THE IMPACT OF KNOWLEDGE MANAGEMENT PRACTICES IN IMPROVING STUDENT LEARNING OUTCOMES

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THE IMPACT OF KNOWLEDGE MANAGEMENT PRACTICES IN IMPROVING STUDENT LEARNING OUTCOMES

by

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A Dissertation Presented in Partial Fulfilment

Of the Requirements for the Degree

Doctorate of Education

Durham University

December 2009

Acknowledgements

This thesis could not have been completed without the support and assistance of many individuals. First and foremost, I would like to thank my supervisor, Mr. Stewart Martin, who was always ready and eager to help me at each step of the way, and whose feedback and suggestions helped ensure that this would become a quality piece of scholarly work. Mr. Martin's critically analytical questioning has been invaluable in helping me clarify ideas and his thoughtfulness and scholarly insights have contributed to my thinking and writing. I will remain forever grateful for the advice and encouragement he provided from start to finish. Secondly, I would like to thank Dr. Remedios for verifying the statistically analysis section of my thesis.

I am also deeply grateful to those professors who have taught on the EdD (Singapore) Programme, whose teaching has stimulated many early thoughts and ideas. I wish to acknowledge the contribution of the many hundreds of students of the Singapore Polytechnic, whose participation in the surveys has provided the data that made this study possible. In addition, I wish to acknowledge my friend, Dr. Wong Lea Choung's contribution in proof-reading my thesis.

This acknowledgement would be incomplete without mentioning my family, friends, peer learners, and colleagues for the interest shown in my pursuit of this degree, for the continuous support and encouragement. To each and every one of you, I must humbly say, "Thank you!"

Dedication

This thesis is dedicated to my wife, Irene, for the unending and unconditional love and support she has given me through this doctoral journey; to my parents for encouraging me at each step along the way. It is also dedicated to each and every member of my immediate family for the understanding they have shown me through this process, but especially to my sons, James and Joshua, for setting my sights on the honour of being called “Dr. Dad.” Finally, this thesis is dedicated to my Lord, God Almighty who provides me with His strength and sustenance at each step along the way.

Declaration

I hereby declare that the work submitted in this thesis is entirely my own which has not been submitted for a degree in the University of Durham or any other university.

Abstract

The thesis is about knowledge management in education: how to create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes; and secondly, how to develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning. An effective knowledge management system must address both the creation and transfer of explicit as well as tacit knowledge. This research set forth that tacit knowledge must be converted into high quality explicit knowledge through the e-learning environment. The success in converting educator's tacit knowledge into explicit knowledge to be internalised by the learner as tacit knowledge is very much depended on information quality as the medium for the conversion process. Thus, in this thesis, information quality is an essential concept to examine in the conversion process. This is to ensure that learners are able to derive quality tacit knowledge from this information. Information quality is always relative and depends on the individual or group of students who are evaluating it. Thus, any standardising of information quality has to match to a considerable large group of students' cognitive structures. This research provides an empirical investigation of the relationship between information quality and student learning outcomes. Data for this study were collected by means of questionnaires through the survey manager in the Blackboard Learning System and were evaluated through a combination of multiple regression analysis. Data analysis revealed evidence that the relationship between the quality of information and student learning outcomes is systematically measurable, in that measurements of information quality can be used to predict student learning outcomes, and that this relationship is, for the most part, positive. Furthermore, this research set forth the conceptual review of developing communities of practice (CoPs) to transfer sustained tacit knowledge effectively to improve student learning.

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Introduction

Organisation of the Thesis

Background to the Study

Nobody would deny that the ultimate question for educational research is how to maximize students' learning opportunities and achievements. The concern with student learning outcomes and achievements in education is by no means new. External pressures for measurable improvements in educational institutions are mounting and demand for improved information about student learning outcomes is escalating. Internally, educational institutions are asking themselves difficult questions about accountability: for example, how can we improve student learning outcomes? In this climate of external and internal demands for accountability and improvements of student learning outcomes, educational institutions are seeking to understand how they can be more effective in collecting, disseminating and sharing knowledge and understand how to transform that knowledge into effective decision making and action to ensure improvements in student learning outcomes.

Why Knowledge Management matters in Education?

As organizations committed to educational missions, schools, colleges, and universities are charged with achieving a number of educational objectives. One of these objectives is to transfer knowledge to students (through exchanges between students and educators, through exchanges between students and books or other resources, and through exchanges among students themselves, etc.). As organizations, however, educational institutions face challenges about how to share information and knowledge among people within the organization. This is the central focus of the thesis.

Knowledge management builds upon a human-centred approach that views organizations as complex systems that spring from the unique organizational contexts in which they are developed. It is still a nascent organizational practice, so as of yet there is no agreed upon definition for knowledge management. Therefore, it is generally described as broadly as possible, such as the following specified by Prusak (1997): knowledge management is any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organizations. Knowledge starts as *data*—raw facts and numbers. Everything outside the mind that can be manipulated in any way can be defined as 'data'. *Information* is data put into context of relevance to the recipient. It is a collection of messages and readily captured in documents or in databases. When information is combined with experience, understanding, capability and judgment, etc., it becomes *knowledge* (i.e. what we know). Knowledge can be highly subjective and hard to codify. Knowledge can be shared with others by exchanging information in appropriate contexts. In this study, the contexts where knowledge is shared between educators and students are through the e-learning environment and communities of practice.

Knowledge management in education can be thought of as a framework or an approach that enables people within an organization to develop a set of practices to collect information and share what they know, leading to action that improves services and outcomes. For educational institutions, the full promise of knowledge management lies in its opportunities for improving student outcomes. The ultimate benefit of this, of course, is to students, educators, and the education community as a whole.

The crucial change in educational institutions is to improve student learning and outcomes: how effective are educational, academic, and other programs inside and outside the classroom in improving student learning? For which students? Over how long? In what ways? These are the general questions for which the practices of knowledge management are particularly helpful. In this thesis, we shall seek to address the question on how to create and transfer quality knowledge through the practices of knowledge management and its possible impact on student learning outcomes.

Learning is a process by which students take in information and translate it into knowledge, understanding or skills. A learning audit is necessary to measure the cognitive and behavioural changes as well as tangible improvements in result during the learning process of students (Garvin, 1993). Indeed, learning and academic assessment can be characterised as two sides of the same coin, in the sense that learning involves detection and correction of errors to improve learning (Argyris & Schon, 1978). Of course, valuable learning involves gaining the abilities and experiences which is beyond the academic assessment of students. However, for many educational institutions, assessment and grading practices are perhaps the most important safeguard of academic standards. The measurement and reporting of student outcomes such as their knowledge, skills, achievement or performance, is now a major reference point for academic standards (James et al., 2002).

Most knowledge management technologies focus on the actionable application of knowledge (Sallis & Jones, 2002). This notion of knowledge for action directly applies to curriculum development and assessment. The knowledge gained from assessment is used to create and improve upon the curriculum which is comprised of courses, topics, instructional materials, presentations, assignments, etc. The association between knowledge management and assessment is also evident in learning. A major goal in successful knowledge management is to achieve learning by the people in the institution and thus involves the necessity for assessment. By testing student performance and by periodically reviewing their own curricula, schools, colleges, and universities assess what they have learnt in their own institutions. This assessment hopefully prompts students to modify their study behaviour and faculty to refine the materials they present to the class. More importantly, assessment also motivates faculty and administrators to reconsider their policies and practices related to curricula in order to improve student learning outcomes.

Knowledge management practices can also be applied to e-learning by creating quality learning materials and providing ongoing assessments. For example, every time students read a chapter of the e-learning materials and complete an interactive worksheet, the system, in turn, provides the educator with ongoing and trend assessment information about each student. This provides timely feedback for the student and educator. Educators see that the real value is in the assessments that are integrated into the learning process, and in the information about patterns of student learning. They can find out which e-learning materials and assignments were most appropriate and which ones were most troubling for specific groups of students in achieving their learning outcomes. Once the educators are provided with this information, they can adapt their pedagogy and content in ways that make sense for their students to improve their learning outcomes. If they have access to a collaborative team discussing these issues school-wide, then the knowledge gained and is shared amongst other educators, which allows them to determine ways to improve student learning outcomes.

Different learning and teaching strategies are effective to varying degrees for different groups of students. Knowledge management practices seek to help educators and faculty gather data and share information about which teaching approaches are most effective for different groups of students in specific environments. Making information available in a timely way to the people who need it means that important discussions among faculty can begin: Is it better to maintain consistent teaching styles and help all students perform within them? Should teaching styles be revised based on who is in the class? Teaching and learning styles are the behaviours or actions that educators and learners exhibit in the learning exchange. Teaching behaviours reflect the beliefs and values that educators hold about the learner's role in the exchange (Heimlich & Norland, 2002). Learners behaviours provide insight into the ways learners perceive, interact with, and respond to the environment in which learning occurs (Ladd & Ruby 1999). Thus, the information gained will inform educators to adopt or adapt appropriate teaching and learning strategies for different groups of students to improve their learning outcomes.

Given the information, educators and faculty can discuss these kinds of questions within their own organizational context, design a series of interventions or a revised curriculum based on the needs of their students, gather outcome information again, review the results, and share their results among a wider circle of colleagues. For educators and faculty as well as students, the knowledge management process promotes participation, interaction, and, most importantly, student learning.

According to Petrides & Nodine (2003: 25-26), the fundamental concerns of promoting the use of knowledge management in education are:

1. **Be rigorous in connecting knowledge management approaches to learning outcomes**

   The overall goal of knowledge management in education is clear: improved decision-making throughout the organization to advance and improve student learning. This overall goal will become increasingly important, as schools, colleges, and universities come under pressure for increased accountability from external and internal sources.

2. **Assess the extent to which knowledge management practices and values can continue to transform the classroom experience**

   Information sharing, teamwork, and collaborative learning have been important curricular developments over the past few decades because students are now the most important stakeholders for schools and colleges. It is crucial to help them develop the kinds of critical thinking and communication skills that will enable them to succeed in an information-rich environment.

For educational institutions, the practices of knowledge management are particularly promising and appropriate. The sharing of information encourages people at every level to contribute, to participate, to interact, to grow, and to learn. Making sense of information that is necessary to success is a crucial step; imparting what one learns and knows to others, especially students, is more difficult and rewarding still.

This thesis is about how to improve student learning outcomes through the e-learning system and communities of practice (CoPs) by applying knowledge management practices.

The possible impact of knowledge management practices on learning outcomes

Learning outcomes are statements that specify what learners will know or be able to do as a result of a learning activity. Outcomes are usually expressed as knowledge, skills, or attitudes (Phillips, 1994). When questions are raised about academic standards they are often associated with assessment practices, in particular student grading. Of course, the assurance of academic standards embraces a wide range of activities beyond the assessment of student learning. However, assessment and grading practices are perhaps the most important and visible safeguard. The role of assessment in assuring academic standards is likely to be further highlighted as tertiary institution entry pathways and the modes of student participation and engagement with learning resources diversify: the maintenance of standards through entry pre-requisites and 'time spent on task' are far less relevant mechanisms for ensuring standards than they once were. The measurement and reporting of student outcomes — their knowledge, skills, achievement or performance — is now a major reference point for academic standards. The experience of academic staff directly involved in teaching and assessing student learning is also central to determining and monitoring standards. Ultimately, individual academic staff and their academic judgement define and protect standards through the ways in which they assess and grade the students they teach. Sound processes for defining and monitoring academic standards will directly support the quality of teaching and learning by making the goals and standards clearer — students who understand goals and standards and who are encouraged to study towards them are likely to have better learning outcomes.

Hallinan (2000: 1) has identified a number of conditions which are needed to insure student learning. One of the conditions concerns how increasing the quantity and quality of instruction would increase student learning. Instruction knowledge can be easily created through the e-learning system. However, how are we going to ensure that the instruction knowledge created through the e-learning system is of high quality so that students indeed acquire the requisite knowledge and skills?

The knowledge management processes involve knowledge creation and transfer. According to literature, there are two fundamental concepts about knowledge: tacit knowledge and explicit knowledge. Tacit knowledge is the backdrop against which all actions are understood (Polanyi, 1966: 136) and consists of skills and competencies, experiences, relationships, beliefs and values, and ideas which are very difficult to articulate and codify. However, explicit knowledge can be more easily articulated and codified in formal language. Moreover, explicit knowledge can be easily transmitted formally across individuals. Explicit knowledge is formal knowledge that is easy to transfer from educators to learners. It is frequently articulated through syllabuses, study guides, and course materials. Thus, explicit knowledge is processed, transmitted and stored in databases with relative ease. On the other hand, tacit knowledge is highly personal and is a comprehensive cognizance of the human mind. Therefore, tacit knowledge is of limited representation to learners since it is difficult to articulate and codify in documents. Moreover, it is difficult to communicate tacit knowledge to others. As a result, educators try hard to apply narration, animation and commentary to represent individual knowledge as effectively as they could. However, a truly effective knowledge management system must address both the creation and transfer of explicit as well as tacit knowledge.

Knowledge management practices attempt to make tacit knowledge more explicit in the knowledge creation process through the e-learning environment. This is one of the single most important factors that affect the transformation from educators' knowledge into learners' knowledge. The knowledge management system would also seek to create quality knowledge through the e-learning environment to ensure learning.

Brown's (1998) insightful study of the use of the Internet to support knowledge transfer found that a reliance on technology as a means of transferring knowledge is insufficient. Instead he contended that abstractions recorded and shared on the Internet can be considered as being inseparable domain expertise (tacit knowledge) that could not be encoded in documents or e-learning infrastructures. Instead, he discovered that social networks should be developed to transfer the domain specific information. Through the practices of knowledge management, learning communities can be developed so as to transfer knowledge to ensure students' learning. Research in learning communities or communities of practice makes a strong case for the interdependency of learning and social context (Johnson, 2001; Wenger, 1998). Thus, the knowledge management practice of developing communities of practice is to ensure that tacit knowledge can be transferred more effectively through such social networks to ensure student learning. The development of communities of practice to transfer tacit knowledge effectively to improve student learning will be discussed in detail in Chapter 2.

Measurement of quality knowledge through e-learning and student learning outcomes

Most of the knowledge management theory and practice aligns the definitions of knowledge to two models: (i) DIKW (data, information, knowledge, wisdom) and (ii) Nonaka's (1994) reformulation of Polanyi's (1966, Prusak (1997)) distinction between tacit and explicit knowledge. These two definitions are contestable and they will be further discussed and distinguished in Chapter 2.

In this thesis, it is proposed that there is a possible direct correlation between quality knowledge created through the e-learning environment and positive student learning outcomes. Ivergard & Hunt (2005) argued that poor quality knowledge created through the e-learning environment "gave users a feeling of being stressed and badly treated by the system" (160) and caused students to feel frustrated and eventually stop learning. In addition, knowledge created should be tailored to the needs of the learners: it should be easy to use and students should have easy access to guidance and information (Howell et al., 2003; James-Gordon et al., 2003). Furthermore, poor usability of an online course will inhibit the learner's ability to acquire knowledge (Smulders, 2003). In short, knowledge created through e-learning environment should be easy to use and come with detailed guidance and ultimately be suitable for all learners. The appropriateness of the knowledge created may increase the learner's satisfaction (Grooms, 2003). Thus, creating quality knowledge through the e-learning environment to suit learners seems to be a difficult task, let alone improving student learning outcomes.

Quality knowledge through the e-learning environment can be measured using the information quality survey instrument developed by Lee et al. (2002). Details of this survey instrument and the definition of information quality will be discussed and explained in the literature review of Chapter 2.

As mentioned earlier, explicit knowledge can be easily processed, transmitted between educator and learner and stored in databases with relative ease within the e-learning system. However, Choo argued that the receiving party (learner) may not be able to immediately comprehend and correctly value the transmitted knowledge due to differences in language, level of maturity, or lack of required capabilities (Choo et al., 2000). How, then, can the transmitted knowledge be recognised as knowledge? A number of researchers (Marwick, 2001; Stenmark, 2002; Wilson, 2002 and Petrides & Nodine, 2003) argued that explicit knowledge is not knowledge but information. Marwick (2001) concluded that, 'there are still significant shortfalls in the ability of technology to support the use of tacit knowledge - for which face-to-face meetings are still the touchstone of effectiveness.' and '…the strongest contribution to current solutions is made by technologies that deal largely with explicit knowledge, such as search and classification.' ('Explicit knowledge', of course, is simply a synonym for 'information'). Therefore, I would agree with them that explicit knowledge is indeed information, and henceforth, information would be equivalent to explicit knowledge.

The educator expert must therefore elicit his or her tacit knowledge from their mental model and convert it into information. This is the process of codifying tacit knowledge and converting it into high quality explicit knowledge or information. As argued by Diemers (2000), the success of the transformation process of converting the educator's tacit knowledge to explicit knowledge to be internalised by the learner as tacit knowledge is very much dependent on information quality as the medium for the transformational process since quality explicit knowledge is not yet 'knowledge' for the student but quality information. From the knowledge management perspective, information quality is the key concept to analyse, measure and evaluate in the transformational process. This is to ensure that learners are able to derive quality tacit knowledge from this information which is obviously very important and should be considered a conceptual cornerstone of any knowledge management theory (Diemers, 2000). Therefore, we have to define the measurable criteria or benchmarks for the information to be successfully internalised by others as tacit knowledge. We can say that information quality is always relative and depends on the individual or group of individuals who are measuring and judging it. Thus, any benchmarking or standardising of information quality has to correspond to a significant large group of individuals' cognitive structures.

To benchmark or measure information quality, we can adopt Kahn et al. (2002) Product and Service Performance Model for information quality (PSP/IQ) as the tool. In this model as shown in Table 1.1, the conformance to specifications' quadrant of *sound* information and the customer expectations' quadrant of *useful* and *usable* information come closest to the view of codified tacit knowledge quality. Some of the respective information quality dimensions of these quadrants are reflecting this consistency in an obvious way: *concise representation, completeness, consistent representation* of the sound information quadrant, and *appropriate amount*, *relevancy, understandability*, *interpretability*, *believability*, *reputation, value-added* of the useful and usable information quadrants.

Thus, these information quality dimensions are the keys to a successful transformation in converting tacit knowledge into quality explicit knowledge (information). The quality explicit knowledge is then transferred from the educator to the students and perceived to be positively related to their learning outcomes since we argued earlier that there is a presumed direct correlation between quality knowledge and positive student learning outcomes.

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	Sound Information Free-of-Error Concise Representation Completeness Consistent Representation	Useful Information Appropriate Amount Relevancy Understandability Interpretability Objectivity
Service Quality	Dependable Information Timeliness Security	Usable Information Believability Accessibility Ease of Manipulation Reputation Value-Added

Table 1.1 Information Quality Dimensions of the PSP/IQ Model (Kahn et al., 2002: 188)

Purpose of the Study and Research Questions

In general, the study aims to apply knowledge management practices in helping lecturers or educators as well as students to gather and share knowledge, and to promote participation, interaction and most importantly, learning. The primary focus of this study is how can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes. This includes the investigation of the presumed relationship between the management of information quality and student learning outcomes. This relationship includes several aspects of information quality and student learning outcomes. A literature review provided the basis for the development of the research model. The model identified four specific aspects of information quality (soundness, dependability, usefulness, and usability) and the student learning outcomes. These items constituted the variables in the conceptual model.

The objective of this research is to examine the impact of knowledge management application on creating quality knowledge and its possible relation to student learning outcomes by addressing the following two problems:

1. How can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?

2. How can we develop learning communities to promote knowledge sharing, sharing, teamwork, and collaborative learning?

It is on these premises that two research questions were formulated. They are thus:

1. *How can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?*
   - *How can we measure knowledge quality as presented on the e-learning environment?*
   - *What is the nature of the relationship between students' perceptions of information quality and learning outcomes?*
   - *What interaction effects exist between different aspects of information quality and learning outcomes?*

As stated before, explicit knowledge can be easily created through the e-learning system but tacit knowledge is difficult to encode in documents or Information Communication Technology (ICT) infrastructures. How can we attempt to make tacit knowledge more explicit in the knowledge creation process through the e-learning environment? A possible solution lies with the creation of quality of knowledge through the e-learning environment. This is one of the most important factors that affect the transformation of educator's tacit knowledge into learner's knowledge. Thus, it is necessary to measure the quality of the knowledge created on-line. With the measurement results, we seek to improve the quality of knowledge created through the e-learning environment to ensure and encourage learning.

2. *How can we develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning?*

Knowledge should be viewed as being relative, provisional, and primarily context-bound (Barley, 1996). Schultze (2000) suggested that exchanging knowledge as if it were an economic asset via ICTs does not relate to the actual experience of the use of knowledge management applications within specific contexts. Brown's (1998) insightful study of the use of the Internet to support knowledge working found that a reliance on technology as a means of transferring knowledge is insufficient. Instead he contended that abstractions recorded and shared on the Internet need to be considered as being inseparable from their own historical and social locations of practice. Hislop et al. (2000) found that domain expertise (tacit knowledge) could not be encoded in documents or e-learning infrastructures. Instead, they discovered that social networks were developed to transfer the domain specific information. A possible solution is how to develop learning communities so as to transfer knowledge effectively. Research in learning communities or communities of practice make a strong case for the interdependency of learning and social context (Johnson, 2001; Wenger, 1998).

These two guiding research questions present the structure and parameters for the investigation that places an emphasis on the knowledge management practices on the quality of student learning outcomes. The research will be reported in the following chapters of the thesis for discussions and conclusions to be made. From time to time, reference will be made to these research questions to help focus the interrogations and to avoid going off at a tangent from the overall purpose of the study.

Organization of the Remainder of the Study

This study is presented in five chapters. Chapter 1 introduces the study, highlighting the importance of understanding the possible impact of knowledge management practices on learning outcomes, and noting the lack of research in this area. Chapter 2 provides a review of literature related to knowledge management practices and student learning outcomes through the e-learning environment and communities of practice, connecting each of these fields to its foundational theories, and setting forth research models. Chapter 3 details the methodology employed in the study. Chapter 4 presents the analysis of the data, including descriptive analysis, construct analysis, and hypothesis testing. Finally, chapter 5 presents a discussion of the implications of the findings from this analysis, along with conclusions, limitations, and recommendations for further research.

Chapter 2
Literature Review

The thesis is about the assessment of the possible impact of knowledge management applications on the quality of student learning outcomes. This chapter is the review of the literature that attempts to form a coherent framework and argument for the thesis and the research study that is underpinned by it.

Part A: Introduction and Background of the Chapter

This chapter presents a review of the literature related to knowledge management, knowledge quality, e-learning, learning outcomes, and the relationship between knowledge quality, communities of practice (CoPs) and learning outcomes. The main focus is in knowledge quality within the knowledge management perspective and the student learning outcomes. In this perspective, there are two fundamental concepts of knowledge; explicit and tacit knowledge. As argued in the subsequent section, explicit knowledge is basically information. Information quality is presented in terms of its theoretical roots in information and quality, and in terms of contemporary research addressing formal definitions, measurement techniques, and contributing factors. In addition, community of Practice is represented in terms of contemporary research. Furthermore, student learning outcomes is also presented in terms of contemporary research. Literature examining relationships between information quality creation, communities of practice, and student learning outcomes is also presented. Based on this review, the chapter establishes the underpinnings of the current research.

This chapter reveals an important gap in the research literature, in that the linkage between information quality and student learning outcomes has only been minimally examined to date, with relatively little theoretical grounding. This chapter thus sets forth a contextual framework within which information quality research can be viewed, and it establishes a research framework and model for examining a set of possible strategic relationships between information quality aspects and student learning outcomes. By investigating this relationship, the current research has contributed to the body of knowledge by examining the nature, direction, and strength of specific connections between information quality and student learning outcomes.

In addition, this chapter will also conduct literature review on the possible relationship between communities of practice and student learning outcomes. By investigating this relationship, this review has contributed to the body of knowledge on the effectiveness of tacit knowledge transfer through the communities of practice to improve student learning. However, this review will only be done conceptually.

