a variety of educational journals underscores the importance of including a wide range of statistical knowledge and skills in training educational researchers. However, various studies have cited the deficiency in research and statistics training among graduate students (Aiken, West, Sechrest, & Reno, 1990; Curtis & Harwell, 1998; Faghigi, 1999; Malaney, 2002). Kuh, Bean, Bradley, & Coomes (1986) and Goodwin & Goodwin (1985a) have noted that the utility of journals as a source of current information is often limited by the research training of the reader. Therefore, Hutchinson & Lovell (2004) have urged that graduate program in higher education need to provide research training of sufficient depth and scope to prepare graduate students not only to be proficient producers of research but also critical consumers of research literature.

Some doctoral and master students were informally interviewed by researcher during colloquium, conference, and research training workshops regarding their preparation in research and statistics. All of them have commented that the current research and statistics courses are hardly adequate to prepare them to evaluate and conduct their own research. In addition, they have expressed the needs for assistance and extensive research and statistics training. In order to gain insight the current graduate research and statistics preparation, Teong, Ong, & Low (2009) have conducted an informal review of research and statistics curriculum through brochures, graduate students' handbook or guide book, and web pages from the school or faculty of education within the four research universities (UKM, UM, UPM, & USM). The results indicated that it is compulsory for graduate students who pursue Master degree to register for a minimum of two courses related to research methodology and statistics. In two of the universities (USM, and UKM), doctoral students who enrolled in research mode are not required to take any research or statistics courses. A detailed analysis of the content of the statistics courses showed that more emphasis was placed on basic statistical techniques such as descriptive, correlation, t-test, chi-square, and one-way ANOVA. More advanced techniques such as factor analysis, hierarchical linear modeling, and canonical correlation seem to be missing in the statistics courses. In the same study (Teong et al., 2009), results from the content analysis on a sample of current theses (2001-2006) completed in the field of education within the four Malaysian public higher institutions (UKM, UM, UPM, & USM) revealed that univariate statistics such as t-test, Pearson correlation r, and one-way ANOVA were overwhelmingly being used throughout the years. Multivariate statistics and more advanced techniques appeared to be missing in the current theses. The statistical techniques used in education

theses match with the content coverage of graduate level statistics courses. This may provide explanation to the claim that the lack of utility of advanced statistical techniques in theses is attributed by the statistics training given to graduate students. Assuming that the statistical techniques employed in theses examined are typical of graduate students' statistical knowledge base, then the findings from this study may signal graduate students exhibit lack of mastery in utilizing more advanced statistical techniques. This finding also suggested that majority of the graduate students will most likely face difficulties to comprehend and to evaluate the journal articles in the field of education. Therefore, this study first sought to examine the current graduate students' research and statistics knowledge base, and their preparedness in conducting and evaluating the research literature.

Research activities constitute the core component in graduate program. Students in many disciplines have reported having problems with research courses. Quantitative methods and statistics in particular have been noticed to cause problems in many disciplines (Onwuegbuzie & Daley, 1998; Thompson, 1994; Murtonen & Lehtinen, 2003). Training that educational researchers or graduate students receive affected all educational research, its quality, and its impact on the field. Therefore, graduate training is the major concern in the university's goal to provide quality education and quality research. Need assessment study is the initial and important step to the success of a training program. It is important that the empirical findings about students' training needs should be considered before appropriate training programs are planned and developed. Various studies have been conducted to assess the graduate students' statistical preparation, statistics curriculum, and their competencies in research and statistics (i.e., Aiken, West, & Millsap, 2008; Aiken et al., 1990; Curtis & Harwell, 1998; Mahmud & Zainol, 2008). Little attention has

been paid to address the training needs. The lack of research-based study to provide reliable and valid information regarding Malaysian graduate students' training needs in the area of research and statistics has motivated this study.