Knowledge Management

Knowledge Management (KM) consists of a range of practices used in an organization to create, capture, collect, transfer and apply of what people in the organisation know, and how they know what people in the organisation know (in this thesis, when we mention organisations ‘having knowledge’ and ‘knowing things’, we are using these terms to refer to people within the organisations). It has been an established discipline since 1995 with a body of university courses and both professional and academic journals dedicated to it (Stankosky, 2005). Knowledge Management began in the corporate sector and many large companies are adopting it.

Knowledge Management practices are typically tied to organizational objectives such as improved performance, competitive advantage, innovation, developmental processes, lessons learnt transfer and the general development of collaborative practices. Knowledge Management focuses on the management of knowledge as an asset and the development and cultivation of the channels through which knowledge and information flow.

Different schools of thought and authors define Knowledge Management differently. For example Prusak (1997) defined knowledge management as any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organizations. It is also defined as: “the explicit control and management of knowledge within an organisation aimed at the achieving of the organizational objectives” (Van der Spek & Spijkervet, 1997: 43); “the formal management of knowledge for facilitating creation, access, and reuse of knowledge, typically using advanced technology” (O’Leary, 1998: 34); “the process of creating, capturing, and using knowledge to enhance organisational performance” (Bassi & Ingram, 1999: 424); and “the ability of organisations to manage, store, value, and distribute knowledge” (Liebowitz & Wilcox, 1997: i). Within an organisation, such as a commercial company, a hospital or an educational institution, knowledge management can be understood as the management of its intellectual capital, of knowledge as a form of capital that, like physical or financial capital, has to be managed to achieve the aims of the organisation. The aims could be in the enhancement of organisational learning and performance. Likewise, different authors define the knowledge management processes differently. The Organisation for Economic Co-Operation and Development (OECD) defines the knowledge management processes as “involving in the production, mediation and use of knowledge ...” (OECD, 2000: 70). Alavi & Tiwana, (2003) identified that there are four knowledge management processes:

knowledge creation, knowledge storage and retrieval, knowledge transfer, and knowledge application. Franco & Mariano (2007) defined knowledge management processes simply as knowledge storage and retrieval. In this thesis, we will adopt Alavi & Tiwana's definition of knowledge management processes. We will seek to know how can we create and transfer knowledge through e-learning environment and transfer knowledge through communities of practice.

There are two dimensions of knowledge, namely, the explicit and tacit aspects. These dimensions of knowledge will be explained and reviewed in detail in the subsequent section.

Knowledge management (KM) in organizations is for supporting creation, capture, storage and dissemination of information. The idea of a KM system is to enable employees to have ready access to the organization's documented facts, sources of information, and solutions. Some of the advantages claimed for KM systems are the sharing of valuable organizational knowledge, the avoidance of re-inventing the wheel, reduction of training time for new employees, and the retention of Intellectual Property after the employee leaves the organization (provided such knowledge can be codified) (Wikipedia). Knowledge management systems provide users with great access to knowledge. However, equally important is the users' ability to use the knowledge once it is accessed and to subsequently share it with others.

There are basically two categories of knowledge management enablers, namely, the technological and organizational enablers. These enablers are systems and infrastructures which ensure knowledge is created, captured, transferred and shared. Technological enablers include expert systems, knowledge bases, various types of Information Management, software help desk tools, document management systems and other Information Technology (IT) systems supporting organizational knowledge flows. The advent of the Internet brought further enabling technologies, including e-learning, web conferencing, collaborative software, content management systems, corporate 'Yellow pages' directories, email lists, wikis, blogs, etc. *Organisational* enablers for knowledge management programs include Communities of Practice, Networks of Practice, before-, after- and during- action reviews, peer assists, information taxonomies, coaching and mentoring, etc. In this thesis, we will focus on e-learning as the technological and communities of practice as the organisational enablers.

Knowledge Management in Education

Educational institutions are under tremendous pressure for increased accountability from external and internal sources. External pressures raised by stakeholders like employers, government agencies, and parents for measurable improvements in educational institutions are mounting and demand for information about student learning outcomes is escalating. Internally, educational institutions are asking themselves difficult questions about accountability: for example, how can we improve student learning outcomes? In this climate of external and internal demands for accountability and improvements of student learning outcomes, schools, colleges, and universities as organizations committed to educational missions, must ensure students are learning by acquiring knowledge in the most efficient and effective way. Institutions must also have the ability to demonstrate enhancement of student learning and development. Thus, educational institutions may find it beneficial to adopt Knowledge Management programs to improve their performances and outcomes.

Consider an individual educator who possesses knowledge on how to improve student learning outcomes. If the institution relies on only this expert individual to conduct ongoing exercises in improving student learning outcomes, it can hamper the flexibility and responsiveness of the organization. The challenge is to convert the knowledge that currently resides in this individual and make it widely and easily available to any educator. Thus, knowledge management can lead to improvements in sharing knowledge - both explicit and tacit - and subsequently benefit the organisation as a whole. Knowledge management in education can be thought of as a framework or an approach that enables people within an organization to develop a set of practices *systematically* to collect information and share what they know (e.g. skills, experiences, beliefs, values, ideas, etc.), leading to action that improves services and outcomes (Petrides & Nodine, 2003).

Knowledge management can be built and integrated into the structures and processes of educational institutions to improve their performances. Knowledge management can benefit educational institutions in at least five areas: research, curriculum development, student and alumni services, administration, strategic planning, and traditional classroom enhancement (DeDiana & Aroyo, 1998, Kidwell et al., 2000). Kidwell et al. argued that knowledge management has several application areas in the curriculum development process. They are curriculum design and revision efforts, knowledge of teaching and learning (with technology), pedagogy and assessment techniques, student evaluations, etc. Some of the benefits identified are to enhance the quality of curriculum, improve responsiveness to student evaluations, leverage the best practices, improve teaching and learning, and monitor outcomes. Furthermore, Petrides & Nodine (2003) stated several implementation areas where knowledge management practices are useful in educational institutions. One of the areas is enabling educators to create and represent quality knowledge for students to advance and improve their learning.

Learning is a process by which students take in information and translate it into knowledge or skills. It has been defined as the process of acquiring knowledge, attitudes, or skills from study, instruction, or experience (Miller & Findlay, 1996: 167). Learning outcomes are statements of what is expected that a student will be able to DO as a result of a learning activity. According to Barr et al. (2001), learning outcomes are statements of the knowledge, skills, and abilities the individual student possesses and can demonstrate upon completion of a learning experience or sequence of learning experiences (e.g., course, program, and degree). The learning activity follows the educator's materials on the e-learning environment or students listening to a lecture based on them, but it could also be a laboratory class, even an entire study programme. Learning outcomes help instructors to be more precise in telling students what is expected of them. A learning audit is necessary to measure the cognitive and behavioural changes as well as tangible improvements that results from the learning process of students (Garvin, 1993). The primary emphasis on knowledge for pedagogical purposes may be for increasing students' learning, which requires a feedback loop in which institutional performance is evaluated, corrective measures are taken, and improvements are made in the knowledge base and practices.

One of the tasks in this complex process of teaching and learning is to code knowledge and to disseminate this knowledge to students in classrooms or through e-learning systems. However, to what extent do students learn by acquiring the requisite knowledge in this way? This question can be addressed by the knowledge management system where knowledge or information concerning student learning and outcomes can be collected and shared amongst the teaching staff. The knowledge gained by the teaching staff allows them to make appropriate decisions to ensure that their courses, topics, instructional materials, presentations, assignments, assessments, etc. are updated to improve the student learning outcomes.

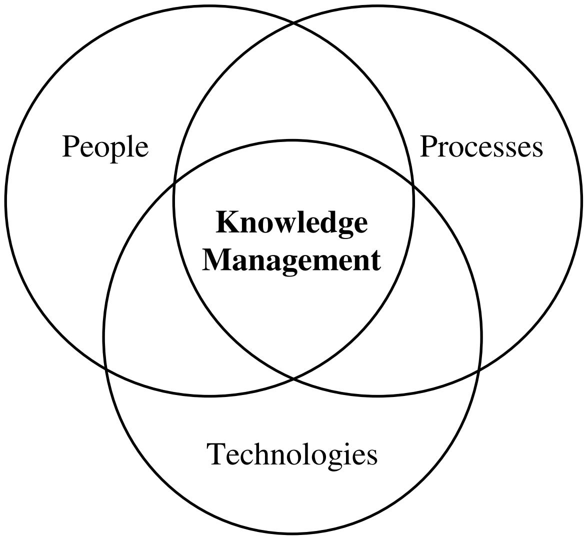

Figure 2.1 The Key realms of knowledge Management (Petrides & Nodine, 2003: 11)

In order to enable educational institutions to use and share knowledge more effectively, a knowledge management system brings together three core organizational resources - people, processes, and technologies (See Figure 2.1).

People

It is people who manage knowledge. Moreover, people are the originator of knowledge. According to Davenport & Volpel (2001), “managing knowledge is managing people; managing people is managing knowledge”. Managing knowledge involves managers developing a set of practices to capture, collect and transfer of relevant knowledge within the organisation of people to improve services, outcomes and performances. Thus, through collegial and professional teamwork, knowledge management practices actively encourage and engage people at many organizational levels in sharing with others what they know, and what they are learning. To make jobs more rewarding and work more effective, working groups of staff and educators from across departments are persuaded to come together as teams by common need and exchange information to address concerns of students, institutions, parents and societal expectations, etc. In this process, the teams also build relationships, trust, and expertise and create a shared repertoire of resources, tools, and artefacts that support future learning. In many organizations, these kinds of informal, self-sustaining collegial bodies have been around for a long time. They are called "communities of practice" (CoPs) (Lave & Wenger, 1991) and have been found to be one of the effective means in managing tacit knowledge within organisations. These CoPs are often at the centre of innovation and energy and have been identified as one of the knowledge management enablers. The concept of CoPs is very important in this study for examining the second research question on the interdependence of learning and social context (Johnson, 2001; Wenger, 1998).

Processes

Many work practice processes affect information flow within every organization. These processes include administrative procedures, curriculum development processes, information sharing patterns, information silos, salary incentives, etc (Petrides & Nodine, 2003). Similarly, knowledge management practices enable people to get the information they need, when they need it, as well as to share it with others who may benefit from it and help to promote these processes that lead to more informed decision-making. The curriculum development processes will be targeted in this study, especially the processes involved in the creation of quality knowledge and the transfer of knowledge to improve student learning outcomes. This is again in accord with the requirement of the first research question i.e. "How can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?"

Technologies

Technology is a vital and necessary contributor to the effectiveness of the organization. The most effective technologies within a knowledge management framework should be broadly accessible to target user groups and promote the tracking and exchange of useful information across departments, or even across institutions (Petrides & Nodine, 2003). Technological tools for knowledge management have been developed to provide for the capture and transfer of knowledge. With the advent of the internet, e-learning, web conferencing, collaborative software, content management systems, email lists, wikis, blogs, and other technologies have become the enablers or facilitators of knowledge management practices in organization. E-learning systems are computerised systems in which the learner's interactions with learning materials are mediated through technology (Alavi & Tiwana, 2003). Again, referring to the first research question, it is the intention of this thesis to measure knowledge quality as presented on the e-learning environment and student learning outcomes. This literature will be further reviewed in the subsequent, knowledge management in e-learning and e-learning outcomes sections.

In conclusion, the use of knowledge management in education is an approach that can inform a wide range of practices within an educational organization. For educational institutions, however, the full promise of knowledge management lies in its opportunities for improving student [learning] outcomes. One of the goals of knowledge management in education is to advance and improve student learning by creating quality knowledge. This goal will become increasingly important as school, colleges, and universities come under pressure for increased accountability from external and internal sources (Petrides & Nodine, 2003). The ultimate benefit of this, of course, is to students, educators, and the education community as a whole.

This thesis will focus on the study of the creation of quality knowledge through the e-learning environment and the conceptual understanding of the interdependence of learning and social context to advance and improve student learning. The knowledge management practice could possibly enable the transfer of quality knowledge through the e-learning environment and communities of practice to improve student learning outcomes.

Knowledge and Knowledge Management

Knowledge is defined in the knowledge management literature in several ways. 'Knowledge' is defined as what we know: knowledge involves the mental processes of comprehension, understanding and learning that go on in the mind, however much they involve interaction with the world outside the mind, and interaction with others. Whenever educators wish to express what they know, they can only do so by uttering messages of one kind or another - oral, written, graphic, gesture or even through 'body language'. Such messages do not carry 'knowledge', they constitute 'information', which a knowing student mind may assimilate, understand, comprehend and incorporate into its own knowledge structures. These structures are not identical for the educator uttering the message and the receiver (student), because each person's knowledge structures are biographically determined (Schutz, 1967). Therefore, the knowledge built from the messages can never be exactly the same as the knowledge base from which the messages were uttered. A significant part of Knowledge Management theory and practice aligns the definition of knowledge to two models: (i) the DIKW model, which places data, information, knowledge and wisdom into an increasingly useful pyramid and (ii) Nonaka's (1994) reformulation of Polanyi's (1966, Prusak (1997)) distinction between tacit and explicit knowledge.

DIKW model

Kidwell et al. (2000) argued that knowledge starts as *data*—raw facts and numbers— for example, e-learning material is irrelevant to the students when they are not required to take the particular subject. Everything outside the mind that can be manipulated in any way can be defined as 'data'. *Information* is data put into context of relevance to the recipient as when human place it in context through interpretation that might seek to highlight patterns, causes, or relationships—e-learning material is an example of information: data placed in context of relevance. Collections of messages, composed in various ways, may be considered as 'information resources' of various kinds - collections of papers in a journal, e-mail messages in an electronic 'folder', manuscript letters in an archive, or whatever. Generally, these are regarded as 'information resources'. Information can be shared or hoarded and is readily captured in documents or in databases; even large amounts are fairly easy to retrieve with modern information technology systems. When information is combined with experience and judgment, it becomes *knowledge* (i.e. what we know). Knowledge can be highly subjective and hard to codify. It includes the insight and wisdom of educators. It is the understanding that develops as people respond to and use the information that is available to them. Knowledge can be described as a belief that is justified through discussion, experience, and perhaps action. Knowledge can be shared with others by exchanging information in appropriate contexts. It may be shared through emailed “best practices” memos or even sticky notes on a cubicle wall. Once we acquire knowledge, educators can put it to work and apply it to decision making.

Tacit knowledge and explicit knowledge

In literature, there are two fundamental concepts about knowledge, that is the tacit knowledge and explicit knowledge. Polanyi observed, “We can know more than we can tell” (1966: 136). He spoke of tacit knowledge as the backdrop against which all actions are understood. Wilson (2002) argued that Polanyi's concept of 'tacit' means 'hidden', tacit knowledge is hidden knowledge, hidden even from the consciousness of the knower. Thus, this hidden knowledge is inaccessible to the consciousness of the knower, and can not be 'captured'.

However, Nonaka (1991) and Nonaka & Takeuchi (1995) used the term to denote particular knowledge that is difficult to express, that is, difficult to articulate. Tacit knowledge is difficult to codify and it consists of skills and competencies, experiences, relationships, beliefs and values, and ideas. It is highly personal and embedded in the individual’s mind. According to Kidwell et al. (2000), tacit knowledge is know-how and learning embedded within the minds of the people in an organization. It involves perceptions, insights, experiences, and craftsmanship. Tacit knowledge is personal, context-specific, difficult to formalize, difficult to communicate, and more difficult to transfer. Therefore, tacit knowledge is of limited representation to learners since it is difficult to articulate and codify in documents. Moreover, it is difficult to communicate tacit knowledge to them. As a result, educators try hard to apply narration, animation and commentary to represent individual knowledge as effectively as they could. Wilson (2002) critiqued that Nonaka, and Nonaka and Takeuchi have appeared to have either misunderstood Polanyi’s work, or deliberately distorted the fact that tacit knowledge can be captured. Wilson further argued that Nonaka's and Nonaka and Takeuchi's definition of tacit knowledge can well be termed as 'implicit' knowledge. Implicit knowledge, which is not normally expressed but may be expressed, is that which we take for granted in our actions, and which may be shared by others through common experience or culture (Wilson, 2002). Implicit knowledge can be captured, but not tacit knowledge, as argued by Wilson. Hence, we can gather that tacit knowledge or implicit knowledge is difficult to be made 100 percent explicit. Therefore, this difficulty poses problems during the knowledge creation and transfer processes. Since most knowledge management theory and practice uses the term tacit knowledge rather than implicit knowledge, this thesis will then use the term tacit knowledge which can well be meant as implicit knowledge.

On the other hand, Nonaka & Takeuchi (1995) defined explicit knowledge or codified knowledge as knowledge that can be articulated and in formal language including grammatical statements, mathematical expressions, specifications, and in manuals. Such explicit knowledge, they concluded, can be transmitted easily and formally across individuals. Choo (1998) suggested that explicit knowledge is knowledge that is made manifest through language, symbols, objects, and artefacts. Explicit knowledge can further be object based, i.e., found as patents, software code, databases, technical drawings and blueprints, chemical and mathematical formulas, business plans, and statistical reports, or rule based, i.e., expressed as rules, routines, and procedures. Moreover, Marwick (2001), Stenmark (2002), Petrides & Nodine (2003) and Wilson (2002) argued that explicit knowledge is not knowledge but information. Organisations tend to depend primarily on this sort of explicit and articulated knowledge, written down in memos and illustrated with graphs and used in decision-making processes, or institutionalised as operating procedures, Choo observed. Explicit knowledge is formal knowledge that is easy to transfer from educators to learners. It is frequently articulated in the form of syllabuses, study guides, and course materials. Explicit knowledge is packaged, easily codified, communicable, and transferable (Kidwell et al., 2000). Thus, explicit knowledge is processed, transmitted and stored in databases with relative ease.

The definition of knowledge from the perspective of knowledge management has been discussed above using the two models: (i) DIKW and (ii) tacit and explicit knowledge models. Based on the discussion, the DIKW model on information is similar in definition to explicit knowledge described in the tacit and explicit knowledge model. Likewise, the DIKW model on knowledge is similar in definition to tacit knowledge of the second model. Therefore, in this thesis, explicit knowledge and information shall then be used interchangeably. In addition, tacit knowledge will be used as the knowledge which is personal and consisting of beliefs, experiences, skills, etc., and difficult to articulate, codify, communicate and transfer.

The goal of the implementation of knowledge management in an educational institution is to increase the amount of tacit knowledge for educators to solve problems and improve the effectiveness with which they teach, and learners to improve their learning outcomes. Nonaka & Takeuchi (1995) argued that a successful Knowledge Management program, on one hand, needs to convert internalised tacit knowledge into explicit codified knowledge in order to share it. On the other hand, individuals and groups need to internalise the codified knowledge and convert it into meaningful tacit knowledge, once it is retrieved from the Knowledge Management system. Furthermore, Nonaka (1991), Nonaka & Takeuchi (1995) argued that tacit knowledge can be captured and converted into explicit knowledge. They have investigated the relationship between tacit knowledge and explicit knowledge and have described four phases of knowledge conversion: Socialization, Externalization, Combination and Internalization. Frappaolo & Toms (1997) suggested that there is a fifth phase, Cognition, which is the application of knowledge that has been exchanged through the other phases:

1. Socialization: Transfer tacit knowledge from one person to another person
2. Externalization: Translate tacit knowledge into explicit knowledge in a repository
3. Combination: Combine different bodies of explicit knowledge to create new explicit knowledge
4. Internalization: Extract the explicit knowledge from a repository that is relevant to a particular person's need and deliver it to that person where it is translated into tacit knowledge
5. Cognition: Apply tacit knowledge to a problem

The above discussion on the phases of knowledge conversion can be used to describe the two research questions more fully. The two research questions of this study focus on the conversion of tacit knowledge into explicit knowledge (information) and the transfer of tacit knowledge:

- *How can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?*
- *How can we develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning?*

In reference to Nonaka & Takeuchi's three of the four phases of knowledge conversion, research question 1 will explore how educators can *externalise* their tacit knowledge through improved pedagogy into explicit knowledge through the e-learning environment. According to Nonaka and Takeuchi, externalization holds the key to knowledge creation, because it creates new, explicit concepts from tacit knowledge. Educators can *combine* these concepts into a systematic knowledge system and integrate different bodies of explicit knowledge to create new explicit knowledge. This integrated explicit knowledge can be stored in the e-learning system and then accessed by students but how can students access the explicit knowledge and *internalise* it into tacit knowledge to improve their learning outcomes? As mentioned earlier, Diemers (2000) argued that success of the transformational process of converting tacit knowledge from educator to explicit knowledge to be internalised by the learner as tacit knowledge is very much dependent on the information quality as the medium for the transformational process. Research question 1 will thus analyse, measure and evaluate information quality in the knowledge conversion process from educators to students.

The first phase of knowledge conversion according to the Nonaka and Takeuchi model is *socialisation*. Research question 2 will therefore explore how educators can *socialise* and share tacit knowledge with students through communities of practice (COPs) to improve student learning outcomes.

Knowledge Management in e-learning

Knowledge management should have a resonance in education, as one major function of education is the imparting of knowledge. Educational institutions could use the potential of Knowledge Management practices to create quality knowledge for student learning, in particularly, through the e-learning environment.

According to Alavi and Tiwana, the four knowledge management processes, are: knowledge creation, knowledge storage and retrieval, knowledge transfer, and knowledge application

(2003). Knowledge creation refers to the development of "new" organisational know-how and capability (Nonaka, 1994; Nonaka & Nishiguchi, 2001). Knowledge originates within individuals or social systems (groups of individuals) (Alavi, 2000). Educational institutions allocate dedicated educators to the knowledge creation process. At the individual student level, knowledge is created through cognitive processes such as reflection and learning whereas in social systems knowledge is generated through collaborative interactions and joint problem solving (Alavi & Tiwana, 2003). Information Technology and e-learning can play a role in the knowledge creation process through its support of the individual student's learning process as well as support of collaborative interactions among educators and students. Welsh et al. (2003: 246) define e-learning as "the use of computer network technology, primarily over or through the internet, to deliver information and instruction to individuals". A 2001 US report by the Commission on Technology and Adult Learning (National Governors Association, 2001: 4) states that e-learning is "instructional content or learning experiences delivered or enabled by electronic technology". The Conference Board of Canada's (Murray, 2001: 3) workplace e-learning report provides: "e-learning uses information and communication technologies (ICTs) to deliver content (knowledge and skills) on a one-way [asynchronous] or two-way [synchronous] basis". Honey (2001: 200) concludes that the only "common thread" linking a wide range of e-learning opportunities is that all offer "the possibility of learning from information delivered to us electronically". As these exemplars suggest, most general definitions provide that learning activities and technology are connected. E-learning systems are computerized systems in which the learner's interactions with learning materials (e.g., assignments and exercises), instructors, and / or peers are mediated through technology. Due to the promise of flexibility and reduced downtime and travel expenses, there has been a recent flux of e-learning activities in corporations as well as educational institutions. E-learning technology has been evolving separately from knowledge management technology. The distinction between e-learning and knowledge management technologies is that the former as a system delivers information and content to students using ICTs whereas the latter focuses on the management and sharing of knowledge. There have been recent investigations into the integration of these technologies in the knowledge management direction (Barron, 2000 and Allee, 2000). In this thesis, the focus will be on knowledge creation and transfer which is of greater value as compared to information delivery through the e-learning system.

The central theme of knowledge management perceived by many experts in the field is that it is an integrated and systematic process of acquiring, eliciting, organising, representing and retrieval of knowledge. The objective of knowledge management in e-learning is to generate value in terms of knowledge to enable faster and efficient learning. Knowledge management in e-learning is about connecting learners with learners, and educators and learners with information and knowledge (Corrall, 1999).

From a knowledge management perspective, e-learning is a system for the generation, codification and representation of knowledge. E-learning tools (for example Blackboard Learning System, http://www.blackboard.com/) provide a context for individual and group learning. Educators construct, codify and represent knowledge as learning materials and store it in repositories of the e-learning system. Students access the e-learning system and information is transferred to individuals' or groups of students' cognitive structures. Knowledge generated and represented by educators at this stage is required to be able to correspond to a significant large group of individuals' cognitive structures. This is necessary so that students can acquire the requisite knowledge to achieve their learning outcomes.

These processes are viewed as information flowing from educators and repositories to individuals and groups which embodies the knowledge management process.

No one seems to doubt that the development and deployment of ICT can potentially have a profound impact on the e-learning mode of education and that it offers a number of benefits and opportunities for both teaching and learning. Some of the benefits may be, firstly, people do not need to travel since e-learning takes place in a virtual environment. Secondly, it can allow high calibre instructors to share their knowledge across borders and students to attend courses across physical, political, and economic boundaries at minimum costs. This might significantly reduce the costs of higher education, making it much more affordable and accessible to the masses.

However, there are still a number of problems and limitations within existing e-learning systems that may prevent educators from creating quality knowledge through the e-learning environment. At the same time, students may be prevented from learning due to the lack of external supports and motivation. A review of these problems and limitations is essential to address research question 1, *how can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?*

Poor design of the e-learning material is a major issue for learners and e-learning providers, as pointed out by Ivergard & Hunt (2005). Poor quality e-learning material "gave users a feeling of being stressed and badly treated by the system" (160) and caused users to feel frustrated and eventually stop learning. Knowledge created should be tailored to the needs of the learners: it should be easy to use and students should have easy access to guidance and information (Howell et al., 2003; James-Gordon et al., 2003). Svensson (2004) noted that it is not easy to design e-learning material, as it should not be limited to just content and should include other supports to enhance learning. Poor usability of an online course will inhibit the learner's ability to acquire knowledge (Smulders, 2003). E-learning may also be too technical for ICT novices (James-Gordon et al., 2003). In short, e-learning material should be easy to use and come with detailed guidance and ultimately be suitable for all learners. The appropriateness of the e-learning material may increase the learner's satisfaction (Grooms, 2003). Creating quality knowledge through the e-learning environment to suit learners seems to be a difficult task.

An inherent problem for students who want to have an in-depth knowledge on any subject through an e-learning system is often the overwhelming amount of information available. To quote Koniger & Janowitz (1995: 6) in the article on "Drowning in information but thirsty for knowledge", "*Information is only valuable to the extent that it is structured. Because of a lack of structure in the creation, distribution and reception of information, the information often does not arrive where it is needed and, therefore, is useless*". This unstructured information becomes a serious barrier to students even before learning is being taken place. There are no formal mechanisms available to filter the information for the quality and authenticity verification. In addition, the information may not be adapted to individual learner's needs and attributed to enhance their learning. Furthermore, information is not available in a uniform format. In other words, the available information is in heterogeneous formats varying even within a single source**.** Therefore, it is important to create quality knowledge with the aim of providing adequate amounts of authentic information with a well-structured, uniform format to meet the needs of individual students.

Furthermore, even with a well-structured, formatted, designed and stimulating e-learning materials (high quality information) aimed at motivating students, it is not sufficient to serve as motivation in the learning process. This is because learning is a complicated process that requires other supports and the student's own motivation. Besides high quality e-learning materials, some of the supports required to improve learning are firstly, opportunities to learn together with others so that the individual is no longer alone in the study situation. Learning alone is successful only for learners who had enough self-discipline and perseverance to study alone for a long period. Secondly, educators are accessible at times and in a form that suits the students. Thirdly, a variety of media is used for communication, and meetings can take place both face-to-face which is more personal and virtually to encourage collaborative learning. In addition, students themselves need to be self-directed and internally motivated to achieve their learning outcomes. Thus, with support systems and high quality e-learning materials in place, together with highly motivated students, greater improvement in learning would take place.

In view of the above limitation and problems with the creation of quality knowledge in the e-learning system, knowledge management practices can provide efficient solutions. The solutions provided by the knowledge management practices are aligned with the central focus of this thesis. This study seeks to know how can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes. Quality knowledge creation demands that the knowledge presented in the e-learning environment must be accurate, authentic, uniformly formatted, relevant, well-structured, and able to correspond to a substantial large group of students' cognitive structures. It also requires the tacit knowledge of the educators to be made more explicit, to be shared and transferred efficiently to the learners in the e-learning environment. In addition, quality knowledge should also be shared easily between educators and educators, educators and learners. Technologies in an e-learning system such as intranets, videoconferencing, and collaborative groupware allow members of an e-learning community to capture and disseminate explicit knowledge. Course Management Systems (CMS) such as WebCT and Blackboard, can be used to distribute selected learning materials, facilitate access to various sources of information and data, and enable teacher-student, as well as student-student interactions. Advanced technologies, such as videoconferencing and chat rooms, allow people to discuss over synchronous, interactive media (e.g. shared text and diagrams), and increase the level of interactivity in online communication. This is to ensure that tacit knowledge can be transferred effectively to improve the student learning.

Learning Outcomes

So far, I have made numerous references on learning outcomes in the previous sections. In this section, literature on the growing importance and purpose of student learning outcomes will be first reviewed. Secondly, literature on the comparison of the difference in the student learning outcomes between the e-learning and traditional classroom delivery modes will also be reviewed.

"Student learning outcomes [SLOs] are rapidly taking centre stage as the principal gauge of higher education's effectiveness" (Ruhland & Brewer, 2001: 142). Very few studies have empirically examined the impact of student learning outcomes (i.e., statements on learning expectations) on student learning and attitudes. As recent researchers have pointed out, "the (current popular) construct of student-centred learning appears to rely more on rhetoric than it does on evidenced-based pedagogical practice" (Maclellan & Soden, 2007: 4). One of the reasons learning outcomes are taking 'centre stage' is because research on this topic asserts that learning is enhanced when students are made aware of the mastery expectations for their courses and degree programs (Appleby, 2003; Chappuis & Stiggins, 2002; Halonen et al., 2002; McKenney, 2003). Increasingly, colleges and universities are not only being asked to specify the learning expectations of their students, but to also provide evidence that those outcomes are being achieved (Allen & Bresciani, 2003; Crow, 2000; Wellman, 2000). Thus, the measure of success for educational institutions is not just in their enrolment and graduation rates, but also their documentation of student achievement of the learning outcomes associated with the qualifications being awarded.

Learning is a process by which students take in information and translate it into knowledge or skills. Learning outcomes are statements of what is expected that a student will be able to DO as a result of a learning activity. According to Barr et al. (2001), learning outcomes are statements of the knowledge, skills, and abilities the individual student possesses and can demonstrate upon completion of a learning experience or sequence of learning experiences (e.g., course, program, and degree). The learning activity follows the educator's materials on the e-learning environment or students listening to a lecture based on them, but it could also be a laboratory class, even an entire study programme. Learning outcomes help instructors more precisely to tell students what is expected of them. As noted by Jenkins & Unwin (1996: 2), the benefits associated with the use of student learning outcomes are to:

1. Help students learn more effectively. They know where they stand and the curriculum is made more open to them.
2. Make it clear what students can hope to gain from following a particular course or lecture.
3. Help instructors to design their materials more effectively by acting as a template for them.

4. Help instructors select the appropriate teaching strategy, for example lecture, seminar, student self-paced, or laboratory class. It obviously makes sense to match the intended outcome to the teaching strategy.
5. Help instructors more precisely to tell their colleagues what a particular activity is designed to achieve.
6. Assist in setting examinations based on the materials delivered.
7. Ensure that appropriate assessment strategies are employed.

Ruhland & Brewer (2001) argue that learning outcomes should not only demonstrate what students know, but should also capture the changes that occur in their cognitive and affective development as a result of their college experiences (e.g., changes in critical thinking and level of civic mindedness). To address the accountability issues raised by stakeholders like employers, government agencies, and parents, an institution must have the ability to demonstrate enhancement of student learning and development.

On the other hand, some educational theorists postulate that the function of SLO statements is primarily to guide students' learning, which increases their ability to achieve each of the expected outcomes of the study program (Banta, 1996). In other words, according to these theorists, students use the SLO statements as a means of focusing on the critical components of the course and to assist them in mastering skills and course content. An informed student (i.e., one who is given the SLOs) is more likely to achieve the expected outcomes than a student who is not informed. Therefore, according to Banta (1996) and Allen & Bresciani (2003), the use of SLOs serves two broad purposes: (a) to improve student learning and (b) to address the issue of institutional accountability.

Recently, there are a lot of emphases on e-learning as mentioned in the previous section. One of the benchmarks for success in Internet-based distance education named by Merisotis (2001) is the need for learning outcomes to be the determinants of whether and how the technology should be used to deliver course content. However, is there a difference in student learning outcomes between e-learning and the traditional classroom?

Even with the large amounts of money being spent in e-learning, it is not clear that any improvement in student learning outcomes has been identified (Conole et al., 2000; Taylor 2001; GAO 2003). One of the reasons why uncertainty remains over the effectiveness of e-learning and its impact on student learning outcomes (Conole et al., 2000, Taylor, 2001) is that the body of research supporting e-learning is weak and subject to methodological flaws (Phipps, 1999; Mitchell, 2000; Conole et al., 2004). In one of the most striking comparative evaluations of traditional versus non-traditional learning, Joy & Garcia (2000) focused on asynchronous learning networks (ALNs) by randomly selecting several media comparison studies and demonstrating the problems inherent in their methodologies and, subsequently, their conclusions. According to Joy & Garcia (2000), most researchers fail to control for essential factors such as prior student knowledge, pedagogical methods techniques, and teacher and student abilities. Joy and Garcia proposed that, rather than compare the effectiveness of varying technologies and instructional media; efforts would be better spent in determining the optimal combinations of instructional strategies and delivery media that would best produce the best learning outcomes for a particular audience (Joy & Garcia, 2000). Instructional strategies is defined as determining the approach an educator may take to achieve the learning objectives and are included in the pre-instructional activities, information presentation, learner activities, testing, and follow-through. The strategies are usually tied to the needs and interests of students to enhance learning and are based on many types of learning styles (Ekwensi et al., 2006). There are many types of instructional strategies that can be used in an e-learning environment. The ten instructional strategies identified are mentorship, forums, small group work, projects, collaborative learning, case studies, learning contracts, discussion, lecture and self-directed learning (Ekwensi et al., 2006 and Illinois Online Network, 2009). To avoid the same mistake made by the researchers mentioned above, this thesis will thus focus on the instructional strategies of lecture material by addressing the first research question on how can we create quality knowledge through the e-learning environment to which is positively related to students' perceptions of their learning outcomes.

While there has been some research comparing traditional classroom and e-learning directly, these are few in number. The most significant results from good research in this area indicate that learning outcomes achieved using technology are at least the same as for those in traditional settings (Brennan et al., 2001). The cases cited by Welsh et al. (2003), a lot of which were from the US army, indicated that learning outcomes were either better or equal for those from e-learning courses, compared with their 'classroom' counterparts. Studies from the field of education also seem to suggest that distance 'e-learners' tend to do slightly better than 'traditional' learners (Bonk & Wisher, 2000: 36-38). Of potential interest to the question of e-learning effectiveness compared with classroom learning, is research conducted by Russell (1997). He compiled 250 research reports on the effectiveness of distance learning *for students* over a 30 year period (Burgess & Russell, 2003; and Welsh et al., 2003). His discovery was that there was no significant difference in learning outcomes between those that learned at a distance, and those learning in the traditional classroom manner. This would seem to lend support to the position that e-learning can be at least as good as classroom learning. On the whole, however, Welsh et al., (2003), argues that it is difficult to compare e-learning outcomes with that of classroom learning, because we may not be comparing like with like. *'It is difficult, if not impossible, to design training that is identical in all ways except delivery… difference[s]… might have been due, at least in part to course design rather than the use of technology (252).'* In other words, the content of the course may have been improved when it was converted to an e-learning version.

Grabe & Grabe (2001) supported the notion that tapping higher-level skills is facilitated by technology. They claimed that, by using asynchronous communication technologies—as in simulation projects, for example—students were more readily able to use the types of skills that foster analysis, evaluation, and synthesis, at the higher levels of Bloom's Taxonomy (Bloom, 1956). Traditional instruction has long been criticized for tapping into only the lower levels of Bloom's Taxonomy of the cognitive domain. "With [e-learning] technology, educators are now able to explore how to teach students so that they can achieve the upper end of the hierarchy" (Owen & Aworuwa, 2003: 22-7).

Methods to measure student learning outcomes

Measuring student learning outcomes (SLOs) can determine if intended learning has actually occurred. Student learning includes the full breadth of education: acquisition of skills, mastery of concepts, and growth in life perspective. Learning outcomes are direct measures of learning, distinct from indirect measures such as graduation rates, course completion rates or even course grades. SLOs focus specifically on the individual's skills, knowledge, and values.

There are different types of measures used to assess SLOs. Experts in the field (Angelo, 1999; Dietel et al., 1991; Huba & Freed, 2000; Maki, 2002; Palomba & Banta, 1999) have recommended multiple assessment measures to be utilised in order to obtain a clearer understanding of what students have learned and to compensate for biases or weaknesses in any single assessment instrument. The ability to draw accurate conclusions and inferences about student achievement of expected outcomes is directly related to the measures and methods used during the assessment process; poor methods and instruments can lead to unreliable results and misleading conclusions. Maki (2004) has identified a comprehensive list of methods to measure SLOs. She divides them into three types: direct methods, indirect methods and Authentic, performance-based methods.

Direct methods are measures where students demonstrate learning so that observers can assess how well their knowledge, skills, and abilities match with expectations. They are usually assessed in the form of standardized instruments focusing on aspects of student learning. Some of the direct method examples are the Collegiate Assessment of Academic Proficiency (CAAP), Watson-Glaser Critical Thinking Appraisal and Graduate Record Examinations (GRE) Subject tests. Indirect methods measure students' perceptions of their learning and the educational environment that supports that learning. Some of the indirect method examples are self-reported surveys of college students, and satisfaction surveys. However, as cautioned by Maki (2004), indirect methods should not be used as the sole evidence of student learning. The authentic, performance-based methods are measures where students represent learning in response to assignments/projects that are embedded into their educational experiences and they are particularly beneficial for types of learning that are integrative, reflective, and generative. Some of the authentic method examples are student portfolios (including digital), capstone projects, performances, creations, case studies, internships and service projects. This shall be further elaborated in Chapter 3.

Part B: Creating Quality Knowledge through the e-learning environment

A major goal in successful knowledge management in education is to improve student learning (Petrides & Nodine, 2003). In this study, the first research question will address the issue on how to create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes. Carroll (1963) has identified that one of the key conditions to insure student learning is the quality of instruction or material. Newmann (1993) argues that increasing the competence and confidence of educators improves the quality and quantity of instruction or learning material which, in turn, raises student achievement.

In e-learning, the course material/content can consist of both printed and digital material. Thus the selection, production and adaptation of course content are of major importance to the quality of e-learning. Course content can be produced by publishers, individual educators or by a group of course developers. When dealing with complex digital media, a team of production experts is often needed. In some cases, learners have become the producers of their own learning material. The recycling of existing material available online and the fact that digital "originals" cannot easily be authenticated or distinguished from copies adds to the complexity of identifying an "author" (Swedish National Agency for Higher Education, 2008). Thus, the different people involved in the production processes raise questions about the quality of the course material.

McGovern (2002) points out that "trillions of words are published on millions of websites [and] much of this publishing is of appalling quality." On the surface, online publishing, which has eliminated the highly technical tasks of typesetting, printing, and distribution, appears deceptively simple. In particular, revising online material seems to be quick, simple, and straightforward. Educators just need to open the source document, use a simple text editor, save the changes to the server, and every course can contain what Nunes & Gaible (2002) refer to as “cutting-edge knowledge”. In addition, just as most educators do not write textbooks, those same educators do not want to, or do not have the skills to write quality e-learning content. As a result, quality electronic learning materials are generally not being created within the institutional environment, and any content that is being written follows a 'cottage industry' model in which unpaid educators take on electronic course creation in their spare time. As educators move on, get upset with their additional work volume, or as the technology changes, course-content deteriorates or is lost.

Putting poor content into the online learning environment can have especially serious consequences, both for students and for the delivering institution (Thiessen & Ambrock, 2004). By ensuring that the course materials delivered to students are of consistently high quality, educators need to remove material-based obstacles to their learning. Thus, increasing the quality of instruction or learning material is seen as key determinants to improve learning. Through the e-learning environment, quantity of instruction to be accessed by students is not a problem but rather the quality of instruction (information). Therefore, through the e-learning environment, educators need to create quality knowledge (information) to improve student learning outcomes.

E-learning was earlier identified as a tool for the support of the knowledge creation process. Moreover, it is the instruction/information that would be transferred in the process; the educator expert must elicit his or her tacit knowledge as mental model, design as instruction which is converted into information. In this process, tacit knowledge needs to be codified and convert it into high quality explicit knowledge or information. As mentioned in Chapter 1, Diemers (2000) argued that the success of the transformation process of converting educator's tacit knowledge into explicit knowledge to be internalised by the learner as tacit knowledge is very much dependent on information quality as the medium for the transformation process. Thus, it is necessary to examine and measure information quality in the transformational process. This is to ensure that learners are able to derive quality tacit knowledge from this information which is obviously very important and should be considered a conceptual cornerstone of any knowledge management theory (Diemers, 2000). In addition, information quality is always relative and depends on the individual student or group of students who are measuring and judging it. Thus, any benchmarking or standardising of information quality has to correspond to a significant large group of students' cognitive structures. To benchmark or measure information quality, we can adopt Kahn et al. (2002) Product and Service Performance Model for Information Quality (PSP/IQ) as the tool.

Information Quality

The Concept of quality

The concept of quality is defined in different ways by different researchers. Among the earliest proponents of quality was W. Edwards Deming. He is best known for his work in the industrial reconstruction of post-World War II Japan. Deming (1982) asserted that quality improvements inevitably lead to productivity improvements, hence improvements in competitive position. In his view, low quality wastes effort and production capacity, and causes rework, each of which brings down productivity, increases cost, and has the potential to damage the firm's reputation. He also emphasized that "the customer is the most important part of the production line" (1982: 225). In particular, he noted that "the cost to replace a defective item on the assembly line is fairly easy to estimate, but the cost of a defective unit that goes out to a customer defies measure" (1982: 225). Ironically, "the most intriguing feature of his concept of quality is that there is no mention of customer satisfaction", according to Mahoney & Thor (1994: 12). Customer satisfaction is relevant in this study since the e-learning material created must be of high quality to meet or exceed student expectation. Another important contribution to quality is the work of Juran. Similar to Deming's work, Juran (1988) emphasized the importance of the customer in defining and measuring quality. He proposed that "a simple definition of quality is 'fitness for use.'" and also noted, however, that "that definition must quickly be enlarged, because there are many uses and users" (1988: 5). Juran (1988) greatly expanded the definition of customers "to include *all persons who are impacted by our processes and our products*" (1988: 8). He elaborated about various internal and external customers, including essentially everyone involved in processing or handling a product until it reaches its eventual end user. A third major contributor to the work on quality is Crosby (1992, 1996). Building upon the works of Deming and Juran, Crosby (1992) emphasized the role of the customer, stating, "the only absolutely essential management characteristic will be to acquire the ability to run an organization that deliberately gives its customers exactly what they have been led to expect and does it with pleasant efficiency" (16-17). Therefore, in defining information quality, we should emphasise the importance of the role of customer and in the case of this thesis, student expectation.

Defining Information Quality

Considerable research attention has been focused on the need for a rigorous definition of information quality. This section attempts at defining information quality and to establish a definitional model, including a look at the model used as the basis of this research.

Conventionally, information quality has been defined as how accurate the information is. However, according to the research and practice of Huang et al. (1999) both researchers and practitioners define information quality to be beyond accuracy. They identify information quality as encompassing multiple dimensions. Some of the dimensions are objective while others subjective; some are context independent and others context dependent. Huang et al. concluded that there is no standard information quality definition exists today. Huang et al. presented three approaches that have been used in the literature and in business practice to study information quality, that is, the intuitive, system and empirical.

The intuitive approach is taken when the selection of information quality is based on individual's experience or intuitive understanding about what attributes are important (ibid.). Huang et al. mentioned that many information quality falls into this category and the cumulative effect of these studies are the selection of a small set of common information quality attributes, e.g. *accuracy*. The system approach to information quality focuses on how information may become deficient during the manufacturing process. For example, a study discovered by Huang et al. uses an ontological approach in which the attributes of information quality are derived based on deficiencies, which are defined as the inconsistencies between of a real-world system that can be inferred from a representing information system and the view that can be obtained by directly observing the real-world system. However, Huang et al. argued that there are not many research examples based on this approach in defining information quality. Both the intuitive and system approaches have their merits in focusing on the information product in terms of development characteristics. However, Huang et al. asserted that both of these approaches have the problem of not focusing on the information product in terms of use characteristics. These approaches are not directed to capturing the voice of the consumer. Moreover, the intuitive approach is difficult to be vigorous. The empirical approach analyses information collected from information consumers to determine the characteristics they use to assess whether information is fit for use in their tasks. The advantage of the empirical approach is that it captures the voice of consumers, however, the correctness and completeness of the results can not be proven based on fundamental principles. The empirical approach that defines information quality is based upon the information consumer's perspective. To define information quality correctly, it is critical to understand both the information manufacturer's objective perspective and the consumer's subjective perspective (ibid).

The information manufacturer's objective perspective considers information systems analogous to manufacturing systems, with the difference being that data[1] are used as the raw material, and processed data, sometimes referred to as information, are the output. In this model, data stores are comparable to inventory. The ISO 9000 concept of "Specification and Design" (Wang et al., 1995) translates into the need to specify different quality aspects of data, such as acceptance and rejection criteria, consistent with management policy, and subject to management processes. Adopting a consumer's subjective perspective similar to the one advocated by Juran (1988), Wang et al. noted, the "use of the term 'data product' emphasizes the fact that the data output has value that is transferred to customers, whether internal or external to the organization" (Wang et al., 1995).

[1] Usage of the terms *data* and *information* is highly inconsistent from one researcher to another. Bovee (2004) conducted a thorough exploration of the terms *data* and *information* in hopes of resolving this dilemma. Instead of finding resolution, he found numerous instances in which, if a distinction was to be made, one term was defined by its relationship to the other, leaving neither term well-defined. After many pages of well reasoned, well-documented consideration, he decided to "bypass the circularity found between these two constructs" (2004: 32), choosing instead to use the terms synonymously. Given these findings in the literature, the terms will likewise be treated as synonyms in this research unless specifically noted otherwise.

The consumer perspective later compelled Wang & Strong (1996) to develop a data quality framework that captures the aspects of data quality that are important to data consumers. They stated that “although firms are improving data quality with practical approaches and tools, their improvement efforts tend to focus narrowly on accuracy” (1996: 5). In their study, Wang & Strong (1996) reported the result of a two-stage survey and a 2-phase sorting study. They began with a very broadly based set of 118 data quality attributes collected from data consumers and then consolidated into twenty dimensions and further reduced to fifteen dimensions on their second-stage survey. These dimensions were grouped into four data quality categories: intrinsic, contextual, representational, access. Their study had also led Huang et al. to develop a framework with four information quality (IQ) categories, similar to the four data categories. They are:

> *Intrinsic IQ denotes that information have quality in their own right. Accuracy is merely one of the four dimensions underlying this category. Contextual IQ highlights the requirement that information quality must be considered within the context of the task at hand; that is information must be relevant, timely complete, and appropriate in terms of amount so as to add value. Representational IQ and accessibility IQ emphasize the importance of the role of systems. The system must be accessible but secure. It must present information in a way that is interpretable, easy to understand, and concisely and consistently represented.*
>
> (Huang et al., 1999: 43)

Table 2.1 depicts the Information Quality (IQ) categories and dimensions by Huang et al. (1999). Although the arrangement of and the exact number of dimensions considered varies somewhat from researcher to researcher, the essence of this categorisation now has broad support among the information quality research community.