1.3 Purpose and Objectives of the study

The primary purpose of this study is to examine the graduate students' state of preparedness in conducting and evaluating research literature, their knowledge base and their training needs in the area of research and statistics. The secondary purpose was to explore and identify the graduate students' background characteristics and situational information that may explain or predict differences in graduate students' self-rated level of knowledge, performance, and training needs in research and statistics. The following objectives were developed to guide this study:

1. To assess the status and trends of statistical techniques used in current education theses.

2. To assess the current state of preparedness of graduate students in research and statistics.

3. To identify and rank-ordered the graduate students' self-rated importance of the selected research and statistics topics.

4. To identify and rank-ordered the graduate students' self-rated knowledge and performance of the selected research and statistics topics.

5. To identify and prioritize the graduate students training needs in research and statistics.

6. To determine the rankings of training needs by mean weighted discrepancy score (MWDS) and by three criterion variables (importance, knowledge, and performance), and the relationships between graduate students overall MWDS and their overall importance, overall knowledge, overall performance, and overall preparedness level.

1.4 Research Questions

Based on the research objectives, the research questions were generated as follows:

1. To assess the status and trends of statistical techniques used in current education theses.

    1.1 What are the commonly used statistical techniques in education theses?

    1.2 Is there any difference in the distribution on the level of statistics employed in education theses and the level of statistics used in current research projects?

2. To assess the current state of preparedness of graduate students in research and statistics.

    2.1 What is the graduate students' self-rated level of preparedness in evaluating and conducting the research?

2.2 Is there any difference in preparedness level between doctoral students and master students in evaluating and conducting the research after controlling the difference in the number of research and statistics course(s) attended?

2.3 How well graduate students' preparedness level can be predicted from a combination of the selected demographic and situational variables?

2.4 Is there any significant difference in the level of preparedness between graduate students who would use different approaches in research and those who would not?

2.5 Are graduate students who have exposure to statistical package(s) more likely to use statistical package(s) in their research project(s)?

2.6 Is graduate student's selection of statistical techniques level used in research projects related to the level of statistics courses attended?

3. To identify and rank-order the graduate students' self-rated importance of the selected research and statistics topics.

3.1 What are the research and statistics topics that are rated as important by the graduate students?

3.2 Is there any difference between doctoral students and master students on a linear combination of self rated importance within the four research stages?

4. To identify the graduate students' self-rated knowledge and performance of the selected research and statistics topics.

4.1 What is graduate students' self-rated level of knowledge in research and statistics topics?

4.2 Is there any difference between doctoral students and master students on a linear combination of self-rated knowledge within the four research stages?

4.3 Which combination of the demographic and situational variable(s) best explains the overall self-rated knowledge score?

4.4 What is graduate students' self-rated level of performance in the topics of research and statistics?

4.5 Is there any difference between master and doctoral students on a linear combination of self-rated performance within the four research stages?

4.6 Which combination of the demographic and situational variable(s) best explains the overall self-rated performance score?

4.7 Do graduate students who have exposure to statistical software package(s) tend to have higher level of knowledge and ability in performing data analysis?

5. To identify and prioritize the graduate students' training needs in research and statistics.

5.1 What are the research and statistics topics that rank highly and rank lowly in knowledge discrepancy mean scores and performance discrepancy mean scores?

5.2 What are the research and statistics training needs in terms of knowledge dimension and performance dimension?

5.3 What are the integrated training needs in research and statistics for graduate students?

5.4 Which combination of the demographic and situational variable(s) best explains the overall training needs (MWDS) scores?

5.5 Is there any difference between master and doctoral students in their research and statistics training needs?

5.6 What are the prioritized training needs in the area of research and statistics for master and doctoral students?

6. To determine the rankings of training needs by mean weighted discrepancy score (MWDS) and by three criterion variables (importance, knowledge, and performance), and relationships between graduate students overall MWDS and their overall importance, overall knowledge, overall performance, and overall preparedness level.

6.1 Is there any relationships between the graduate students' overall training needs and their self-rated overall importance, overall knowledge, overall performance, and overall preparedness level?

6.2 Is there any difference in the rankings of the self-rated level of importance, knowledge, and performance for each of the research and statistics topics/skills?

6.3 Do the rankings of training needs by MWDS differ from the rankings by singly importance means, knowledge means, or performance means?