IQ Category	**IQ Dimensions**
Intrinsic IQ	Accuracy, objectivity, believability, reputation
Contextual IQ	Relevancy, value-added, timeliness, completeness, amount of data
Representational IQ	Interpretability, ease of understanding, concise representation, consistent representation
Accessibility IQ	Access, security

Table 2.1 Information Quality (IQ) Categories and Dimensions (Huang et al., 1999).

The Product and Service Performance Model for Information Quality

Kahn et al. (2002) extended Wang & Strong (1996), and Huang et al. (1999) models significantly and developed a two-by-two conceptual model for describing information quality. They referred this model as the "product and service performance model for information quality (PSP/IQ)". Drawing from the quality literature, Kahn et al. (2002: 185) adopted two definitions of quality: *conformance to specifications* and *meeting or exceeding customer expectations*. They argued that the *conformance to specifications* definition can usually be defined and measured and "specifications are established to ensure products and services are free of deficiencies that may interfere with their use" (2002: 185). Kahn et al. further reasoned that the *conforming to specifications* definition is inadequate because the product or service must also meet or exceed consumer expectations (2002). They highlighted that "information must be useful and add value to the tasks of information consumers but, it can be difficult to measure since consumer expectations may change over time" (2002: 185).

Kahn et al. conceded that the conventional view of information quality is product-oriented. In addition, they also argued that information can be conceptualised as a service. A service unlike product "is produced and consumed simultaneously. The process of converting data to information has the typical characteristics of a service, for it often involves customized, personal interaction between information technology staff and users" (2002: 186).

For the product and service performance model for information quality (PSP/IQ) model, Kahn et al. (2002) assigned the *conformance to specifications* and *meeting or exceeding customer expectations* definitions of quality as the two columns. They also assigned the *product* quality and *service* quality as the two rows in the PSP/IQ model (2002). These are depicted in Table 2.2.

On the product quality row, the product-conformance quadrant is referred to as *sound information* and the product-expectations quadrant represents *useful information* (Kahn et al., 2002: 189). Moreover, on the service quality row, the service-conformance quadrant represents *dependable information*, with *usable information* making up the service-expectation quadrant (2002).

In their previous research, Kahn et al. (2002) identified the essential dimensions of the IQ for delivering high quality information as shown in Table 2.3. These dimensions are developed from the perspective of information consumers.

	Conforms to Specifications	**Meets or Exceeds Consumer Expectations**
Product Quality	Sound Information The characteristics of the information supplied meet IQ standards.	Useful Information The information supplied meets information consumer tasks needs.
Service Quality	Dependable Information The process of converting data into information meets standards.	Usable Information The process of converting data into information exceeds information consumer needs.

Table 2.2 Aspects of the PSP/IQ Model (Kahn et al., 2002).

According to Kahn et al. (2002), these IQ dimensions have demonstrated validity, and they asserted that it is necessary to achieve high quality along these dimensions in order for consumers to consider information to be of high quality (2002).

Furthermore, Kahn et al. mapped these IQ dimensions into the PSP/IQ model and found all dimensions but two (in italics in the product-expectations, useful information quadrant) fell solidly into the four quadrants as shown in Table 2.4 (Kahn et al., 2002).

According to Lee et al. (2002), the PSP/IQ model organizes the key IQ dimensions so that meaningful decisions can be made about improving IQ.

Dimensions	Definitions
Accessibility	the extent to which information is available, or easily and quickly retrievable
Appropriate Amount of Information	the extent to which the volume of information is appropriate for the task at hand
Believability	the extent to which information is regarded as true and credible
Completeness	the extent to which information is not missing and is of sufficient breadth and depth for the task at hand
Concise Representation	the extent to which information is compactly represented
Consistent Representation	the extent to which information is presented in the same format
Ease of Manipulation	the extent to which information is easy to manipulate and apply to different tasks
Free-of-Error	the extent to which information is correct and reliable
Interpretability	the extent to which information is in appropriate languages, symbols, and units, and the definitions are clear
Objectivity	the extent to which information is unbiased, unprejudiced, and impartial
Relevancy	the extent to which information is applicable and helpful for the task at hand
Reputation	the extent to which information is highly regarded in terms of its source or content
Security	the extent to which access to information is restricted appropriately to maintain its security
Timeliness	the extent to which the information is sufficiently up-to-date for the task at hand
Understandability	the extent to which information is easily comprehended
Value-Added	the extent to which information is beneficial and provides advantages from its use

Table 2.3 Dimensions of information quality (Kahn et al., 2002).

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	<u>Sound Information</u> Free-of-Error Concise Representation Completeness Consistent Representation	<u>Useful Information</u> Appropriate Amount Relevancy Understandability *Interpretability* *Objectivity*
Service Quality	<u>Dependable Information</u> Timeliness Security	<u>Usable Information</u> Believability Accessibility Ease of Manipulation Reputation Value-Added

Table 2.4 Mapping of the information quality dimensions into the PSP/IQ model (Kahn et al., 2002).

Measuring Information Quality

To manage explicit knowledge (information) effectively, one must measure, analyse, and to improve the quality of information. This section presents a discussion of the objective and subjective approaches towards information quality measurement.

The objective measurement is based on the system approach as mentioned earlier. It measures information quality along quantifiable and objective variables of information quality that are derived based on deficiencies. The deficiencies are defined as the inconsistencies between of a real-world system that can be inferred from a representing information system and the view that can be obtained by directly observing the real-world system. However, the objective approach is problematic, for example, the dimension on accuracy, in particular, is especially troubling. As Redman (2005: 23) put it, “there is nothing akin to length, viscosity, impurities in parts per million, impedance, or other physical dimensions”. He (2005: 23) went on to note that “all measurements of data accuracy must, of necessity, make reference to human knowledge, other data, or the real world”. Moreover, the objective approach has the problem of not focusing on the information product in terms of user characteristics. This approach is not directed to capturing the voice of the consumer. The advantage of the subjective approach is that it captures the voice of consumers. The subjective information quality measurement will be adopted because it measures how good do information consumers (students who use the information) think the quality of information is.

In 2002, Lee et al. (2002: 133) observed that “despite a decade of research and practice, only piece-meal, ad hoc techniques are available for measuring, analyzing, and improving IQ in organizations”. They responded by developing an IQ measurement instrument, known as the Information Quality Assessment (IQA), which measures stakeholders (information consumers, producers, and custodians) perceptions of each dimension as tabulated in Table 2.3. With the 16 dimensions as shown, Huang et al. (1999) and Lee et al. (2002), generated 69 questionnaire items to measure the various information quality dimensions. This instrument has been used as the basis of several studies requiring information quality measurement (Huang et al., 1999; Kahn et al., 2002; Lee et al., 2002). This information quality measurement concept has been extended to the PSP/IQ model (Kahn et al., 2002). The PSP/IQ model aggregates the results of the 69 items and 16 dimensions measured by the IQA to produce a measure of information quality consisting of the four quadrant measurements as shown in Table 2.4. By using the IQA to measure the dimensions, the quadrant measurements of sound, dependable, useful and usable information are derived by calculating the mean scores for the dimensions associated with each quadrant (Kahn et al., 2002; Lee et al., 2002). This resulted in the measurement of information quality consisting of only four numbers for the four quadrants.

Thus, these information quality dimensions are the keys to a successful transformational process to effectively transfer the codified tacit knowledge from the educator to the learner and vice versa.

It is this perspective and the conceptual model it offers that guide the conceptualisation of the assessment of the impact of knowledge management practices through e-learning on student learning outcomes for this thesis. The major research concern is thus how we can create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes and to develop learning communities to promote knowledge sharing, sharing, teamwork, and collaborative learning in the social contexts.

Information Quality and Student Learning Outcomes

As identified earlier, the primary function of knowledge management is to codify [tacit knowledge into explicit knowledge] and capture knowledge [explicit knowledge into tacit knowledge] (Sorensen & Lundh-Snis, 2001). One of the most important roles of educators is to transfer their knowledge to learners. Thus, educators (as senders) attempt to transfer and codify explicit and tacit knowledge to learners (as receivers). One of the ways where this can take place is through the e-learning environment. However, educators face the difficulty of codifying tacit knowledge into explicit knowledge for learners' retrieval and of facilitating them to acquire the tacit knowledge.

One aspect of the educators' role in the course development process of e-learning is to improve the course material (information) quality so that students' learning experiences can be enhanced. When learners are accessing quality material through the e-learning environment, it is easier for educators to direct them to appropriate information based on their needs. If designed properly, e-learning systems can be used to determine learners' needs and current level of expertise, and to assign appropriate quality material for learners to select from to achieve the desired learning outcomes. Learning occurs when learners go through the sequence of instruction (information), to complete the learning activities, and to achieve learning outcomes and objectives through the e-learning environment (Ally, 2002; Ritchie & Hoffman, 1997). Learners should be informed of the learning outcomes clearly in the e-learning material, so that they know what is expected of them and will be able to gauge when they have achieved the learning outcomes. Ideally, the "learning outcomes are translated into course content (information) …that will enable a student to achieve those outcomes" (Davis, 2004: 133). It must be the learning outcomes and not technology that drive the content of the e-learning material. To ensure ongoing improvement on the student learning outcomes, an evaluation process for the effectiveness of the e-learning material, based on achievement of the learning outcomes and students' feedback have to be in place.

A Research Framework for Information Quality and Student Learning Outcomes

This section of the chapter presents a framework for information quality and its possible relation to student learning outcomes through the e-learning environment. The section begins by presenting the conceptual framework used for this research, centred on the concept of a possible relationship between information quality and student learning outcomes. Finally, the section presents the research model used for this research.

Educators need to become effective facilitators of e-learning and create quality e-learning material to improve student learning outcomes. Educational institutions should develop and implement a scientific research agenda related to the use of e-learning with students. This agenda should determine which instructional design practices are required to create quality material in order to optimize student achievement and authentic learning outcomes. Quality e-learning information that promote effective e-learning outcomes currently are not recognized, generally understood, or agreed upon by e-learning producers, consumers, and education policy leaders. There is an important gap in the research literature, in that the linkage between information quality and student learning outcomes has only been minimally examined to date, with relatively little theoretical grounding.

Conceptual Framework

The concepts discussed above form the basis of a conceptual framework. This section presents such a framework, which will be used in this study for evaluating the possible relationship between information quality and student learning outcomes.

The central element of this framework is the possible strategic relationship as shown generically in Figure 2.2. Through the e-learning environment, educators need to create quality knowledge (information) which is positively related to students' perceptions of their learning outcomes. The framework is the possible strategic relationship between quality information and student learning outcomes.

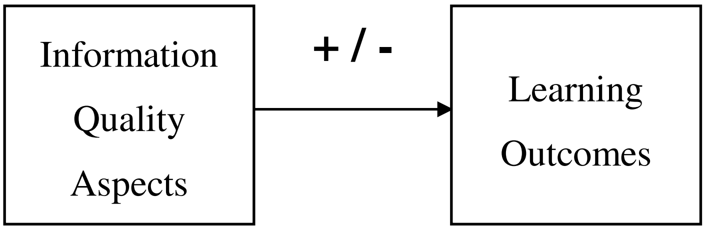

Figure 2.2 Strategic relationship between information quality aspect and student learning outcomes

Operationalizing the Variables

To operationalize the variables for this research, it was necessary to precisely define and measure the information quality aspects and student learning outcomes, and to frame the research within a broader context. The following paragraphs describe how this was done.

Operationalizing Information Quality Aspects

As discussed earlier in the chapter, researchers have established that information quality can be measured in a variety of ways, including both subjectively and objectively. Of the measurement techniques available, the Information Quality Assessment (IQA) instrument, a subjective measurement, is the most comprehensive. It uses 69 survey items to measure 16 dimensions. The PSP/IQ Model then reduces the 16 dimensions to four quadrants (Kahn et al., 2002; Lee et al., 2002) was shown in Table 2.4.

Operationalizing the information quality aspects, therefore, will be accomplished through a straightforward adaptation of the IQA instrument and the Product and Service Performance model for Information Quality (PSP/IQ). Each quadrant is thus used to represent an information quality aspect in the strategic relationship shown in Table 2.4.

Operationalizing Student Learning Outcomes

As discussed earlier in the chapter, Maki (2004) identifies that there are several methods of assessment that provide direct or indirect evidence of student learning. Assessments of students' success can be brought to bear on the content and presentation through the e-learning environment, so as to enhance student learning outcomes. Therefore, one of the strategies identified by Maki (2004) in using assessment to improve student learning outcomes is to "revise [instructional] content to assure appropriate attention to areas that need increased attention". In this study, due to the limitation of time for this thesis, we will be using the indirect method of a self-reported survey of students to assess their learning outcomes. However, Maki (2004) cautions indirect methods should not be used as the sole evidence of student learning.

On the other hand, a number of researchers argue that the student self-reports do provide a comprehensive indicator of students' learning outcomes. Despite the difficulty to fix with any certainty the closeness of the correspondence between other measures of cognitive outcomes and students' self-reports, there is considerable support from earlier research evidence in the literature that students are credible reporters (Anaya, 1999; Baird, 1976; Berdie, 1971; Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984).

The Research Model

The conceptual framework and variables defined above were thus combined to form the research model as shown in Figure 2.3. The four information quality quadrants from the PSP/IQ model (Lee et al., 2002) are shown on the left and the learning outcomes is shown on the right. Taken together, four relationships (R1 through R4) result, and were the focus on this research.

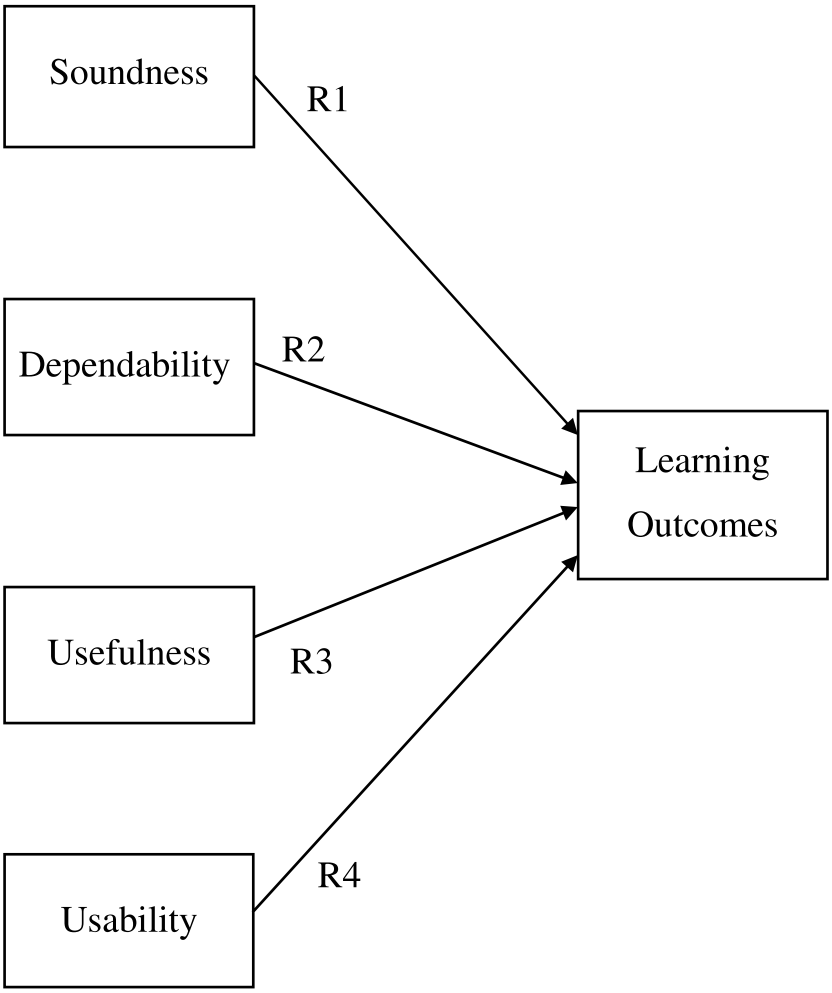

Figure 2.3 The Research Model

Part C: Knowledge transfer through Communities of Practice to improve learning

In Chapter 1, I have argued (based on Brown (1998)) that the use of the Internet as a means of transferring knowledge is insufficient. Instead Brown contended that abstractions recorded and shared on the Internet need to be considered as being inseparable from their own historical and social locations of practice. In addition, Hislop et al. (2000) found that tacit knowledge could not be encoded in documents or e-learning infrastructures. Instead, they discovered that social networks[2] should be developed to transfer tacit knowledge. Through the practices of knowledge management, learning communities or communities of practice can be developed so as to transfer tacit knowledge effectively. Research in learning communities or communities of practice (a knowledge management enabler) make a strong case for the interdependency of learning and social context (Johnson, 2001; Wenger, 1998). The sharing of knowledge induces educators and learners at every level to contribute, to participate, to interact, to grow, and to learn. Making sense of knowledge that is necessary to success is a crucial step. Thus, the knowledge management practice of developing communities of practice is to ensure that tacit knowledge can be transferred more effectively through such social networks to improve student learning.

In this section, I will seek to address the second research question: *How can we develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning?* However, I shall only carry out conceptual analysis on this question.

Tacit Knowledge Transfer

Knowledge transfer is an important part of knowledge management (Simard & Rice, 2001), and has been identified as one of the most important managerial issues of the late 1990s (Szulanski, 1996). This section focuses on the transfer of knowledge within the organization. Earl & Scott (1999) maintain that successful organisations are those that "consistently create

[2] A **social network** is a social structure made of nodes which are generally individuals or organizations. It indicates the ways in which they are connected through various social familiarities ranging from casual acquaintance to close familial bonds. The term was first coined in 1954 by J. A. Barnes (in: *Class and Committees in a Norwegian Island Parish*, "Human Relations"). The maximum size of social networks tends to be around 150 people (Dunbar's number) and the average size around 124 (Hill and Dunbar, 2002).

new knowledge, disseminate it through the organization, and embody it in technologies, products, and services". Zander & Kogut (1995) regard organisations as social communities that enhance new skills' transfer, communication and capabilities by means of their relational structure and shared coding schemes. They assert that new knowledge is difficult to replicate if there is no "social capability". The aim in this section is therefore to build the basis of a good understanding of the phenomenon of knowledge transfer.

Szulanski (1996), and O'Dell & Grayson (1998) identify that tacit knowledge – knowledge resulting from experience and intuition – constitutes 80% of the real-value knowledge which is contained in a practice. Since this type of knowledge is very difficult to express and to codify, most of the valuable knowledge usually stays with the transmitter (educator) while the receiver (junior educator or student) often only gets 20% in a codified form. They further contend that even though the transfer of knowledge does occur, it is sometimes difficult to sustain through time – either though a lack of motivation, interest, training, leadership, connections between the members etc. In practice, there is a real risk of know-how loss during tacit knowledge's conversion to explicit knowledge. There is not as yet an acceptably established procedure to actively manage knowledge within an organization.

However, through the knowledge transfer process, practices are improved when replicated across common communities of practice (Wolford, 1999). He further states effective knowledge transfer can take place when replicated across common communities of practices – thus linking knowledge transfer to communities of practice.

Communities of Practice

This section begins by drawing a general picture of communities of practice (CoPs), and establishing the general links between this networked structure and the transfer of tacit knowledge.

When Lave & Wenger (1991) first mentioned the term *communities of practice* in the literature, they defined them as "a set of relations among persons, activities, and world, over time and in relation with other tangential and overlapping communities of practice". A more practical approach is presented by Wenger et al. (2002), who describe a community of practice as a group of employees who share a common interest for a defined subject, and who exchange information and knowledge across and beyond organizational boundaries, with a motivation to develop new knowledge or best practices. CoPs focus on practical aspects of a practice (McDermott, 2001).

According to Wenger (1998), CoPs imply a shared practice between members, and exist in any organization. He adds that because membership is based on participation rather than on official status, "these communities are not bound by organizational affiliations; they can span institutional structure and hierarchies". For Liedtka (1999), the community's practice exists and evolves in its social interaction and not in its members' individual heads and hands. Brown & Gray (1998) mention that CoP at the simplest level, is a small group of people who have worked together over a period of time; "not a team, not a task force, not necessarily an authorized or identified group". He adds that what holds these individuals together is "a common sense of purposes and a real need to know what each other knows". Comparing CoPs to teams, McDermott (1999) states that "the heart of the team is a set of interdependent tasks that lead to an objective; whereas that heart of a CoP is the knowledge members share and develop". A CoP is, in fact, a group of people who learn together and create common practices (McDermott, 1999). The community and the degree of participation in it are inseparable from the practice (Kimble et al., 2001). CoPs share knowledge related to best practices across an enterprise's geographical and organizational boundaries (Hildreth et al., 2000), and are much more efficient at doing so if they get support from top management (Wenger et al., 2002). Brown & Duguid (1991) maintain that members of a CoP should work together on a regular basis to find solutions to common problems, and then evaluate the achieved results together.

Wenger (1998) suggests that CoPs could resolve the major problems pointed out by Szulanski (1996), and O'Dell & Grayson (1998). The problems concerning the transfer of tacit knowledge as stated in the second research question are:

1. Tacit knowledge – knowledge resulting from experience and intuition – counts for 80% of the real-value knowledge which is contained in a practice. Since this type of knowledge is very difficult to express and to codify, most of the valuable knowledge usually stays on the transmitter's (educator's) side, and the receiver (junior educator or student) often only gets 20% of this valuable knowledge, in a codified form.

2. Even though the transfer of a tacit knowledge takes place, it sometimes is difficult to sustain the use of knowledge through time – or by lack of motivation, of interest, of training, of leadership, of connections between the members, etc. In practice, there really exists a risk of know-how loss during the conversion of tacit knowledge to explicit knowledge. There isn't yet a real established procedure to actively manage best practices within the organization.

With reference to the two problems shown above, O'Dell & Grayson (1998) suggested that the solution to these problems is to build communities of practice in order to allow the members to continuously exchange their knowledge linked to practices. Furthermore, Wenger (1998) considers the problems related to the tacit knowledge within a practice and to maintaining the utilization of a practice over time by emphasizing CoPs' very dynamic and social aspects: the members know one another and are intensely dedicated to the development of best practices over time. Wenger (1998) suggests that since the links between these individuals are very dense, the creation and exchange of tacit and explicit knowledge are encouraged and stimulated. Regular face-to-face contact between members is stressed in order to optimize the transfer of tacit knowledge. Consequently, the quasi totality of tacit knowledge contained in a practice that has been developed within the community of practice remains within the network, which considerably diminishes the risk of this know-how being lost (Wenger, 1998; Wenger et al., 2002).

Hildreth et al. (2000) perceive CoPs' networked structure as appropriate for development and transfer of knowledge. In their conclusion, they furthermore state that tacit knowledge, which is difficult to codify, could be the key to an organisation's continuity, but that for tacit knowledge to be exchanged and kept "alive" within the organization, it has to foster the creation of CoP networks at an international level. Since a best practice is essentially constituted of tacit knowledge (Bogan & English, 1994; Szulanski, 1993, 1995, 1996; O'Dell & Grayson, 1998; Jarrar & Zairi, 2000; Ellis, 2001), it seems implicit that a CoP organizational structure is well suited to the development and transfer of tacit knowledge. Liedtka (1999) asserts that tacit knowledge transfer exist and evolve in the "social interactions" of CoPs, simultaneously with the development of "individual and collective capabilities". For Büchel & Raub (2002), the transfer of tacit knowledge should occur between practitioners who share a high degree of trust, interpersonal relations, and shared experiences. This last statement is especially relevant in respect of a community of practice structure.

In his research, McDermott (2002) makes reference to the problems with regard to tacit knowledge by stating that "tacit knowledge is the real gold in knowledge management and communities of practice are the key to unlocking this hidden treasure". This undermines the idea that CoPs are a structure that is well suited to identifying, capturing, keeping alive and further developing the tacit knowledge encapsulated in a best practice, and having this practice evolve through time.

To move towards the management of tacit knowledge we need to understand the processes that govern its construction and nurturing in an organisation. Lave & Wenger (1991) suggest that a process called Legitimate Peripheral Participation (LPP) in Communities of Practice (CoPs) can assist the creation and sustenance of such knowledge. For Lave & Wenger (1991) LPP defines a CoP. Students and junior educators learn the practice of the community by being situated in it and from its established members (seniors and educators/experts from industry). LPP is part of the process by which a learner becomes an established member of a CoP. According to LPP, newcomers become members of a community initially by participating in minute and superficial yet productive and necessary tasks that contribute to the overall goal of the community. The student's activities such as academic exercises, tutorials, assignments, etc., are typically simple and carry low risk to the community as a whole but, are also important. Through peripheral activities, novices become acquainted with the tasks, vocabulary, and organizing principles of the community. Newcomers are allowed to observe and learn for a long period before they engage in full participation (Lave and Wenger, 1991). Once having been "enculturized" - learned the dogma of a community: the jargon, the values, the rules of participation - they may then begin to participate as peers, offering their own perspectives which can influence the community and construct new knowledge in the process. Gradually, as newcomers become old timers, their participation takes forms that are more and more central to the functioning of the community.

LPP suggests that membership in a community of practice is mediated by the possible forms of participation to which newcomers have access, both physically and socially. If newcomers can directly observe the practices of experts, they understand the broader context into which their own efforts fit. Hence, the fundamental challenge for schools is to design the learning environment so that newcomers can legitimately and peripherally participate in authentic social practice in rich and productive ways making it possible for learners to 'steal' the knowledge (Brown & Duguid, 1993).

Explicit knowledge can be articulated and may be exemplified by tasks the members of a CoP perform. Tacit knowledge is that knowledge which the learner cannot learn simply by demonstration or instruction. It includes learning the language and unspoken conventions of the community. Tacit knowledge is developed and learnt through being socialised into the community and through interaction with the existing members. Thus, CoPs are more than environments in which tacit knowledge is developed - both explicit and tacit knowledge are created and shared. We need to move from trying to capture/codify/store towards emphasising the human aspect. Wenger's tacit/explicit duality provides a way forward for knowledge management as it takes into account the need to maintain the balance between the explicit and the tacit aspects of knowledge and reinforces the idea of Communities of

Practice as an environment for creating, sustaining and nurturing the tacit aspects of knowledge (Hildreth & Kimble, 2002)

A review on the impact of Communities of Practice on student learning

The purpose of this section is to provide a review of the literature on the impact of Communities of practice (CoPs) on student learning. In an attempt to create a comprehensive picture we first provide an overview of the essential characteristics of Professional Learning Communities (PLCs) and CoPs, and their linkage. After developing this foundation, we examine the current literature as it relates to the question on "Does the literature support the assumption that student learning increases when educators participate in a CoP? And, what aspects of the CoPs support increased student learning? This is to address the second research question: *How can we develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning?*

Vescio et al. (2008) has done a substantial review on the impact of Professional Learning Communities (PLCs) on teaching practices and student learning. They found that well-developed PLCs have a positive impact on both teaching practice and student achievement. The concept of a PLC is based on a premise from the business sector regarding the capacity of organizations to learn. Modified to fit the world of education, the concept of a learning organization became that of a learning community that would strive to develop collaborative work cultures for educators (Thompson et al., 2004). Learning communities are grounded in two assumptions. First, it is assumed that knowledge is situated in the day-to-day lived experiences of educators and best understood through critical reflection with others who share the same experience (Buysse et al., 2003). Second, it is assumed that actively engaging educators in PLCs will increase their professional knowledge and enhance student learning.

PLCs are well grounded in Wenger's CoPs. Current research suggests that the effects of PLCs are optimized when they exist not in isolation but as part of overlapping, interconnected communities of practice (Resnick & Hall, 2001; Mitchell et al., 2001). Members of such "overlapping" communities are both formally and informally bound together by what they do, by what they have learned through their mutual engagement in the work, and through the work they have produced (Wenger 1998). Overlapping PLCs can help schools and districts develop the capacity necessary for them to assume authority and knowledge for improved teaching and learning (Coburn 2003). In this way, knowledge is created, shared, organized, revised, and passed on within and among these communities. As a result, educational institutions are better positioned to construct organizational expertise and to develop strategies that ensure that their individual work is connected to the larger goals and purposes of the organization (Wenger 1998). This shift gives rise to viewing professional learning communities as communities of practice (Wenger 1998). The approach presumes that organizations and groups within and across organizations will develop and share their capacity to create and use knowledge for the purpose of producing a 'shared practice' as members engage in a collective process of learning (Wenger 1998). This shift also entails an expanded notion of "community," one that includes all adults who work directly or indirectly with students, including educators, school and district administrators, superintendents, business, industries and community partners, parents, university faculty, and school board members (AISR, 2004). Therefore, PLCs are components of a larger CoP.

Currently, institutions are shifting their professional development efforts toward integrating educator learning into communities of practice with the goal of meeting the educational needs of their students through collaboratively examining their day-to-day practice.

Newmann et al. (1996) describe five essential characteristics of these communities. First, shared values and norms must be developed with regard to such issues as the group's collective ''views about children and children's ability to learn, school priorities for the use of time and space, and the proper roles of parents, educators, and administrators'' (181). A second essential characteristic is a clear and consistent focus on student learning (182). DuFour (2004) reiterates this notion when he writes that the mission ''is not simply to ensure that students are taught but to ensure that they learn. This simple shift—from a focus on teaching to a focus on learning—has profound implications'' (paragraph 5). The third characteristic is reflective dialogue that leads to ''extensive and continuing conversations among educators about curriculum, instruction, and student development'' (Newmann et al., 1996: 182). De-privatizing practice to make teaching public and focusing on collaboration are the last two characteristics of a CoP (Newmann et al., 1996). In order to ensure effectiveness of CoPs, DuFour (2004) recommends that educators should continually reflect on the ways they are working to embed student learning and educator collaboration into the culture of the schools. Ultimately, educators must critically examine the results of their efforts in terms of student achievement. To demonstrate results, CoPs must be able to articulate their outcomes in terms of data that indicate changed teaching practices and improved student learning, something they have not yet established as common practice Vescio et al. (2008). In this review, we will focus on communities of practice to improve student learning.

Communities of Practice and student learning

Does the literature provide evidence about the effects of CoPs on student learning? In an educational climate that is increasingly directed by the demands of accountability, the viability of CoPs will be determined by their success in enhancing student learning. This makes it incumbent upon educators to demonstrate how their work in CoPs improves student learning.

Vescio et al. (2008) reviewed 11 studies and eight of these that examined the relationship between educators' participation in CoPs and student learning found that student learning has indeed improved (Berry et al., 2005; Bolam et al., 2005; Hollins et al., 2004; Louis & Marks, 1998; Phillips, 2003; Strahan, 2003; Supovitz, 2002; Supovitz & Christman, 2003). These studies focused on CoPs in relations to students' grade results, test scores, and outcome data in terms of performance and progress. According to Vescio et al. (2008), all the eight studies found significant improvement in student learning when these educators participated in CoPs. Louis & Marks (1998) went a step further by stating that student learning was significantly higher in schools with the strongest CoPs. This effect was so strong that the strength of the CoP accounted for 85% of the variance in learning. Furthermore, Supovitz (2002) and Supovitz and Christman (2003: 5) state that "there was evidence to suggest that those communities that did engage in structured, sustained, and supported instructional discussions and that investigated the relationships between instructional practices and student work produce significant gains in student learning". Vescio et al. (2008) pointed out that it is important to note similar gains were not evident even though educators worked together but did not engage in structured work that was highly focused around student learning. Therefore, the collective results of these studies offer an unequivocal "yes" answer to the question about whether the literature supports the assumption that student learning increases when educators participate in CoPs.

Investigation into how CoPs improve student learning is important to the continued and future work of educators. Vescio et al. (2008) identified a common feature that facilitated success which was a persistent focus on student learning and learning by the educators in CoPs. Vescio et al. (2008) found evidence of improved learning in particularly, where educators worked in CoPs that focused on instructional practices and how they impacted student learning. These educators develop instructional strategies (based on student data and reinforced by professional literature) that lead to meaningful student learning. In addition, Vescio et al. (2008) further identified that educators ensure that the efforts of their collaborations were always rooted in improving test scores and other measures of student learning. Similarly, educators' collaborative efforts were always driven by data-directed dialogue about student learning and directed toward increasing that learning. Furthermore, Vescio et al. (2008) recognised CoPs that focus on the intellectual quality would boost student learning because it pushes educators toward the use of authentic pedagogy. Finally, Vescio et al. (2008) acknowledged that educators who analyzed data of each child would continually identify ways to affect success in both the child's cognitive and affective domains. Phillips concluded that the educators who ''knew their students' population well, and they deliberately created culturally relevant programs to make learning more meaningful'' (2003: 258). In the long run, the key element of successful CoPs is their pervasive attention to meeting the learning needs of their students.

The use of CoPs as a means to improve teaching practice and student learning is a move that educators support and value. There is also some limited evidence that the impact is measurable beyond educator perceptions (Vescio et al., 2008). However, when educators participate in a CoP, students benefit, as indicated by improved learning scores over time. An intense focus on student learning and achievement was the aspect of CoP that impacted student learning outcomes.

Developing Communities of Instructional Practice to improve student learning

In the previous section, a common feature identified was that when educators in CoPs focus on instructional practices, it leads to meaningful student learning. Supovitz & Christman (2003) concluded that these CoPs would enhance the quality of instruction to improve student learning. CoPs are a powerful way for educators to engage in instructional improvement through sustained enquiry into their practice and investigations into ways that their teaching can most effectively produce greater student learning. CoPs that focused on instructional quality bring educators out of isolated classrooms and collaborate together in structured ways to systematically explore how to improve student learning.

In this section, we will explore how educational institutions can develop Communities of Instructional Practice (CoIPs) and provide the necessary supports. Supovitz & Christman (2003) concluded that to develop CoIPs, institutions must provide these communities with specific structure, strategies, and supports.

Supovitz & Christman (2003) stated structures that facilitate community engagement in instructional practice must provide sufficient and protected time for educators to meet. In addition, the communities must be organised in such ways that capitalize on both the horizontal and vertical nature of schooling.

Educational institutions must realize that the development of CoPs that engage in systematic inquiries about their instruction and how it relates to student learning is as much a cultural shift as it is an organizational one. While organizational structures can facilitate this change, they are just the means to facilitate the work of communities of instructional practice. As identified earlier, the CoP structure must encourage a high degree of trust, interpersonal relations and shared experiences for the effectiveness of tacit knowledge transfer (Büchel & Raub, 2002). This would ensure members know one and another and dedicated to the development of best practices. The institutions must rethink of the roles and responsibilities of the administrators, principal and educators and reshape their functions to support the CoPs. Institutions must provide communities with protected time that frees educators to investigate instruction and provides them the opportunities to share with each other about the connections between their instructional strategies and student learning. Furthermore, an institution must distribute instructional talent across CoPs to allow for a more equitable allocation of educators and ensure that students do receive equal learning opportunities over time. To develop a CoP, legitimate authority must be assigned to a CoP leader to enable him or her to lead the community by developing consensus about the actions and requiring others to participate and carry out community decisions. Community leaders are required to lead their members in developing and using a shared repertoire of community practices that will focus on what students are and are not learning and what can be done to improve their performance. Institutions must allow communities as much autonomy as possible over curriculum, staffing, scheduling, and budgets and be clear about the parameters of autonomy. However, Supovitz & Christman (2003) cautioned that limitations of authority of these community leaders vis-à-vis the principal's must be clearly delineated. This is to ensure that as the head, the principal has the final say in matters concerning the institution.

Supovitz & Christman (2003) also recommended structure must be developed to allow educators in CoPs to establish both the vertical and horizontal relationships. Vertical relationships (i.e., educators in different grades) allow educators to articulate across grades and even to connect with their students over multiple years. Horizontal relationships (educators at the same grade level) allow educators to talk with their peers who are teaching similar curriculum topics to students of the same age. These vertical and horizontal relationships allow educators continually in dialogues amongst themselves and with the students to determine ways to improve student learning.

Supovitz & Christman (2003) advocated that CoPs need strategies to help them plan, assess, and revise their efforts. The strategies are to ensure the educators in the same community take advantage of their communal arrangements: learning opportunities that are connected to their content areas and to the materials they are using in their classrooms, linking to student performance and learning. The strategies must enhance community members to capitalize on the social arrangements inherent in communities of practice to share and collaborate with each other on teaching and learning improvements. Supovitz & Christman (2003) proposed that institutions can do several things to focus communities on instructionally related activities. First, institutions can provide communities with the tools and training to develop structured routines in which they systematically inquire into the relationships between their practices and the learning of their students. Second, institutions can organize and provide communities with meaningful information to guide their investigations of their practices and student learning. Third, they can establish processes for communities to be reviewed and provided with feedback about their instructional programs and their students' progress. Fourth, they can send a clear message throughout the system that improving instruction is the first priority of communities. Finally, they can facilitate the work of communities by helping with the logistical arrangements necessary for team teaching and enabling educators to enhance their own practices and intellectual lives through access to each other's classrooms.

In addition, institutions must strategise CoPs in such a way that they foster constructive interaction among members. Regular face-to-face contact between members should be stressed to optimise the transfer of tacit knowledge between them. Institutions can also play an important role in networking communities so that educators can learn from the experiences of colleagues in other settings such as other educational institutions, industries, etc.

Finally, Supovitz & Christman (2003) proposed that institutions must provide supports which include professional development opportunities that afford community members the occasions to improve their instructional craft knowledge, as well as organizational supports that provide both the resources and legitimacy that breaks down obstacles and facilitates the challenging work that communities are being asked to do.

Conclusion on Part C: Knowledge transfer through CoPs to improve learning

This section has presented research literature relevant to the second research question: *How can we develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning?*

The transfer of tacit knowledge through communities of practice to improve student learning was examined in terms of its theoretical grounding and current lines of research. We have conceptually reviewed that communities of practice can effectively transfer sustained tacit knowledge. Tacit knowledge which resides in expert educators and inseparable from its historical and social locations of practice is very difficult to express, codify and transfer to junior educators and students. Building communities of practice can facilitate this transfer of tacit knowledge between members. Once tacit knowledge has been shared with the CoPs, it would enable educators to improve student learning. There is much literature which provides some examples in support of student learning improvement when educators participate in CoPs focusing on instructional practices.

To develop and support CoPs, institutions must provide them with specific structure, strategies and supports to enable them to improve student learning.

Chapter 3
Methodology

Introduction

The principal research concern of this study is to assess the impact of knowledge management application on the quality of students' learning outcomes through the e-learning environment. This chapter presents the methodology used to conduct the research for this study. It begins with the reiteration of the problems and the research questions that determine the empirical design. The next section describes the theoretical framework within which the research was conducted and presents the hypotheses that were tested. Furthermore, it describes the research design and sampling design, followed by detailed discussions of the measures used in the study, the data collection procedures, and the data analysis procedures which include the instrument validation. It then proceeds to interrogate the analysis method to be used and to identify the limitations that are inherent in the design, which have implications for subsequent conclusions to be drawn from the findings and data analyses. The primary focus is on the effect of knowledge management practices on the quality of students learning outcomes through the e-learning environment. The research question that provides the framework for the design is: *How can we create quality knowledge (explicit) through the e-learning environment which is positively related to students' perceptions of their learning outcomes?*

This guiding research question presents the structure and parameters for the investigation that places an emphasis on student learning outcomes. The research will be reported in the following chapters of the thesis for discussions and conclusions to be made about student learning outcomes. From time to time, reference will be made to this research question to help focus the interrogations and to avoid going off at a tangent from the overall purpose of the study.

Theoretical Framework

In the knowledge management perspective, there are two fundamental concepts of knowledge; explicit and tacit knowledge which were defined and explained in Chapter 2. For a truly effective knowledge management system, it must address both the creation and transfer of explicit as well as tacit knowledge through the e-learning system. As argued in Chapter 2, explicit knowledge is easily articulated and coded by educators. It can also be easily stored in e-learning databases and then transferred to learners. However, Marwick (2001), Stenmark (2002), Petrides & Nodine (2003), and Wilson (2002) argued that explicit knowledge is not knowledge but information. Therefore, the educator expert must elicit his or her tacit knowledge as mental model and convert it into information. Educators should try to codify tacit knowledge and convert it into high quality explicit knowledge or information. In addition, Diemers (2000) argued that the success of the transformational process of converting tacit knowledge from educator to explicit knowledge to be internalised by the learner as tacit knowledge is very much dependent on information (explicit knowledge) quality as the medium for the transformational process. From the knowledge management perspective, information (explicit knowledge) quality is the key concept to analyse, measure and evaluate in the transformational process. This is to ensure that learners are able to derive quality tacit knowledge from this information which is obviously very important and should be considered a conceptual cornerstone of any knowledge management theory (Diemers, 2000). Therefore, we have to define the measurable criteria or benchmarks for the information to be successfully internalised by others as tacit knowledge. We can say that information quality is always relative and depends on the individual or group of individuals who are measuring and judging it. Thus, any benchmarking or standardising of information quality has to correspond to a significant large group of individuals' cognitive structures.

Student learning outcomes are statements of what is expected that a student will be able to DO as a result of a learning activity. According to Barr et al. (2001), learning outcomes are statements of the knowledge, skills, and abilities the individual student possesses and can demonstrate upon completion of a learning experience or sequence of learning experiences (e.g., course, program, and degree).

At this present moment, there is a lack of evidence in the literature to establish the relationship between the management of information quality and student learning outcomes. Much of the evidence may be anecdotal. A research model was proposed for investigating this relationship. Hypotheses based on this model are discussed below.

It was hypothesized that students' perception in various aspects of information quality would positively affect the students' learning outcomes. It was hypothesised that information that is relevant, timely, accessible, accurate, complete, concisely and consistently represented can help an institution to enhance student learning. Therefore, the five hypotheses stated below address the possible relationships between information quality and student learning outcomes. The first four hypotheses address the relationships with individual quadrants in the PSP/IQ model, and the fifth addresses information quality as a whole.

H1: Students' perceptions in the soundness of information will be positively related to students' perceptions of their learning outcomes.

H2: Students' perceptions in the dependability of information will be positively related to students' perceptions of their learning outcomes.

H3: Students' perceptions in the usefulness of information will be positively related to students' perceptions of their learning outcomes.

H4: Students' perceptions in the usability of information will be positively related to students' perceptions of their learning outcomes.

H5: Students' perceptions in information quality will be positively related to students' perceptions of their learning outcomes.

As reviewed in the previous chapter, "soundness of information" has been defined as the characteristics of the information supplied that meet information quality standards in terms freedom-from-error, concise representation, completeness and consistent representation. In addition, "dependability of information" has been defined as the process of converting data into information that meets standards in terms of timeliness and security. Furthermore, "usefulness of information" has been defined as the information supplied that meets information consumer (student) tasks needs in terms of appropriate amount, relevancy, understandability, interpretability and objectivity. Finally, "usability of information" has been defined as the process of converting data into information that exceeds information consumer (student) needs in terms of believability, accessibility, ease of manipulation, reputation and value-addedness.

According to Kahn et al. (2002) product and service performance model for information quality (PSP/IQ) model, the product-conformance quadrant is referred to as *sound information* and the product-expectations quadrant represents *useful information* on the product quality row as shown Moreover, the service-conformance quadrant represents *dependable information*, with *usable information* making up the service-expectation quadrant on the service quality row.

In the research of Huang et al. (1999) and Lee at al. (2002), they had identified the essential dimensions of the Information Quality for delivering high quality information. These dimensions are developed from the perspective of information consumers. Lee et al. (2002) developed an IQ measurement instrument, known as the Information Quality Assessment (IQA), which measures stakeholders (information consumers (students), producers, and custodians) perceptions of each dimension. With the 16 dimensions as shown in Table 2.3 of Chapter 2, Huang et al. (1999) and Lee et al. (2002) generated 69 questionnaire items as shown in Appendix I to measure the various information quality dimensions. This instrument has been used as the basis of several studies requiring information quality measurement (Huang et al., 1999; Kahn et al., 2002; Lee et al., 2002). This information quality measurement concept has been extended to the PSP/IQ model (Kahn et al., 2002) as shown in Table 2.4 and is hereby reproduced. By using the IQA to measure the dimensions, the quadrant measurements of sound, dependable, useful and usable information are derived by calculating the mean scores for the dimensions associated with each quadrant (Kahn et al., 2002; Lee et al., 2002). This resulted in the measurement, analysis and improvement of information quality consisting of the soundness, dependability, usefulness and usability of information.

	Conforms to Specifications	Meets or Exceeds Consumer Expectations
Product Quality	Sound Information Free-of-Error Concise Representation Completeness Consistent Representation	Useful Information Appropriate Amount Relevancy Understandability Interpretability Objectivity
Service Quality	Dependable Information Timeliness Security	Usable Information Believability Accessibility Ease of Manipulation Reputation Value-Added

Table 2.4 Mapping of the information quality dimensions into the PSP/IQ model (Kahn et al., 2002).

Research Design

This study used an electronically administered survey to obtain data measuring students' perceptions of information quality presented in the e-learning environment using the Blackboard Learning System, a course management system. Statistical analysis was conducted on the data to test the null alternatives to the hypotheses presented above.

Existing items from the validated IQA instrument mentioned above were used as the survey items. The information quality instrument has demonstrated validity (Kahn et al. (2002). Most of the survey items had been widely validated within a variety of populations and in various business organizational settings, but not in the educational institutional settings. Therefore, statistical tests such as content validity and construct validity were conducted to validate the instrument in the context of this study's population and to test the reliability and validity of the instrument. The reasons for conducting the content validity and construct validity tests will be explained in detail in the instrument validation section. The survey was administered to a probabilistic sample of third year students within the School of Mechanical and Manufacturing Engineering, Singapore Polytechnic.

In social research such as education, researchers are interested in generalizing to specific groups. The group to generalize to is often called the population in the study. This is the group to sample from because this is the group the researchers are interested in generalizing to. It was the intention in this study to generalize to a group of third year students taking the Organisational Management module in the School of Mechanical and Manufacturing Engineering. To generalise more widely, further and larger studies are required.

The sampling frame is the listing of the population from which the sample is drawn. The sampling frame in this study was the 300 third year students taking Organisational Management module in the School of Mechanical and Manufacturing Engineering. The sample was the group of these students to be selected in the study.

A probability sampling method is a sampling method that utilizes some form of *random selection*. In order to have a random selection method, the researcher needs to set up some process or procedure that assures that the different units in the population have equal probabilities of being chosen. At least with a probabilistic sample, the odds or probability are known to represent the population well. With non-probability samples, the probability may or may not represent the population well, and it will often be hard to know how well the samples are representative (RMKB). In general, researchers prefer probabilistic or random sampling methods over non-probabilistic ones, and consider them to be more accurate and rigorous.

The probabilistic sampling procedure in this study was to send survey notifications and follow-up reminders by electronic mail to all the 300 (the sampling frame) third year students taking Organisational Management module in the School of Mechanical and Manufacturing Engineering. The probability sampling was drawn through the number of students' responses of the survey and collected via the Blackboard Web-based Course Management System. The IQA survey was conducted online (instead of interviewing a substantial number of students) via the Blackboard Web-based Course Management System due to primarily the practical reasons of time limitation and lower cost incurred. Response statistics were collected to determine the response rate. This probability sampling method is a fair way to select the sample, and it is reasonable to generalize the results from the sample back to the population.