1.5 Significance of the Study

In the National Higher Education Plan 2007-2010 (Ministry of Higher Education Malaysia, 2007), "My Brain 15", it was stated that "Malaysia must accelerate the production of high-caliber human capital at the doctoral level … create a pool of up to 100,000 high quality graduates with doctoral degrees within the next 15 years". It is clear that higher institutions will undergo profound changes in years to come. One of which is the increasing cohorts of graduate students and generally a more diverse set of students than in the past. Graduate research and statistics training informs our expectations about the capacity of future scholars or researchers to produce sound and quality educational research. The task of training graduate students with diverse quantitative backgrounds is complicated by the sheer volume of knowledge which has to be transferred in a limited time frame. This also creates the challenge for the faculty and educator to develop common and oriented research and statistics course to meet the needs of this burgeoning group. This study can serve as an initial and essential step toward assessing the training needs in research and statistics among graduate students and provide fundamental information to develop common core of studies that all beginning researchers in the field of education should master.

In the quest to be world renowned research universities, all universities strive to achieve excellence in all their activities, one of which is the production of high

quality graduates. The qualities of graduates are measured in part by the quality of the students' research works. There is no doubt that the training of graduate students in research methodology and statistics becomes vital to ensure the quality of the empirical research. A lack of training can easily lead to an incomplete understanding and misuse of the methods. Recent developments in statistics and research methodology combined with increased expectation of human service providers require researchers in social sciences to increase the integrity and sophistication of their research. These have created challenges to faculty and educators in their work of equipping students for a constantly evolve methodological field. Therefore, the training of researchers or graduate students in research and statistics becomes much more acute. The need for well-trained researchers has not lessened; more are needed with the knowledge and skills necessary to deal with advancement in statistics. Awareness of graduate students' statistical preparation and training needs is important for planning graduate training programs which will ensure graduates are equipped with the necessary skills to be intelligent consumers as well as producers of research. The findings from this study provide baseline research data for designing or revising graduate research curriculum to suit the different audience or learners, and in planning more research and statistics courses or workshops to equip graduate students with adequate and relevant knowledge and skills.

As far as this study is able to determine, there is not much literature on training graduate students and researchers in the area of research and statistics. Although a survey of statistical preparation for doctoral students has been conducted in the field of education (Curtis & Harwell, 1998) and studies of quantitative methodology curriculum have been conducted in psychology (Aiken et al., 2008; Aiken et al., 1990), there is a lack of systematic research on what current graduate

students' are learning and their training needs in the area of research and statistics. This study will provide a framework or systematic approach to assess the training needs of graduate students as well as provide momentum for future needs assessment studies.

1.6 Definition of Terms

Background Characteristics/Variables provided information on type of program (Master, PhD, or EdD), candidature status (Full Time or Part Time), program mode (Coursework, Mix-mode, or Research Mode), current semester (I, II, III, IV, V, VI, VII, VIII & Above), and gender (Female or Male)

Situational Information/Variables provided information on number of research and statistics courses attended by graduate students during their undergraduate and graduate studies (0, 1, 2, 3, 4, & 5), and the exposure to statistical package (Yes or No).

Graduate students referred to all master students and doctoral students who enrolled in the school/faculty of education in Malaysia Science University (USM), Malaya University (UM), Malaysia Putra University (UPM), and Malaysia National University (UKM) at the time the data were collected.

Research and Statistics Topics or Skills represented the concepts and tasks related to quantitative educational research. These concepts and tasks were grouped into four common research stages which are research process/design; data

collection/gathering, data analysis, and data interpretation (Refer to Section B in Appendix B).

Preparedness was determined by graduate students' self-rated level in understanding the basic concepts or general idea of some statistical techniques; to read the analysis procedures in research articles/literature; critically evaluate the appropriateness or inappropriate use of statistical techniques in research literature; conduct data analysis by applying the correct statistical techniques; interpret the results in relation to p-value, effect size, and generalization.

Importance was indicated by graduate students' self-rated the relative importance of the research and statistics topics or skills to their studies and research projects.

Knowledge was indicated by graduate students' self-rated ability to accurately recall, paraphrase, or summarize the procedural mechanics of the research and statistics tasks.