Data collected from the survey were input into Microsoft Office Excel, examined, described, and cleansed as discussed below, and were analyzed using SPSS for Windows. A series of multiple regression analyses were conducted to test the main effect hypotheses, each with multiple independent variables and a single dependent variable.

Sampling Design

The target population for this study was individual students from the School of Mechanical and Manufacturing Engineering in Singapore Polytechnic who regularly use the Blackboard learning system. Given the size of a total 300 third year students in the sampling frame, the selection of a representative sample is the preferred approach for efficiently gathering data about the population (Cooper & Schindler, 2003; Lewin, 2005). The course module selected was "Organisational Management" since it was personally developed and taught by the author. The module instruction and material were uploaded in the Blackboard learning system for students' access. The IQA survey conducted was to allow students to assess the quality of information as presented through the web-based instruction and material, and its possible relation to students' positive perceptions of their learning outcomes through self-reports. This module was offered by the School of Mechanical and Manufacturing Engineering, Singapore Polytechnic. It was taught in all the courses offered by the School as a core module in the final stages of the three year diploma courses. The courses are Diploma in Aeronautical Engineering, Diploma in Mechatronics, and Diploma in Mechanical Engineering. The students enrolled in these courses are predominantly male and their average age is around 19 years old. The predominant male students with average age of 19 would pose problem in generalizing results which would be limited to that category of population.

Measures

This section identifies the different variables measured in this study and describes how those variables were measured. The section is divided into three major sub-sections: operationalizing the variables, design of the data collection instrument, and validation of the data collection instrument.

Operationalizing the Variables

Two types of variables were operationalized for this study: independent variables measuring various aspects of information quality and dependent variables measuring student learning outcomes. The reasons for operationalizing these two variables were explained in chapter 2.

Operationalizing Information Quality Aspects

The independent variables for this study were those used to measure information quality. The information quality variables were operationalized at two levels: the dimension level and the Product and Service Performance/Information Quality (PSP/IQ) quadrant level as explained earlier. The dimension level was measured directly by using the 40 of the 69 survey items from the Information Quality Assessment (IQA) instrument (Kahn et al., 2002; Lee et al., 2002) as listed in Tables 3.1 through 3.2. The original instrument utilizes a scale from 0 to 10, where 0 represents *not at all* and 10 represents *completely*, and the midpoint is identified with the label *average*. However, the scale has been modified to simplify it for the students. A recent empirical study found that data from 5-level, 7-level and 10-level items showed very similar characteristics in terms of mean, variance, skewness and kurtosis. In addition, simulation studies and empirical studies have generally concurred that reliability and validity are improved by using 5- to 7-point scales rather than coarser ones (those with fewer scale points). But continually adding items to produce even more finely graded scales does not improve reliability and validity further (Dawes, 2008). Nevertheless, validity would be assessed. The modified scale ranges from 1 (*not at all)* to 5 (*completely*), where the midpoint 3 is labelled *average*. One independent variable per information quality dimension was calculated as the mean value of the response items of the student sample measuring that particular dimension. The PSP/IQ quadrant level variables were each calculated as the mean value of the dimension values corresponding to that particular quadrant (Kahn et al., 2002; Lee et al., 2002) as explained in Chapter 2.

Table 3.1. Information Quality Measurement Items

Dimension	Item – items labelled with "(R)" are reverse coded
Accessibility	This information is easily accessible. This information is easily obtainable.
Appropriate Amount	The amount of information does not match our needs. (R) The amount of information is not sufficient for our needs. (R)
Believability	This information is believable. This information is trustworthy.
Completeness	This information is incomplete. (R) This information is complete. This information is sufficiently complete for our needs.
Concise Representation	This information is presented concisely. This information is presented in a compact form.
Consistent Representation	This information is consistently presented in the same format. This information is not presented consistently. (R) This information is presented consistently.
Ease of Operation	This information is easy to manipulate to meet our needs. This information is difficult to manipulate to meet our needs. (R) This information is difficult to aggregate. (R)
Free of Error	This information is correct[1]. This information is incorrect[1]. (R) This information is accurate[1].

Table 3.2. Information Quality Measurement Items

Dimension	Item – items labelled with "(R)" are reverse coded
Interpretability	It is easy to interpret what this information means. This information is difficult to interpret. (R) This information is easily interpretable.
Objectivity	This information is based on facts[1]. This information is objective[1].
Relevancy	This information is useful to our work. This information is applicable to our work.
Reputation	This information has a poor reputation for quality. (R) This information has a good reputation. This information has a reputation for quality.
Security	This information is not protected with adequate security. (R) Access to this information is sufficiently restricted.
Timeliness	This information is sufficiently current for our work. This information is sufficiently timely. This information is sufficiently up-to-date for our work.
Understandability	This information is easy to understand. This information is not easy to comprehend.
Value-Added	This information provides a major benefit to our work. Using this information increases the value of our work. This information adds value to our tasks.

Note:

[1] The students were able to judge the e-learning material accurately to a certain extent since they could compare it with the material in the student notes.

Operationalizing Student Learning Outcomes

The dependent variables for this study were those used to measure student learning outcomes.

As mentioned in chapter 2, the measurement of learning outcomes can be informed by the students self-reporting of their learning outcome gains. A number of researchers argued that the student self-reports do provide a comprehensive indicator of students' learning outcomes. Despite the difficulty to fix with any certainty the closeness of the correspondence between other measures of cognitive outcomes and students' self-reports, there is considerable support from earlier research evidence in the literature that students are credible reporters (Anaya, 1999; Baird, 1976; Berdie, 1971; Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984). As mentioned earlier, statistical tests will be conducted to test the reliability and validity of the student self-reports instrument. This will be discussed in detail in the Instrument Validation section.

The dependent variables are to determine whether student learning outcomes have been achieved with students' perceptions of the information quality. The self-reported gains include a number of dimensions that encompass their educational and vocational growth. Again, this instrument utilizes a scale from 1 to 5, where 1 represents *Not at All* and 5 represents *Completely* and 3 is labelled as *Average.* One dependent variable per learning outcome dimension was calculated as a mean value of the response items measuring that particular dimension.

Data was collected on aspects of student learning outcomes like estimate of gains in the educational and vocational growth dimensions through student self-reports. These learning outcomes were targeted to reflect more accurately the vocational and educational goals of the

Polytechnic in question, that is, the Singapore Polytechnic, which is a technology polytechnic with emphases on vocational competence and educational excellence. The learning outcomes to be gained were based on one of the topics within the selected final year module “Organisational Management”, entitled “Capitalism, Entrepreneurship, Small and Medium Enterprises”. There are eight measures of gains and they are indices of student learning outcomes. These estimated gains aspects can be conceptually grouped under two categories: vocational and educational gains and they are listed in Table 3.3. The students are required to indicate how much they think they have gained or made progress in each of the 4 aspects for vocational gains and each of the 4 aspects for educational gains.

Table 3.3. Student Learning Outcomes Measurement Items

Vocational gains	1. Acquiring knowledge and skills applicable to a manager in a business enterprise. 2. Gaining a range of information that may be relevant to a career as a manager. 3. Gaining a strong sense of the responsibility of a business enterprise. 4. Gaining an understanding of the roles of the Small and Medium Enterprises in Singapore.
Educational gains	1. Gaining a broad general education about capitalism, entrepreneurship, and Small and Medium Enterprise. 2. Gaining an understanding of the basic economic system and the roles of the individual, capital and profit. 3. Gaining an understanding of entrepreneurship and the legal forms of business. 4. Acquiring background and specialisation for further education in business studies.

Instrument Design

Cooper and Schindler (2003) recommended that answers to four types of questions are to be collected when utilizing surveys to conduct research: administrative questions, filtering questions, target questions, and classification questions. However, in the context of the Singapore Polytechnic, only the administrative and target questions are used in the survey. The filtering questions are used to screen respondents with respect to their qualifications for participating in a study (Cooper & Schindler, 2003). However, full time students learning the Organisational Management, a year three modules, should be qualified to participate in the study since they are in the same stage of their studies. Furthermore, classification questions are used to allow responses to be grouped for analysis according to demographic criteria or other categories (Cooper & Schindler, 2003). Again, the classification questions are deemed unnecessary since these are third year full time students (around the same age). The following sections describe the use of the administrative and target questions in this study.

Administrative Questions

According to Cooper & Schindler, (2003: 361), administrative questions, which provide basic identifying information regarding the participants, "are rarely asked of the participant but are necessary to study patterns within the data and identify possible error sources". For this study, the tracing of responses to a specific respondent can be done through the Blackboard learning system, thus administrative questions were not asked of the participants. Questions about the attitude, values, academic ability and family background of students were not asked even though some of these uncontrolled variables might influence the final outcomes of the survey results.

Target Questions

According to Cooper & Schindler, (2003: 362), target questions are those which "address the investigative questions of a specific study". The specific questions identified for this study are those included above in Tables 3.1, 3.2 and 3.3. Cooper and Schindler suggest that target questions be arranged logically with more general questions asked early in the survey and specific ones asked later, and that they be grouped logically with clear transitions between groups. The target questions were used to measure the various aspects information quality of instruction presented in the e-learning environment and the student learning outcomes. The questions were presented in the same order as in Tables 3.1, 3.2 and 3.3.

Instrument Validation

An instrument used to measure a phenomenon must be assessed with respect to its content validity and its construct validity. Validity provides assurance that the instrument actually measures appropriate, meaningful, correct, and useful inferences from the data obtained through the use of an instrument (Fraenkel & Wallen, 2006) and does not inadvertently measure anything else (Churchill, 1979). Moreover, reliability refers to the consistency of scores or answers (responses) provided by an instrument (Fraenkel & Wallen, 2006). What is desired of an instrument is that it must yield high validity and reliability.

Content validity refers to the content and format of the instrument. It examines whether the content and format of items adequately cover the entire domain of the construct being measured. Content validity is frequently estimated from the review of the literature on the topic or through consultation with experts in the field. After the literature has been critically reviewed, questions or instruments are constructed to cover the known content represented in the literature. In addition, an expert should be able to judge whether or not the tool adequately samples the known content. Researchers, therefore, frequently call upon experts in the field to verify content validity for newly developed tools. However, content validity is subjective; thus, it is not a sufficient measure of validity (Malhotra, 2006, Fraenkel & Wallen, 2006). To overcome the problem with content validity, we should use construct validity which provides the highest level of validation (ITRM). Construct validity refers to the nature of the psychological construct or characteristics being measured by the instrument. It examines the extent to which the construct explains the differences in the behaviour of individuals or their performance on certain tasks and it includes both the convergent and discriminant validity (Fraenkel & Wallen, 2006, Malhotra, 2006). Fiske & Campbell (1992) stated that the convergent and discriminant validity of sets of items in the instrument can be measured using statistical means.

The measurement of the convergent validity of an instrument is usually determined by calculating the Cronbach's alpha coefficient value of a set of items (Cooper & Schindler, 2003; Moore & Benbaset, 1991; Nunnally, 1978). Cronbach's alpha coefficient normally ranges between 0 and 1, with higher numbers representing greater degrees of convergence among the items. Acceptable level of alpha coefficient depends on the purpose of the study. Nunnally (ibid) argued that in the early stages of research, alpha values of 0.50 to 0.60 are adequate. George & Mallery (2003: 231) provide the following rules of thumb: "≥ 0.9 – Excellent, ≥ 0.8 – Good, ≥ 0.7 – Acceptable, ≥ 0.6 – Questionable, ≥ 0.5 – Poor, and < 0.5 – Unacceptable". Nunnally (1967: 226) and Moore & Benbaset (1991: 205) suggested that "alpha coefficient values beyond 0.80 are often wasteful". Thus, for this study the target level of alpha coefficient value is set with a minimum of 0.70.

Assessing discriminant validity is less straightforward than assessing convergent validity, and there are differences of opinion with respect to what constitutes an appropriate method (Fiske & Campbell, 1992; Shemwell & Yavas, 1999)). One of the approaches involves examining some form of the multitrait-multimethod matrix (MTMM) approach to analyze the correlation matrix (i.e., Sullivan & Feldman, 1979; Kalleberg & Klugel, 1975) presented a path-analytic decomposition of the MTMM matrix, which they found inadequate due to assumptions that traits and methods are uncorrelated and that methods are minimally correlated with each other (Jackson, 1969). They also found the method was "basically qualitative in nature" (Kalleberg & Klugel, 1975: 3) and turned to factor analysis to assess validity. The factor analysis approach (Anderson & Gerbing, 1982; Joreskog 1971; Long, 1983) is a widely recommended method for assessing discriminant validity (Schmitt & Stults, 1986) but requires an iterative procedure to arrive at a solution. Furthermore, the issue of whether multidimensional constructs (for example, the information quality portion is multidimensional) are appropriate for measuring phenomena has been debated. Shemwell & Yavas (1999) argue in favour of including such constructs, noting that they are a reality in many domains. They argue that such a construct is useful and meaningful when the constructs are distinct at one level, yet share common variance at another level. They describe such a construct as having a "weak form of discriminant validity" (68). Regardless whether multidimensional constructs are deemed permissible, factor analysis, either exploratory or confirmatory, is a common method for assessing discriminant validity.

The student learning outcomes survey instrument is new. Core to the design of the student learning outcomes is a set of items under the Estimate of Gains section of the questionnaire where students were asked to consider how much gain they believed they have made in their learning.

The student self-reports do provide a comprehensive indicator of students' learning outcomes. Despite the difficulty to fix with any certainty the closeness of the correspondence between other measures of cognitive outcomes and students' self-reports, there is considerable support from earlier research evidence in the literature that students are credible reporters. Under the right conditions, student self-reports of their behaviour and college experiences which certainly include learning gains, are both valid and reliable (Anaya, 1999; Baird, 1976; Berdie, 1971; Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984). There are five general conditions identified by a number of researchers (Bradburn & Sudman, 1988; Brandt, 1958; Converse & Presser, 1989; DeNisi & Shaw, 1977; Hansford & Hattie, 1982; Laing et al., 1989; Lowman & Williams, 1987; Pace, 1985; Pike, 1995, 1996). They are: (1) the information requested is known to the respondents; (2) the questions are phrased clearly and unambiguously; (3) the questions refer to recent activities; (4) the respondents think the questions merit a serious and thoughtful response; and (5) answering the questions does not threaten, embarrass, or violate the privacy of the respondent or encourage the respondent to answer in socially desirable, rather than truthful, ways. All these five general conditions have been met. The information requested in the survey is made known to the students, which is_posted in the Blackboard to be accessed by them. The opinions from students involved in the pilot test indicated that the survey questions are phrased clearly and unambiguously and they refer to recent learning in the Organisational management module. In addition, the same pilot study indicated that a majority of the students think the survey questions merit a serious and thoughtful response. Finally, condition (5) is certainly met, where students are not threatened, embarrassed, violated, etc. in answering the survey questions as observed by the author during the pilot study. All things considered, self-reports are likely to be valid and reliable since the above five conditions have been met (Anaya, 1999; Baird, 1976; Berdie, 1971; Bradburn & Sudman, 1988; Brandt, 1958; Converse & Presser, 1989; DeNisi & Shaw, 1977; Gershuny & Robinson, 1988; Hansford & Hattie, 1982; Kuh et al., 2001; Laing et al., 1989; Lowman & Williams, 1987; Pace, 1985; Pike, 1995, 1996; Pohlmann & Beggs, 1974; Turner & Martin, 1984). The assumption that students are credible reporters is important as the findings to be reported in the next chapter are predicated on what students talked about their learning and how much they thought have been added to their knowledge, and their intellectual skills.

On the other hand, the information quality survey instrument used for this study was drawn directly from prior studies for which the validity had already been determined in varying degrees (Kahn et al., (2002). To assess the validity of this instrument, it was deemed appropriate to consider the steps that had been completed with respect to the separate portions of the instrument, and to determine what additional steps were needed to assure the validity of the instrument as a whole (Robson, 2002).

When designing new instruments, Churchill (1979) recommended a seven-step development approach. They are (1) specify the domain of the construct based on a literature search; (2) the researcher should generate a sample of items, drawing on knowledgeable individuals' opinions and experiences; (3) the researcher should collect a set of data using those items; (4) use the data collected to purify the measure using an iterative process of conducting factor analysis to group items, calculating the coefficient alpha, and removing items that contribute relatively little to the alpha value; (5) collect additional data using the modified measurement, followed by (6) an assessment of the reliability and then (7) an assessment of the validity.

As discussed above, the two main portions of this instrument assessed information quality and student learning outcomes. Steps 1 through 7 had been conducted previously on the information quality portion (Lee et al., 2002) both in the original studies and in studies other than the ones in which the instruments were developed (Kahn et al., 2002; Pipino et al., 2002; Pipino et al., 2005). However, steps 1 through 7 had not been conducted on the student learning outcomes portion.

Therefore, it was deemed necessary to determine both convergent and discriminant validity for the student learning outcomes portion of the instrument. After screening the data for outliers and missing or invalid values, principal components analysis, without rotation and with VARIMAX rotation, was conducted using SPSS to assess the dimensionality of the construct. Two factors were expected to result, representing student learning outcomes of the vocational and education gains. The Cronbach alphas of the items loading on each factor were assessed. For any factors with an alpha less than .70, the item loading coefficients were to be considered. Low-loading items were to be examined for their contributions by dropping them one at a time, beginning with the lowest loading value, followed by calculation of a new Cronbach alpha. This process was to be repeated until an alpha value of .70 was attained or until only two items remained for that factor. If no combination of items could be found to result in an alpha of .70, the data were to be re-examined from the beginning using a threshold of .60. Factors for which no combination resulted in an alpha of at least .60 were to be dropped from further consideration. If no combination could be found resulting in an alpha of .60 for any of the factors, then the hypotheses examining the main effect (H1 through H5) would be considered unsupportable by the data and would not be tested further. The detailed results of this analysis are provided in chapter 4.

The other portion of the instrument, information quality, had been widely validated as mentioned, thus it was not deemed necessary to revalidate this portion for the purpose of this study. Nonetheless, Cronbach alpha values were calculated for the construct as a way of identifying unexpected patterns in the data. Any alpha values below .70 were investigated for the purpose of understanding the cause and determining whether any modifications to the study were warranted. The detailed results of this analysis are also provided in chapter 4.

Prior studies have indicated fairly strong correlation among information quality dimensions (Lee et al., 2002). For this reason, it was hypothesized that the instrument would exhibit the weak form of discriminant analysis, thus a second order analysis, modelled after the analyses conducted by Shemwell & Yavas (1999) was deemed appropriate. The second order analysis was chosen to analyse students' perceptions of information quality at three levels of abstraction while still allowing for the same strict assessment of construct validity as the first order analysis at two levels of abstraction (ibid.). The three levels of abstraction for information quality are the individual questions, dimension level and quadrant level. Thus, the second order analysis provided the most information due to the three levels of abstraction and the most accurate portrayal of the information on the weak form of discriminant validity. That is, the second level dimensions were strongly correlated because they shared common variance based on their relationship of the third level quadrants – but the second level dimensions were basically distinct (ibid). Therefore, this analysis was to be used to test for both convergent and discriminant validity at a level of abstraction higher than that discussed above, that is, at the level of the PSP/IQ quadrants, and student learning outcomes.

Data Collection Procedure

This section presents the procedures used for data collection, data security and storage, and protection of human participants who provided the data.

Procedures for Data Collection

Data for this research were collected by means of questionnaires through the survey manager in the Blackboard Learning System. A sample of the survey instrument is shown in Appendix II. Students registered for the Organisational Management module were required to participate through the Blackboard Learning System. After accessing the Blackboard Learning System, participants indicated their responses by making selections on a series of screens. Upon completion of the survey, participants submitted their responses to the Blackboard server, where they were collected and stored until retrieved by the researcher.

Data Security and Storage

Data were collected on the Blackboard Learning System server hosting the survey. The server was protected using industry standard security practices, including firewalls, password-protected accounts, and intrusion detection system. Access to the data collected on the server was available only to the researcher upon presentation of appropriate login credentials. Upon completion of the survey, the data were retrieved from the server in the form of an Excel spreadsheet, which was downloaded to the researcher's personal computer. The researcher's personal computer was protected from unauthorized access and other exploits through the use of multiple layers of security, including hardware and software firewalls, an encrypted local network, and anti-virus software regularly and frequently updated through automated processes. The data have backed up from the personal computer onto compact disk, and a copy has been stored in a locked facility at a separate location. The data will still be retained after the publication of these research results. However, the subjects were not aware of this and no prior approval was solicited from them.

Protection of Human Participants

According to the Research Methods Knowledge Base (RMKB), there are a number of key principles that describe the system of ethical protections that the contemporary research establishment have created to try to protect the rights of their research participants. Firstly, participants were recruited using non-coercive means based on the principles of voluntary participation (RMKB) and informed consent. Students were fully informed and invited through emails and announcements made during classes to participate in the survey. The students consented to voluntarily participate in the survey, either on their own or in the computer laboratories made available to them. An informed notification in the Blackboard was provided to give essential information and procedure about the research. Participants were not paid for their participation. Secondly, participants were not put in a situation where they might be at risk of both the physical or psychological harm (RMKB). Furthermore, the participants' anonymity (RMKB) were guaranteed where their identifying information were not be made available to anyone including the author of this study even though the author was one of the instructors of some of these students. Survey responses extracted from the Blackboard survey manager were not granted with students' identifying information.

Data Analysis Procedures

There are two sections which provide details regarding the data handling and analysis. Section one describes the exploratory data analysis process used, as well as how the data were screened and cleansed with respect to missing data and extreme values. Section two describes how the data were analyzed for the main effect hypotheses. The detailed results of these procedures are provided in Chapter 4.

Exploratory Data Analysis

Before the testing of the hypotheses, it is vital that data be examined, screened, and cleansed to comply with the assumptions associated with the statistical techniques employed. This section describes the procedures taken for such exploratory data analysis.

Data were first screened and if any were found to be missing, the data set was studied to decide on the best approach for handling the missing data. Basically, there are two approaches to handling missing data; either remove the cases or variables or substitute values for the missing data. Mertler & Vannatta (2005) recommend that if the number of cases with missing data is small, then deleting those cases is generally appropriate. However, if the number missing is not small, then substitution should be considered. In this study, the number of cases with missing data was small. These cases were deleted provided they did not result in the substantial loss of data nor rapid decrease in sample size (Mertler & Vannatta, 2005). The discussion of data screening and the detailed results are provided in Chapter 4.

Next, the data used in evaluating each hypothesis were screened for unusual extreme values or outliers. Mertler & Vannatta, (2005: 29) state that multivariate outliers can be identified through the use of the Mahalanobis distance procedure, which "is evaluated as a chi-square (χ^2) statistic with degrees of freedom equal to the number of variables in the analysis". According to Mertler and Vannatta, outlier cases for which the Mahalanobis distance is significant at $p < .001$ should be investigated. If the test statistic is greater than the upper critical value or less than the lower critical value, we reject the null hypothesis. In chi-square analysis, the null hypothesis generates expected frequencies against which observed frequencies are tested. If the observed frequencies are similar to the expected frequencies, then the value of χ^2 is small and the null hypothesis is retained; if they are sufficiently different, then the value of χ^2 is large and the null hypothesis is rejected (Tabachnick & Fidell, 2007). In addition, if it appears that the case represents an error, it should be dropped. If it appears legitimate, the researcher should consider whether to analyze the results with and without the case in question and should assess options such as transforming the data as a way of reducing its impact. In this study, if outlier cases are found to exceed the upper critical value (upper bound) and lower critical value (lower bound), they are investigated before deciding whether to delete outlier cases. If the outlier cases are due to errors in data entry, the extreme values are correctly entered and the data reanalysed. However, if it is determined that the extreme values are correctly entered and it may be due to instrumentation errors or the values are simply different from the rest of the sample, then it is appropriate to drop the cases from the analysis (Mertler & Vannatta, 2005).