Performance was indicated by graduate students' self-rated ability to perform or use the research and statistics knowledge/skills in their research studies and projects.

Gaps were determined by knowledge discrepancy scores and performance discrepancy scores. Adopting the Borich Model (1980), knowledge discrepancy score of each topic/skill was calculated by subtracting the knowledge rating from importance rating, and the performance discrepancy score of each topic/skill was calculated by subtracting the performance rating from importance rating.

Training Needs were determined by mean weighted discrepancy scores (MWDS). Adopting the Borich Model (1980), MWDS of each topic/skill was calculated by

assigning weight (mean importance) to the discrepancy score (gap). Refer to Chapter 3 for the calculation of MWDS.

1.7 Assumptions

Thesis can be viewed as capstone in doctoral training. It ends an academic training process and begins an academic career of research, publications and teaching. Therefore, it is reasonable to assume that the statistical techniques used in education theses mirror some degree of statistical knowledge or skills possessed by graduate students in particular and statistical practices by educational researchers in general.

According to Borich (1980), a central characteristic of this model is that it is self-evaluating, relying upon the respondents' judgment about their own performance. The underlying assumption is that the respondents can best judge their own performance and rate themselves objectively. Therefore, this study assumes that the graduate students are the only ones who can best judge their own knowledge and performance and, when called upon to make such judgment, they could objectively do so. This assumption is particularly true when the purpose of data collection is the evaluation of training needs not the evaluation of individual graduate students.

Given that the four public higher institutions in this study are among the first announced research–based universities in the nation and have most graduate students who are currently pursuing their master and doctoral degree in educational studies. Thus, it is assumed that the determined training needs can be generalized to other higher institutions in the country.

1.8 Limitations

Although every effort is taken to ensure that sound methodology is employed, several limitations associated with the current study need to be described.

The review of theses completed by doctoral students was for a short duration (from 2001-2006). Generally, a doctoral candidate takes three or more years to complete a thesis. Thus, caution is needed for making generalization of findings of this study to previous years and to other educational theses which are different from those under studied. Furthermore, the classification levels of statistical techniques into basic, intermediate and advanced level is based on the statistics listed by Baumberger & Bangert (2005). The advancement of technology has propelled and facilitated the use of advanced statistics which may require changes in the classification.

The results from the cross-sectional survey are limited to the time that the study is conducted. The population was limited to four research-based universities and the exclusion of other universities and private institutions may limit the generalizability of findings. Likewise, various university policies concerning the right of privacy did limit access to entire university populations in some cases. Thus, an important potential limitation is that the group of non-responders in each university may have significantly different training needs than those reported by the sample in this study.

1.9 Summary

The background and problem statement of this study have been discussed. The purpose and objective for this study, research questions, significance of the study, assumptions, limitations, and definition of terms have been presented. The primary purpose of this study is to examine the graduate students' state of preparedness in conducting and evaluating research literature, their knowledge base and their training needs in the area of research and statistics. The secondary purpose is to explore and identify the graduate students' background characteristics and situational information that may explain or predict differences in graduate students' training needs in research and statistics.

CHAPTER 2

REVIEW OF LITERATURE

This chapter first depicted the role of statistics in research, followed by discussion of development and advancement in statistics. Previous studies on graduate students' research and statistical preparation, statistics curriculum were reviewed. Next is to review research and statistics competencies or skills needed by graduate students to be critical consumers and producers of research. The reviews of statistical techniques used in some prominent educational journals were summarized. And finally, various needs assessment models were reviewed to frame the conceptual model for this study.