Furthermore, in addition to missing data and outliers, the use of multiple regression is based on three basic assumptions regarding the data: normality, linearity, and homoscedasticity. The tests for these assumptions include both graphical and statistical examinations. For each hypothesis, a scatterplot matrix of the dependent variable and each independent variable was generated as a first indication. The ideal shape of each plot is an ellipse which indicates linearity and normality (Mertler & Vannatta, 2005). When the plot was not elliptical, normality for each variable was assessed individually for skewness, kurtosis and the Kolmorgov-Smirnov statistical test. However, statistical tests were conducted straight away on these basic assumptions rather than depending on the scatterplot matrices as first indications. Whenever these tests revealed problems, transformations such as square roots, logarithms, reflections, and inverses were considered as appropriate for the particular normality problem detected (31). Detailed results of statistics are shown in Chapter 4 to verify the assumptions of normality and linearity. To examine linearity, normality and homoscedasticity, we can plot the standardized values against the predicted residuals. If the assumptions of linearity, normality and homoscedasticity are met, a relatively straight line relationship among the points clustering along a horizontal line and the plot should fit a roughly rectangular pattern for linearity. Moreover, linearity problems revealed through these plots were examined and, to the extent necessary, were addressed through transformations. In addition, if normality is defensible, an even distribution of points should be seen both above and below the same horizontal line. Furthermore, to indicate homoscedasticity, the values should be distributed fairly evenly above and below the same horizontal (plotted reference) line. In this study, scatterplots of standardised values against the predicted residuals will be plotted to examine the three basic assumptions of linearity, normality and homoscedasticity. Examination of these scatterplots provides a test for all three of these crucial assumptions (Tabachnick & Fidell, 2007). The scatterplots and results are shown in detail in Chapter 4. Finally, it should be noted that while fitting to these assumptions is the ideal, some departure from the ideal was expected due to sampling fluctuations, that is, how much the figure for a given statistic fluctuates from sample to sample. Moreover, slight to moderate violations of the assumptions “merely weaken the regression analysis, but do not invalidate it” (Mertler & Vannatta, 2005: 174). Unfortunately, there are no rules to explicitly define that which constitutes “moderate” violation. In reality, we would probably be justified in expecting some slight departures from the ideal situation as depicted in figure 3.1 due to sampling fluctuations (ibid.).

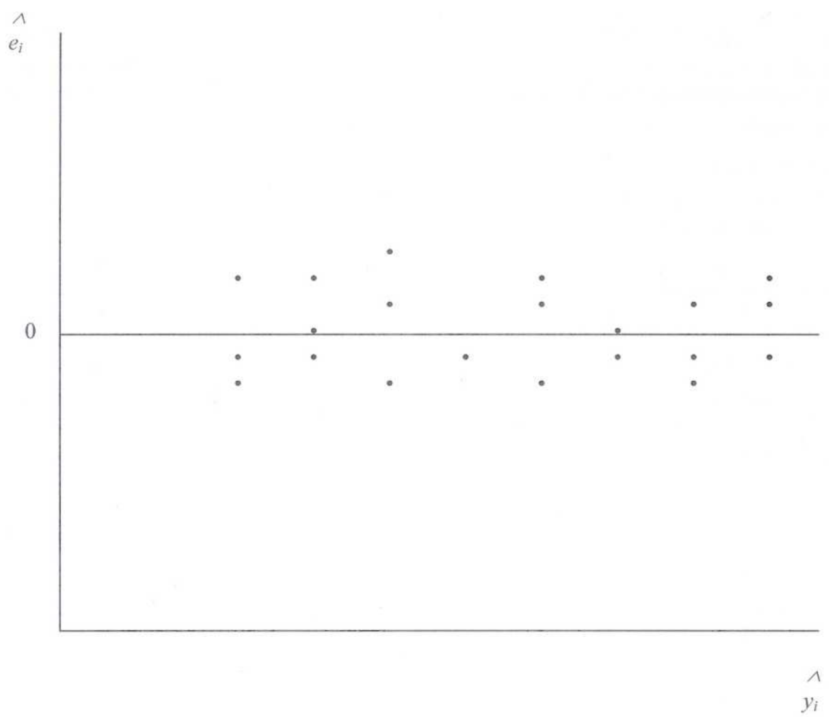

Figure 3.1 Residual Plots when Basic Assumptions of Linearity, Normality, and Homoscedasticity are Met (Mertler & Vannatta, 2005: 174)

Main Effect Hypothesis Testing

Regression analysis procedures, as compared to the other kind of analyses, have as their primary purpose the development of an equation that can be used for predicting values on some dependent variables (DV) for all members of the population (Mertler & Vannatta, 2005). In this study, stepwise multiple regression was used to analyse the main effect hypotheses, instead of the other two types: the standard and sequential approaches. Both the sequential and stepwise approaches to regression contain a distinct advantage over standard multiple regression since both approaches add one variable at a time and each is continually checked for significant improvement to prediction (Mertler & Vannatta, 2005). However, the important difference between these two is that sequential regression orders and adds variables based on some theory or plan by the researcher; whereas, in stepwise regression, those decisions are being made by a computer based solely on statistical analysis (Aron &

Aron, 1999). Therefore, stepwise multiple regression is considered appropriate and often used for exploratory studies (ibid.). Stepwise selection enters variables in the order of their contributions (in terms of their coefficient of determination R^2 where R is the Pearson or multiple correlation) during the analysis and yet the significance (in terms of changes in R^2 (ΔR^2)) of each variable is tested at each step. If these independent variables are found to be no longer providing a significant contribution, then, they are removed from the analysis, resulting in the potential for a more parsimonious regression model. The end result of each regression is an equation of the form:

$$\hat{Y} = B_0 + B_1X_1 + B_2X_2 + \ldots\ldots\ldots\ldots B_kX_k + \hat{e}_i \qquad \text{(Equation 1)}$$

Where B_k = a regression coefficient for each corresponding independent variable (X_k), and $\hat{Y}$ = is an instance of a single dependent variable. $\hat{e}_i$ = errors of prediction. (B_k is also known as *beta coefficients* or *beta weights (β)*).

This multiple regression equation predicts the value of a single dependent variable (represented by the Y) from a linear combination of multiplications between corresponding regression coefficients and independent variables (represented by B_k and X_k). In this study, the independent variables were those used to measure information quality. In addition, the dependent variables were those used to measure student learning outcomes. This is to address the research question on "*How can we create quality knowledge (information) through the e-learning environment* which is positively related to students' perceptions of their *student learning outcomes?*"

Prior to the execution of the regression analysis, Mertler & Vannatta (2005) recommend that the issue of multicollinearity should be addressed. Multicollinearity is a problem that arises when there exists moderate to high intercorrelations among independent variables (IVs) to be used in a regression analysis. The underlying problem of multicollinearity is that if two variables are highly correlated, they are essentially containing the same information and are therefore measuring the same thing. Stevens (1992) pointed out three reasons why multicollinearity can be problematic for researchers. Firstly, multicollinearity severely limits the size of *R* since the IVs are "going after" much of the same variability on the dependent variable (DV). Secondly, when trying to determine the importance of individual IVs, multicollinearity causes difficulty because individual effects are confounded due to the overlapping information. Thirdly, multicollinearity tends to increase the variances of the regression coefficients, which ultimately results in more unstable equations.

The tolerance statistical value can be obtained for each independent variable. Tolerance is a measure of multicollinearity among the independent variables, where possible values range from 0 to 1. Values of less than 0.1 are indicative of a multicollinearity problem. A second test for multicollinearity is the variance inflation factor (VIF), for which values greater than 10 are cause for concern. The VIF for a given predictor indicates whether there exists a strong linear association between it and all remaining predictors (ibid.). The VIF is defined by the quantity $1/\ (1-R_j^2)$ and can be obtained from SPSS. Two suitable approaches for dealing with multicollinearity problems are to delete the problematic variable(s) from the analysis or to combine two problem variables into a single variable. The latter approach is recommended when the variables have an intercorrelation between them of 0.80 or higher (measured by *R*, ibid.). However, in this study the tolerance statistics will be obtained first and the results are shown in Chapter 4.

Conducting regression analysis usually generates output consisting of three parts. They are the model summary, an ANOVA table, and a set of coefficients. The model summary displays the values for multiple correlation (R), the squared multiple correlation (R^2), and the adjusted squared multiple correlation (R^2_{adj}). The multiple correlation (R) is a Pearson correlation coefficient between the predicted and actual scores of the dependent variable. In this study, the predictors, the information quality dimensions, are used to predict the dependent variables, the educational gains and vocational gains. The squared multiple correlation (R^2) represents the degrees of variance in dependent variables accounted for by the independent variable or combination of these variables. However, both R and R^2 tend to overestimate the contribution, especially with small samples, in which cases R^2_{adj} is considered to be more representative of the true contribution to the prediction. In addition, since this analysis is using the stepwise method, the change in the value of R^2 (ΔR^2) was calculated for every step generated (Mertler & Vannatta, 2005). This is necessary since the change in the value of R^2 (ΔR^2) is used to determine which variables provide significant contribution, and in this study using the stepwise method, to decide which variables are added or removed from the analysis.

The ANOVA table presented the F-test and corresponding level of significance for each step generated, reporting the degree to which the relationship between the dependent variable and independent variables was linear. A significant F-test is indicative of a linear relationship between the independent variables and dependent variable, hence a significant prediction of the dependent variable.

Finally, the set of coefficients was examined to consider the unstandardized regression coefficients (*B*), the standardized regression coefficients (*β*), the *t* and *p* values, and a set of correlation indices (ibid). The unstandardized regression coefficient *(B),* also known as the *partial regression coefficient,* represents the slope weight for each variable and is used to create the regression equation. *B* weights also indicate how much the value of the dependent variable changes when the independent variable increases by 1 and the other independent variables remain the same. A positive *B* specifies a positive change in the dependent variable, whereas a negative *B* indicates a negative change in the dependent variable, when the independent variable increases for both cases. Beta weights (*β*) or standardized regression coefficients are often utilized to create a prediction equation for the standardized variables since it is difficult to interpret the relative importance of the predictors when the slope weights are not standardized. Beta weights are based upon z-scores with a mean of 0 and standard deviation of 1. The *t* and *p* values indicate the significance of the *B* weights, beta weights, and the subsequent part and partial correlation coefficients. Next, there are three correlation coefficient indices displayed in the coefficients table. (1) The zero-order correlation represents the bivariate correlation between the independent variable and dependent variable. (2) The partial correlation coefficient indicates the relationship between the independent variable and dependent variable after partialing out all other independent variables. (3) The part correlation, rarely used when interpreting the output, represents the correlation between the independent variable and independent variable after partialing only one of the independent variables. Last but not least, an important statistic is the tolerance, which is a measure of multicollinearity among the independent variables, the information quality dimensions, in this study. Since the inclusion of independent variables that are highly dependent upon each other can create an erroneous regression analysis, determining which variables account for a high degree of common variance in the dependent variable is critical.

Tolerance is reported for all the independent variables included and excluded in the analysis. This statistic represents the proportion of variance in a particular independent variable that is not explained by its linear relationship with the other independent variables. Tolerance ranges from 0 to 1, with 0 indicating multicollinearity. Typically, if tolerance of an independent variable is less than .1, the regression procedure should be repeated without the violating independent variable.

In this study, detail results will be generated and displayed in the model summary and coefficient tables as shown in Chapter 4.

Limitation of Analysis

This section discusses limitations identified for the analysis used in this study. Four broad categories of such limitations have been identified: limitations of survey research, limitations of students' self-report, limitations of the statistical analysis techniques used in this study, and the problem of causal ambiguity.

Limitations of Survey Research

The validity of the survey research is depended upon the extent to which the responses accurately reflect the perspectives of the participants, and the extent to which those perspectives reflect the real-world situation under investigation. These limitations can be moderated through rigorous attention to the design of the survey instrument and the extent of the limitation can be assessed by analyzing the construct validity of the instrument (Robson, 2002). The instrument used for this study was developed using accepted practices and the majority of the items used in the instrument had been validated previously. Further tests were conducted to assess the validity of the remaining items, as described earlier in this chapter.

Limitations of students' self-report

In the research design, the assessment of student change and growth takes the form of their self-reported gains on their learning outcomes. Students' self-reported perceptions of their learning outcomes may not correspond to more objective developmental measures. Several writers (Pace, 1985; Pike, 1995, 1996; Pascarella & Terenzini, 1991) of the social science literature have argued that student self-reports have only moderately positive correlations with objective measures when used to gauge the learning or skill of *individuals.* Although this alternative way of assessing the change in students is not perfect, research generally supports the view that students' self-reports of their learning outcomes are both valid and reliable (Baird, 1976; Berdie, 1971; Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984). The most important factors are whether respondents have the information to provide accurate answers (Wentland & Smith, 1993) and whether they are willing to do so (Aaker et al., 1998). People generally tend to respond accurately when questions are about their past behaviour within a reasonably recent period of time (Converse & Presser, 1989; Singleton et al., 1993) and the items avoid sensitive, potentially embarrassing matters (Bradburn & Sudman, 1988).

In addition, the student-reported method of studying college impact is attractive from a methodological perspective in that it can cover a wide range of learning and developmental outcomes as compared to objective measures like GPA (Anaya, 1999). It is attractive from a practical perspective since it is fairly inexpensive to survey students and to ask them to report how much they think they have learned or changed since entering college. This is because developing objective tests of student learning and skills can be extremely time-consuming and costly. The use of self reported outcomes is thus widespread (Pascarella & Terenzini, 1991).

Limitations of the Statistical Analysis Techniques in this Study

Multiple regression analysis was the primary technique used in this study. As discussed earlier in this chapter, this technique is based on a number of assumptions regarding the data. Each of these assumptions was tested for as described earlier, and to the extent feasible, data transformations were employed to meet the assumptions. In those cases where the assumptions could not be met through such transformations, the statistical power of the analysis was reduced, and any interpretations were limited accordingly.

The instruments that have been adapted for use in the present study measured information quality and student learning outcomes using five values each since more than five to seven values on a Likert scale are not deemed to significantly increase measurement capability (Carte & Russell, 2003). Moreover, Carte and Russell recommend that the scale of the dependent variable be adjusted to a number of values equal the product of the values used to measure the other factors. In the case of this study, that would have required changing the scale of the student learning outcomes to 25 values. This number was deemed unreasonably high for a Likert-type instrument. Rather than change the scale to such a high number of values, this research retained the scales used in the original instruments, and the increased risk of Type II errors was accepted and explicitly acknowledged. Type II errors is the probability of incorrectly failing to reject the null hypothesis (i.e., failing to detect relationships that do exist (Mertler & Vannatta, 2005)).

The problem of causal ambiguity

Correlational investigations of this nature suffer from the inherent problem of ambiguity in causal direction. Explanation of research results is made difficult by the ambiguous causal linkages and directionality of influence, which demands caution in making causal inferences. For example, the student's perception of the polytechnic environment can be affected both by what the environment is really like and by how the student has been influenced by that environment. In other words, the student's subjective view of his polytechnic experience has been influenced by learning outcomes or how much the student thinks he has gained from the experience. Hence, it cannot be sure that the interaction between the environment and learning outcome really explains the change simply because the direction of causation might well be reversed. This presents the chicken-and-egg problem which makes it difficult to separate cause and effect when both are intermingled in the student's experience and his perceptions about learning outcomes. To deal with this problem, an experiment, not a correlational investigation, is required to determine the causal relationship between two variables. A simple correlation coefficient is mute on the question of which is cause and which is effect. The direction of influence remains unclear (Coladarci, 1988). However, it is time-consuming and costly to conduct experiments to determine the causal relationship between two variables.

There are therefore problems in drawing conclusions from the research findings because of the ambiguities in the direction of causal influence. One cannot tell whether it is the teacher-student interaction that has caused better learning outcome or it is the better outcome in learning that leads to closer relationships and more frequent interactions with the teacher. Moreover, it may something else entirely which the researcher may not have taken into account or been aware of. It appears that the causal linkages are circular or reciprocal, where the cause influences the effect, and vice versa. By no means, however, does this ambiguity dispute the practical import of correlational evidence. First, controlled experiments based on hypotheses derived from correlational results have established cause-effect relationships between general instructional models and student achievement (Gage, 1985). Second, irrespective of experimental confirmation, correlational evidence provides educators with a critical basis for speculating about causal relationships regarding instruction and learning. And such speculation arguably is the core of a thoughtful, deliberative orientation toward teaching rather than a mechanistic, technological one (Coladarci, 1959, Zumwalt, 1982). So despite the problematic nature of any cause and effect relationship which may appear, the value of the present study is that eLearning or knowledge management systems are tools to support and improve teaching and learning.

Despite this ambiguity, the relationships identified between independent and dependent variables demonstrated in Chapter 4 ‘Data Analysis and Findings’ do suggest the existence and different magnitude of the effect of certain factors on learning outcomes to result in a better understanding of the correlations between information quality and student learning outcomes.

While it is difficult to analyse the correlations between variables and the results are bound to be inherently ambiguous, it is important that caution is exercised and interpretations are done with a full awareness and recognition of the inherent ambiguities. The causal ambiguity requires that researchers be especially critical when examining research findings of this kind. Does it seem plausible, for example, that in any one correlational study a causal relationship exists? If so, does one direction of influence appear more plausible than the other? Have any important variables been overlooked by the researcher? If so, in what way might the neglected variables be related to the variables that were included in the research? How might these omissions alter our interpretation of the reported results and their implications for practice? Some of these questions shall be addressed in Chapter 5, the “Results, Conclusions, and Recommendations” chapter.

Chapter 4
Data Analysis and Findings

Introduction

This chapter presents an analysis of the data collected and the findings from this research. A total of 328 students were invited to participate in a Web-based survey through the Blackboard Learning System, and 134 responses were received. Data were then prepared, examined, and screened for outliers and missing values. The hypotheses were then tested using a combination of multiple regression analysis, moderated regression analysis, and subgroup analysis. Support was found for all the main-effect hypotheses that were developed to address systematic differences uncovered during the data examination.

Survey Administration

The variables identified in the research model were operationalized through a self-administered Web-based survey through the Blackboard Learning System. An announcement was posted in the Blackboard Learning System to invite students to participate in the survey.

In addition, lecturers were requested to make announcements in class to invite students to participate in the survey. In each case, the invitation identified the purpose of the survey, encouraged participation, and assured participants of the confidentiality of responses. A URL was provided within the Blackboard Learning System, directing participants to the first page of the survey. The total number of responses received between 23 July 2007 and 24 August 2007 (a five-week period) were 134, representing a response rate of 41%. Table 4.1 provides a summary of the responses received during that period. Out of the 134 respondents, 3 students did not answer the questionnaires and 1 student gave answer “1” for all questions. As such, only 130 students were deemed to have appropriately completed the survey, representing a response rate of 39.6%. The composition of these 130 students has been dealt with in great length in chapter 3. The Web-based survey within the Blackboard Learning System allowed students to have only a single attempt and thus multiple responses from a single student was deemed not possible. However, as stated, the attitude, values, academic ability and family background of students were some of the uncontrolled variables which might influence the final outcomes of the survey results.

Table 4.1 Responses for the period between 19 July 2007 and 24 August 2007

Event	*Date*	*Responses*
Survey started	19-Jul	-
	23-Jul	11
	23-Jul	1
	24-Jul	2
	24-Jul	26
	24-Jul	1
	25-Jul	2
	26-Jul	2
	27-Jul	40
	30-Jul	2
	30-Jul	30
	31-Jul	4
	02-Aug	4
	04-Aug	3
Survey ended	24-Aug	6
Total		**134**

Data Coding

Responses were collected in the Gradebook of the Blackboard Learning System for each instance of the survey, and were subsequently downloaded as an Excel spreadsheet. The survey used a 5-point scale with values from 1 through 5 and included several reverse-coded items. Data for this part of the survey were collected on a scale of 1 to 5, hence required adjustment for proper coding prior to importing into SPSS. Each of these items was assigned a text label code in Excel, and that text label was associated with an appropriate text label in SPSS (Please refer to Appendix III for an example of items assigned with text labels). These items were examined and mapped to either one of the existing codes or to a new code as deemed appropriate by the researcher. The recoding function (available in the SPSS) allowed some of the reverse-coded items to be recoded and missing data appropriately addressed to ensure the eventual data were accurate and complete before analysis. Each of the variables used in hypothesis testing was associated with a set of survey items. Following instrument validation (as explained in detail in Chapter 3), the values for these variables were calculated as the statistical mean of the retained items associated with each variable.

Response Analysis

This section presents a response analysis, reviewing general characteristics of the data set and the respondents. First, the data will be screened for coding errors and unusual patterns. Next, the data will be examined to assess the general characteristics of the respondents.

Data Screening

Univariate analysis was conducted on all the variables to ensure proper coding and proper recording of all values and to examine the data for any unusual patterns that could be problematic to the analysis. The steps involved in conducting the univariate analysis were stated in the Exploratory Data Analysis Section of Chapter 3. This was done using SPSS and the detail steps are shown in Appendix IV as recommended by Mertler & Vannatta (62-63). Some minor errors were noted and corrected as a result of this analysis.

The maximum number of target item values possible from the 134 responses was 6,432. An examination of the data (refer to Appendix V for table) revealed that only 129 of the 134 responses had values for all 48 target items. Upon closer examination of the data set revealed that there were three cases (#39, #43, and #98) had gross missing values, thus these cases were excluded and the data were re-examined. Two cases, #2 and #84, were having at least one missing value but amounting to not more than 5% of their total values and so they were included for further analysis. Based on this analysis, it was determined that the 131 remaining cases would be useful for subsequent analysis and that the missing data among those cases would not pose a systematic problem.

Each target item was screened for univariate outliers by transforming the data to z-scores. According to Mertler & Vannatta (2005), for sample sizes greater than 100, the likelihood of finding a few cases with values more than three standard deviations from the mean is very high. As such, they suggest that four standard deviations is a better rule of thumb for deciding which responses to classify and exclude as outliers for this size sample.

Toward that end, standardized z-scores were calculated for each variable, and any value in excess of ±3.00 was treated as an outlier. There were twelve cases (#42, #49, #54, #79, #87, #89, #95, #102, #103, #107, #118 and #129) that met this criterion. There was only one outlier for cases #42, #49, #54, #79, #95, #103, #107 and #129, and two outliers for cases

#102 and #118. There were eight outliers for case #87 and 21 outliers for case #89. To address this issue, rather than drop the cases outright, a new variable was created, recoding those eleven specific responses, except case #89, as 'system-missing', thus permitting the cases to be used in calculations. Upon closer examination of case #89, out of 48 responses, 28 were having values of '1's. As such, case #89 was dropped from further analysis. After recoding the data following this procedure, it was determined that no values exceeded three standard deviations from the mean. Thus, there were 130 remaining cases for subsequent analysis and that the missing data among those cases would not pose a systematic problem.

To test for multivariate outliers, the Mahalanobis distance (refer to Chapter 3, Exploratory Data Analysis section for explanation) was calculated for each case, taking into account all 48 target items, and those distance values were compared against the chi square (refer to Chapter 3, Exploratory Data Analysis section for explanation) critical values for 48 degrees of freedom at p = .001. The upper and lower bounds were determined to be 84.037 and 23.295, respectively. Three cases (#29, #98, and #3) were found to exceed the upper bound as shown in Table 4.2. Moreover, there were twenty cases (#1, #6, #15, #19, #24, #33, #44, #46, #56, #64, #66, #68, #69, #75, #76, #91, #96, #104, #112, #125) were below the lower bound. These cases were investigated to assess whether deletion was appropriate. An examination of these cases indicated that half of the twenty cases (#15, #19, #24, #44, #64, #69, #75, #91, #96, and #104) were found to have all 3's and were dropped. Cases #1 and #56 were found to have all 4's and were thus dropped. The rest (#6, #33, #46, #66, #68, #76, #112, and #125) were having nothing unusual except for a relatively narrow range of response selections. As such, it was decided that this represented a legitimate case and that it should be retained. In contrast, three cases which had exceeded the upper bound value of

84.037 were identified as outliers. These cases were most appropriately deleted. Thus, there were 115 remaining cases for subsequent analysis.