2.1 Role of statistics in Research

Statistics is a subject that provides a body of principles and methodology for designing the process of data collection, summarizing and interpreting the data, and drawing conclusion or generalities (Johnson & Bhattacharyya, 2006). Statistics play a number of major, interrelated roles in quantitative research. Statistics is a discipline which mainly deals with data quantification. Even in the case of non numerical data, statistical methods use transformations to change non numerical to numerical data with the aim of achieving some level of quantification to make conclusions about the matter of interest (Cobanovic, 2002). Therefore, statistics can be used as a tool for research generally, spreading in scientific research as well as social sciences research. The science of statistics has much to offer the researchers in planning, analyzing, and interpreting the results of their investigations. The

science of statistics deals with collecting and summarizing data, designing experiments and surveys, measuring the magnitude of variation in both experimental and survey data, estimating population parameters and providing various measures of the accuracy and precision of these estimates, testing hypotheses about populations, and studying relationships among two or more variables (Ostle & Malone,1988).

Guilford & Frutcher (1978) stated that statistical techniques provided the basic tools in educational research. Without understanding of these available tools, it is impossible to design and carry out a sound quantitative educational research. Researchers needed knowledge and skills in statistical techniques to keep alive his research interest and research activities. He further stated the importance of statistics in research and the advantages of statistical thinking in research operation as follows:

1. Statistics permit the most exact kind of description.

2. Statistics force us to definite and exact in our procedures and in our thinking.

3. Statistics enable us to summarize our results in a meaningful and convenient form.

4. Statistics enable us to draw general conclusions.

5. Statistics enable us to make predictions.

6. Statistics enable us to analyze some of the causal factors of complex and otherwise bewildering events.

Healey (2002) explained the role of statistics in scientific inquiry based on the thinking of Walter Wallace. Figure 2.1 graphically represents the role of

statistics in the research process. The diagram illustrates how the knowledge base of any scientific enterprise grows and develops. Wallace's wheel of science illustrates how theory stimulates research and how research shapes theory. This constant interaction between theory and research is the lifeblood of science and the key to enhancing the understandings of social world. The dialog between theory and research occurs at many levels and in multiple forms. Statistics are one of the most important links between these two realms. The figure is circular and has no beginning or end, so the discussion can start at any point. A theory is an explanation of the relationships between phenomena. People develop explanation to understand these phenomena. According to Healey (2002), a major difference between informal explanations of social phenomena and scientific theory is that the latter is subject to rigorous testing process. To find out whether the theory is true or false, some research needed to be conducted. Scientific theories are often too complex and abstract to be fully tested in a single research. Therefore, one or more hypotheses must be derived from the theory. A hypothesis is a specific and exact statement about the relationship between variables which logically derived from the theory. The next step is data gathering phase of the research in where the decisions have to be made on how cases will be tested, how samples will be selected, and how exactly the variables will be measured. These will lead to the observation phase where the social reality is measured. The statistics will take place as the observations phase comes to an end. Statistics provide systematic ways to analyze data, to identify and probe trends and relationship, to develop generalization, and to revise and improve the theories. At the end of statistical analysis, the empirical generalizations begin to develop based on the observed empirical patterns. Besides assessing the theory, other trends in the data also will be observed. The process of revising and

elaborating theory begins when tentative explanations are developed. If researchers change the theory to take account of these findings, however, a new research designed to test the revised theory is called for, and the wheel of science would begin to turn again. With the new, and hopefully, improved theory, researcher will go through the entire process once again.

Healey (2002) pointed out two important features about statistics: First, statistics are crucial, simply put, without statistics, quantitative research is impossible. Without quantitative research, the development of the social sciences would be severely impaired. Only by the application of statistical techniques can mere data in shaping and refining the theories and understand the social world better. Second, as Figure 2.1 makes clear, scientific research proceeds through several mutually interdependent stages, and the statistics become directly relevant only at the end of the observation stage. According to Johnson & Bhattacharyya (2006), statistical concepts are also essential during the planning stage of an investigation when decision must be made as to the mode and extent of the sampling process. In other words, before any statistical analysis can be legitimately applied, the preceding phases of the process must have been successfully completed. If the researcher has asked poorly conceived questions or has made serious errors of design or method, then even the most sophisticated statistical analysis is valueless. Therefore, statistics plays important role in scientific inquiry by providing the methodology to make inferences about the population from the collection of data and analysis. Without statistics, the interaction between theory and research would become extremely difficult, and the progress of the disciplines would be severely retarded. Given its extended goal, statistics has penetrated all field of human endeavor in which the evaluation of information must be grounded in data-based evidence. Statistics is

clearly an important tool in scientific discovery that significantly impacts modern society.

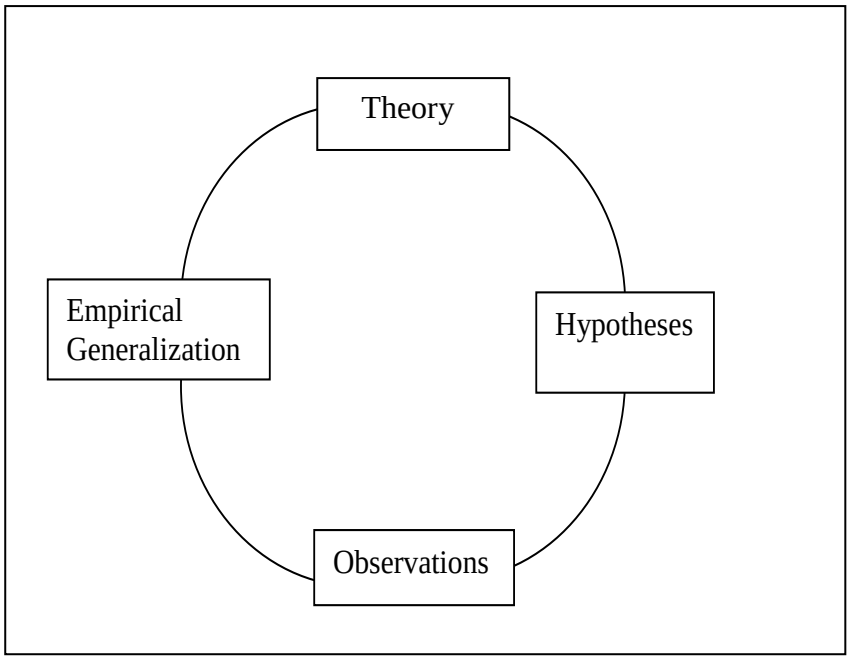

Figure 2.1. Wheel of Science
Source: Cited from Healey J.F. *A Tool for Social Research* (2002)

2.2 Development and Advancement in Statistics

In 1960s, some statistical techniques had limited use because of the computing difficulty. Many statistical procedures require inversion of matrices, much efforts was spent to trying to manage computational problem especially when the large number of variables under studied and the need to work with the large data sets. The used of statistical techniques or theories were restricted by the computing limitations. However, with the advent and accessibility of high-speed computers, statistical software have been developed which not only makes the job of statistician easier but also puts statistics within the reach of people who consider themselves as "statistics illiterate".

Methodologists during the past century have produced a wealth of statistical techniques that can be used to explore and understand research data. More complex research methodologies and data analysis procedures are designed to facilitate more rigorous test of theories. With the widespread availability of statistical software (i.e., SPSS, SAS, and Minitab), many different statistical techniques such as factor analysis, multiple regression, multivariate analyses of variance (MANOVA), structural equation modeling (SEM), canonical correlation, and discriminant analysis can be utilized. The development likely affected the selection of statistical techniques in data analyses. Kieffer, Reese, & Thompson (2001) also noted that advances in both technology and methodology affect the manner in which analyses are conducted and even researchers' paradigm for thinking about analytical issues. The advances in statistical techniques have changed the nature of the questions researchers ask and the settings in which they perform their research, these developments also have led to the posing of broader and more complex questions. Consequently, use of more sophisticated techniques can potentially allow more thorough analysis of study data by utilizing complex modeling with multiple variables.

In the first half of the 1900s, univariate procedures such as analysis of variance, the t test, chi square, and the simple bivariate correlation are popular data analysis techniques used in educational research. ANOVA methods have been used throughout a variety of education and psychological journals (Edgington, 1974; Elmore & Woehlke, 1988; Goodwin & Goodwin, 1985a, 1985b). The utility of ANOVA is limited to nominally scaled manipulated variables or naturally occurring nominally scaled independent variables. The landscape of statistical analysis changed with the realization that ANOVA methods are extension of General Linear