Table 4.2 Extreme Values

			Case Number	Value
Mahalanobis Distance	Highest	1	29	90.05980
		2	98	88.53051
		3	3	84.60674
		4	40	83.17251
		5	114	82.36236
	Lowest	1	33	3.91760
		2	104	4.92127
		3	96	4.92127
		4	75	4.92127
		5	64	4.92127(a)

a Only a partial list of cases with the value 4.92127 are shown in the table of lower extremes.

Construct Analysis

In this section, the steps to conduct construct analysis of the survey instrument are demonstrated. The need to conduct the construct analysis was explained in detail in the *Instrument Validation* Section of Chapter 3. Construct analysis of the survey containing target questions for the information quality and student learning outcomes will be evaluated separately in Part 1 and II, respectively. There were 40 items (Part I) for the Information Quality portion and 8 items for the student learning outcomes (Part II) portion. Upon completion of the construct analysis, survey item responses were used to construct the variables to be used in hypothesis testing. These variables were then screened for outliers.

Part I – Information Quality

As stated in chapter 3, discriminant and convergent validity tests have been conducted in prior research studies (Lee et al., 2002, Kahn et al., 2002; Pipino et al., 2002; Pipino et al., 2005) on the items in Part I, the information quality portion, of the survey instrument. Nonetheless, it was decided that convergent validity would be reassessed to screen for unusual data patterns.

Table 4.3 Extreme Values

			Case Number	Value
Mahalanobis Distance	Highest	1	22	71.75522
		2	91	69.39697
		3	93	68.52076
		4	99	64.47442
		5	35	62.86051
	Lowest	1	27	3.36042
		2	59	4.07143
		3	4	4.52743
		4	89	5.97115
		5	39	9.58446

First, however, to screen for multivariate outliers in this portion, the Mahalanobis distance was assessed using only the 40 information quality items of Part I of the survey. The chi-square critical values at p = .001 for 40 degrees of freedom are 17.916 for the lower bound and 73.402 for the upper bound. There were no cases having the Mahalanobis distances exceeding the upper bound. However, there were five cases (#4, #27, #39, #59, and #89) below the lower bound as shown in Table 4.3. These cases were investigated to assess whether deletion was appropriate. They were found to have nothing unusual except for a relatively narrow range of response selections. As such, it was decided that this represented a legitimate case and that it should be retained to ensure generalisability to the entire population (Hair et al., 2006).

Cronbach alpha values were calculated for each set of items in Part I of the study. These values are listed in Table 4.4. Out of the sixteen dimensions, only seven were having an initial alpha values of well above the target of 0.7. They were concise representation, timeliness, appropriate amount, objectivity, relevancy, believability, and reputation. Examination of those dimensions with alphas below 0.7 indicated that adjustments could be made to improve the alpha of free of error, ease of operation, and reputation dimensions. The adjustments made for this category of dimensions were described in detail in Table 4.4. The rest of the six dimensions (completeness, consistent representation, security, interpretability, understandability, and accessibility) with alpha values below 0.7 needed no adjustments to improve the alpha. For the detailed reasons stated in table 4.4, it was decided that these six dimensions would be removed from further consideration.

Therefore, the remaining 22 items making up the ten dimensions with alpha values of well above 0.7 were retained and the shown in table 4.5.

Table 4.4 Information Quality Item Convergence

PSP/IQ Quadrant	Dimension	No. of Items	α and Remark		
Soundness	Completeness	3	**0.534**		Each of the three items had item-to-total correlations of approximately 0.287, and removing any of them would have lowered the alpha rather than raise it. It was decided that this dimension would be removed from further consideration.
Soundness	Concise Representation	2	0.729		
Soundness	Consistent Representation	3	**0.508**		Each of the three items had item-to-total correlations of approximately 0.292, and removing the first item would have raised the alpha to 0.647 but did not meet the minimum of 0.7. Removing the second or third items would lowered the alpha rather than raise it. It was decided that this dimension would be removed from further consideration.
Soundness	Free of Error	3	**0.644**	**0.772**	Each of the three items had item-to-total correlations of approximately 0.415, and removing the second item would have raised the alpha to 0.772.
Dependability	Security	2	**0.072**		There were only two items, thus removal one would result in the inability to calculate a new alpha. It was decided that this dimension would be removed from further consideration.
Dependability	Timeliness	3	0.799		
Usefulness	Appropriate Amount	2	0.800		
Usefulness	Interpretability	3	**0.466**		Each of the three items had item-to-total correlations of approximately 0.266, and removing the second item would have raised the alpha to 0.660 but did not meet the minimum of 0.7. Removing the second or third items would lowered the alpha rather than raise it. It was decided that this dimension would be removed from further consideration.
Usefulness	Objectivity	2	0.701		
Usefulness	Relevancy	2	0.800		
Usefulness	Understand-ability	2	**0.184**		There were only two items, thus removal one would result in the inability to calculate a new alpha. It was decided that this dimension would be removed from further consideration.
Usability	Accessibility	2	**0.609**		There were only two items, thus removal one would result in the inability to calculate a new alpha. It was decided that this dimension would be removed from further consideration.
Usability	Believability	2	0.783		
Usability	Ease of operation	3	**0.672**	0.877	Each of the three items had item-to-total correlations of approximately 0.369, and removing the first item would have raised the alpha to 0.877.
Usability	Reputation	3	**0.585**	0.742	Each of the three items had item-to-total correlations of approximately 0.353, and removing the first item would have raised the alpha to 0.742.
Usability	Value-added	3	0.864		

Table 4.5 Information Quality Item Convergence

PSP/IQ Quadrant	Dimension	Item-to-total Correlation (No. of items)	Final Number of Items	Final Item-to-total Correlation	Final α
Soundness	Concise Representation	.582 (2)	2	.582	0.729
Soundness	Free of Error	.415 (3)	2	.632	0.772
Dependability	Timeliness	.570 (3)	3	.570	0.799
Usefulness	Appropriate Amount	.668 (2)	2	.668	0.800
Usefulness	Objectivity	.548 (2)	2	.548	0.701
Usefulness	Relevancy	.668 (2)	2	.668	0.800
Usability	Believability	.645 (2)	2	.645	0.783
Usability	Ease of operation	.369 (3)	2	.781	0.877
Usability	Reputation	.353 (3)	2	.590	0.742
Usability	Value-added	.684 (3)	3	.684	0.864

According to classical test theory (Lord & Novick, 1968), a measure’s reliability is strongly related to the number of items. They state that the Spearman-Brown prophecy formula dictates that as the number of items increases, reliability increases. In contrast, as the number of items decreases, reliability of the measure decreases. Cronbach's alpha increases as the number of items in the scale increases, even controlling for the same level of average intercorrelation of items. This assumes, of course, that the added items are not bad items compared to the existing set. Increasing the number of items can be a way to push alpha to an acceptable level. This reflects the assumption that scales and instruments with a greater number of items are more reliable. However, in practice, the number of items on a questionnaire is usually limited by various other factors (e.g., respondents get tired, overall space is limited, etc.)[3]. While increasing the number of items in a scale can thus improves the scale's reliability, there is a significant limitation to this procedure. According to Carmines & Zeller (1979: 46), they identify three limitations. First, the adding of items indefinitely makes progressively less impact on the reliability. Second, the greater the number of items in the scale, the more time and resources are spent constructing the instrument. Finally, adding items to a scale can, in some instances, reduce the lengthened scale's reliability if the additional items substantially lower the average inter-item correlation. In addition, McKnight et al. (2007) argue that modern measurement theory (e.g., the Rash model and item response theory, IRT) holds that there is no definitive relationship between the number of items and the reliability of the measure. Instead, the actual performance of each item and the interrelationships among items dictate the measure's reliability. Therefore, the internal consistency of a measure is highly dependent on the item variances and co-variances, and dependent to a lesser extent on the number of items. A short measure consisting of only a few high highly reliable items would be more reliable that a measure with many poor items, according to modern measurement theory. As shown in Table 4.4, those dimensions with three items (Free of Error, Ease of operation and reputation) did not have alpha values of $\geq$ 0.7, initially. By removing one of the items in each of these dimensions, it has demonstrated that the item-to-total correlations and alpha values have both improved as shown in Table 4.5. Therefore, the final retained items of all the dimensions have alpha values of well above 0.7, as shown in Table 4.5.

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[3] http://www.statsoft.com/textbook/streliab.html

Part II –Student Learning Outcomes

As stated in chapter 3, it was necessary to determine the convergent and discriminant validity of Part II, the student learning outcomes portion of the survey instrument. To screen for multivariate outliers in this portion, the Mahalanobis distance was assessed using only the 8 items from this part of the survey. The chi-square critical value at p = .001 for 8 degrees of freedom are 0.857 for the lower bound and 26.125 for the upper bound. There were twenty-three cases below the lower bound. These cases were investigated to assess whether deletion was appropriate. They were found to have responses of all 4's and not otherwise unusual. Based on this assessment, all of these cases were retained. There were four cases (#6, #35, #102, and #113) as shown in Table 4.6 that exceeded the chi-square critical value of 26.125. Three cases (#6, #102, and #113) were investigated and found to be made up largely of response values at each extreme. As such, these cases were dropped from further consideration except for case #35 which had responses of mostly 5's, but was not otherwise unusual.

Table 4.6 Extreme Values

			Case Number	Value
Mahalanobis Distance	Highest	1	102	50.53772
		2	113	33.97381
		3	6	28.93902
		4	35	28.22451
		5	38	24.95320
	Lowest	1	110	.35409
		2	104	.35409
		3	95	.35409
		4	82	.35409
		5	81	.35409(a)

a Only a partial list of cases with the value .35409 are shown in the table of lower extremes.

Discriminant analysis was performed on these items using the principal components analysis. The most widely accepted approach to identifying the number of principle components or factors to retain is to rely upon the "Kaiser's rule". This rule states that only those components with eigenvalues[4] of 1 or greater are retained. In addition, Mertler & Vanatta (2005) suggest that besides complying with the Kaiser's rule, several other criteria should be considered concurrently to determine the appropriate number of factors to be extracted. Firstly, they suggest consideration of all communalities to be above 0.70 when the number of variables is less than 30 in conjunction with eigenvalues of 1or greater. Secondly, retain components that account for at least 70% of the cumulative total variance explained. Thirdly, retain components if only a few residuals exceed 0.05. If the above criteria are not satisfied, in particularly, some of the communalities are not above 0.70, then, the analysis is to be conducted iteratively. The iterative process requires the Kaiser's rule to be overridden, and the number of factors needs to be increased until all the criteria are satisfied (Refer to the discriminant analysis being performed where the Kaiser's rule must be overridden in order to satisfy the other criteria). Moreover, Mertler & Vanatta (2005) state that sample size should be at least 300 for a factor analysis to return reliable factors and an approximate of 100 sample size as having poor reliability. However, Field (2005) argued that in some circumstances a sample size of less than 100 can be perfectly acceptable. Nunnally & Bernstein (1994) stressed that highly intercorrelated variables should be used with larger samples. To compensate for this weakness when evaluating smaller sample sizes, they recommend applying Bartlett's test of sphericity. The Bartlett's sphericity test is to reject the null hypothesis that the variables in the population matrix are uncorrelated. In addition, for

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[4] An ***eigenvalue*** is defined as the amount of total variance explained by each factor, with the total amount of variability in the analysis equal to the number of original variables in the analysis (Mertler and Vanatta, 2005: 250.

small samples, Garson (2009) also recommends assessing the Kaiser-Meyer-Olkin (KMO) statistic, accepting only samples that produce values of at least 0.6.

Principal components analysis on the student learning outcomes survey was thus conducted using this approach. Both Bartlett's test of sphericity with p = 0.000 and the KMO statistic test = 0.898, indicated that the sample size was sufficient as shown in Table 4.7. This was because the Bartlett's test of sphericity of p = 0.000 was small enough to reject the null hypothesis as mentioned above. It was concluded that the strength of the relationship among variables was strong and thus it was recommended to proceed with a factor analysis for the data. In addition, the KMO statistic test of 0.898 was well above the 0.6 recommended by Garson (2006a) and thus these samples were accepted for factor analysis.

Kaiser's rule was used for the first iteration, yielding only one component that had an eigenvalue (5.827) greater than 1 (Table 4.8). The rest of the components have eigenvalues of less than 1.

Table 4.7 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.898**
Bartlett's Test of Sphericity	Approx. Chi-Square	829.249
	df	28
	Sig.	**.000**

The first iteration also yielded four communalities out of eight being above 0.7 (Table 4.9), a cumulative total explained variance of 72.839%, and with more than half (15 of 28, see Table 4.10) the residuals exceeding 0.05.

Table 4.8 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**5.827**	72.839	72.839	5.827	**72.839**	72.839
2	.795	9.943	82.781			
3	.436	5.451	88.232			
4	.295	3.684	91.915			
5	.196	2.454	94.369			
6	.174	2.177	96.547			
7	.150	1.873	98.419			
8	.126	1.581	100.000			

Extraction Method: Principal Component Analysis.

Based on the above analysis, two criteria (out of four) were not satisfied. The first was that not all communalities were above 0.70 (only four out of eight). The second was that there were many residuals (15 out of 28) exceeded the 0.05 criterion. Since two criteria were not satisfied, the Kaiser's rule of eigenvalue of greater than 1 must be overridden. Thus, a two-factor model was investigated by adding another factor to ensure all four criteria were satisfied.

At two factors, the Kaiser's rule (3.558 and 3.064, respectively) was satisfied after the Varimax rotation was applied, there were no communalities below 0.7 (Table 4.11). A cumulative total of 82.781% variance (44.479% and 38.302%, respectively, Table 4.12) was explained, and the number of residuals above .05 had been reduced to 10 (Table 4.13). Table 4.14 displays the factors and their loadings after rotation.

Table 4.9 Communalities

		Initial	Extraction
SLOED1	Gaining a broad general education about capitalism, entrepreneurship & SMEs	1.000	.693
SLOED2	Gaining an understanding of the basic economic system & the roles of the individual, capital & profit	1.000	**.772**
SLOED3	Gaining an understanding of entrepreneurship and the legal forms of business	1.000	**.740**
SLOVO4	Gaining an understanding of the roles of the Small and Medium Enterprises in Singapore	1.000	**.809**
SLOVO1	Acquiring knowledge and skills applicable to a manager in a business enterprise	1.000	**.823**
SLOED4	Acquiring background and specialisation for further education in business studies	1.000	.671
SLOVO2	Gaining a range of information that may be relevant to a career as a manager	1.000	.681
SLOVO3	Gaining a strong sense of the responsibility of a business enterprise	1.000	.639

Extraction Method: Principal Component Analysis.

Table 4.10 Residuals

		SLOED1	SLOED2	SLOED3	SLOVO4	SLOVO1	SLOED4	SLOVO2	SLOVO3
Reproduced Correlation	SLOED1	.693(b)	.731	.716	.749	.755	.682	.687	.665
	SLOED2	.731	.772(b)	.756	.790	.797	.720	.725	.702
	SLOED3	.716	.756	.740(b)	.774	.780	.704	.710	.687
	SLOVO4	.749	.790	.774	.809(b)	.816	.737	.742	.719
	SLOVO1	.755	.797	.780	.816	.823(b)	.743	.749	.725
	SLOED4	.682	.720	.704	.737	.743	.671(b)	.676	.655
	SLOVO2	.687	.725	.710	.742	.749	.676	.681(b)	.659
	SLOVO3	.665	.702	.687	.719	.725	.655	.659	.639(b)
Residual(a)	SLOED1		.032	.063	.009	-.094	-.162	-.113	-.043
	SLOED2	.032		.032	.040	-.034	-.096	-.135	-.088
	SLOED3	**.063**	.032		.028	-.040	-.069	-.105	-.188
	SLOVO4	.009	.040	.028		-.004	-.075	-.120	-.093
	SLOVO1	**-.094**	-.034	-.040	-.004		.007	-.018	-.007
	SLOED4	**-.162**	**-.096**	**-.069**	**-.075**	.007		.099	-.013
	SLOVO2	**-.113**	**-.135**	**-.105**	**-.120**	-.018	**.099**		.104
	SLOVO3	-.043	**-.088**	**-.188**	**-.093**	-.007	-.013	**.104**	

Extraction Method: Principal Component Analysis.

a Residuals are computed between observed and reproduced correlations. There are 15 (53.0%) non redundant residuals with absolute values greater than 0.05.

b Reproduced communalities

Table 4.11 Communalities

	Initial	Extraction
SLOED1	1.000	.799
SLOED2	1.000	.849
SLOED3	1.000	.851
SLOVO4	1.000	.860
SLOVO1	1.000	.829
SLOED4	1.000	.786
SLOVO2	1.000	.871
SLOVO3	1.000	.778

Table 4.12 Total Variance Explained

Com-ponent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**5.827**	72.839	72.839	5.827	72.839	72.839	**3.558**	**44.479**	44.479
2	.795	9.943	82.781	.795	9.943	82.781	**3.064**	**38.302**	82.781
3	.436	5.451	88.232						
4	.295	3.684	91.915						
5	.196	2.454	94.369						
6	.174	2.177	96.547						
7	.150	1.873	98.419						
8	.126	1.581	100.000						

Table 4.13 Residuals

		SLOED1	SLOED2	SLOED3	SLOVO4	SLOVO1	SLOED4	SLOVO2	SLOVO3
Reproduced Correlation	SLOED1	.799(b)	.822	.825	.822	.731	.571	.545	.543
	SLOED2	.822	.849(b)	.848	.853	.776	.626	.604	.598
	SLOED3	.825	.848	.851(b)	.849	.755	.591	.564	.563
	SLOVO4	.822	.853	.849	.860(b)	.799	.660	.644	.635
	SLOVO1	.731	.776	.755	.799	.829(b)	.769	.781	.753
	SLOED4	.571	.626	.591	.660	.769	.786(b)	.824	.781
	SLOVO2	.545	.604	.564	.644	.781	.824	.871(b)	.822
	SLOVO3	.543	.598	.563	.635	.753	.781	.822	.778(b)
Residual(a)	SLOED1		-.058	-.046	-.064	-.070	-.052	.029	.079
	SLOED2	**-.058**		-.060	-.023	-.013	-.002	-.014	.015
	SLOED3	-.046	**-.060**		-.047	-.015	.044	.040	-.063
	SLOVO4	**-.064**	-.023	-.047		.013	.001	-.022	-.008
	SLOVO1	**-.070**	-.013	-.015	.013		-.019	-.051	-.035
	SLOED4	**-.052**	-.002	.044	.001	-.019		-.049	-.140
	SLOVO2	.029	-.014	.040	-.022	**-.051**	-.049		-.059
	SLOVO3	**.079**	.015	**-.063**	-.008	-.035	**-.140**	**-.059**	

Extraction Method: Principal Component Analysis.
a Residuals are computed between observed and reproduced correlations. There are 10 (35.0%) non redundant residuals with absolute values greater than 0.05.
b Reproduced communalities

Table 4.14 Student Learning Outcomes Factors and Their Loadings

		Component	
		1	2
SLOED3	Gaining an understanding of entrepreneurship and the legal forms of business.	.861	.331
SLOED2	Gaining an understanding of the basic economic system and the roles of individual, capital and profit.	.837	.385
SLOED1	Gaining a broad general education about capitalism, entrepreneurship, and Small and Medium Enterprises.	.836	.317
SLOVO4	Gaining an understanding of the roles of the Small and Medium Enterprises in Singapore.	.818	.437
SLOVO2	Gaining a range of information that may be relevant to a career as a manager.	.319	.877
SLOVO3	Gaining a strong sense of the responsibility of a business enterprise.	.341	.814
SLOED4	Acquiring background and specialisation for further education in business studies.	.379	.801
SLOVO1	Acquiring knowledge and skills applicable to a manager in a business enterprise.	.622	.665

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

[a] Rotation converged in 3 iterations.

Table 4.14 displays the factors and their loadings after rotation. Component (factor) 1 was composed of high positive loadings. They included the items of SLOED3 (.861), SLOED2 (.837), SLOED1 (.836) and SLOVO4 (.818). Since these items all seemed to relate to the students' education, this component will be named *Educational Gains*. Component (factor) 2 included high positive loadings of SLOVO2 (.877), SLOVO3 (.814), SLOED4 (.801) and SLOVO1 (.665). Since these items all seemed to relate to the students' vocation, this component will be labelled *Vocational Gains*.

To determine the convergent validity of these factors, Cronbach Alpha was calculated for each set of items. The first factor (Educational Gains), with four items, has an alpha value of 0.936, which is well above the target threshold of 0.70. The second factor (Vocational Gains), also with four items, has an alpha of 0.915, placing it well above the target.

Based on this analysis, it was decided that the eight items loading on these two factors would be retained for subsequent analysis. The solution is instinctively meaningful and has acceptably high degrees of both discriminant and convergent validity.

Variables Construction and Screening

Using the results of the analysis described above, new variables were constructed at two levels for the student learning outcomes portion as shown in Table 4.15. At the lower level, survey items were used to construct a set of dimension-level variables. The lower level, there were the educational (SLOEG) and vocational (SLOVG) gains dimension-level variables. The educational gains dimension was made up of the SLOED1, SLOED2, SLOED3 and SLOED4 survey items. Furthermore, the vocational gains dimension was made up of SLOVO1, SLOVO2, SLOVO3, and SLOVO4 survey items. At the upper level, dimension-level variables were used to construct a set of category or upper-level variable. Thus, the upper-level variable, the student learning outcomes (SLO) was made up of the educational and vocational gains dimensions. In each case, the statistical mean of the variables at one level was used to construct a single variable at the next level, that is, the statistical means of the respective items were used to construct the educational and vocational gains dimensional variables. In addition, the statistical means of these two dimensional variables were used to construct the single student learning outcomes (SLO) variable.

For information quality, nine variables (IQSDCC, IQSDFE, IQUFAA, IQUFO, IQUFRL, IQUBB, IQUBEO, IQUBRP, and IQUBVA) were constructed to represent the dimensions, and then four (IQSD, IQDP, IQUF, and IQUB) were constructed to represent the quadrants in the PSP/IQ model. For student learning outcomes, two variables (SLOEG and SLOVG) were constructed to represent the educational gains and vocational gains dimensions, and then a single variable (SLO) was constructed to represent student learning outcomes.

Table 4.15 Variables constructed for Student learning outcomes

	Variables	Description	No. of Items	Level
1	SLOEG	Educational gains	4	Lower
2	SLOVG	Vocational gains	4	Lower
3	SLO	Student learning outcomes	2	Upper

These variables were then screened for outliers and normality. Two cases (#14 and #67) had values more than three standard deviations away from the mean in the information quality usefulness appropriate amount (IQUFAA) variable. These were addressed by creating a new variable in which these two cases were coded as missing. No other outliers were identified.

Having addressed the outliers, initial screening for normality was conducted by calculating the Kolmogorov-Smirnov statistic, looking specifically at the Lilliefors significance correlation which was explained in the Exploratory Data Analysis section of chapter 3. Initial screening for normality indicated that all the information quality and the student learning outcomes variables were not very normally distributed. The conclusions of this initial screening were confirmed by the Kolmogorov-Smirnov statistics where the significance levels of all variables were at $p < 0.05$ which implied that the all the variables had non-normal distributions (Table 4.16).

Table 4.16 Tests of Normality

	Kolmogorov-Smirnov(a)		
	Statistic	df	Sig.
Concise Representation	.193	108	.000
Free of Error	.153	108	.000
Soundness	.104	108	.006
Dependability (Timeliness)	.133	108	.000
Appropriate Amount	.189	108	.000
Objectivity	.222	108	.000
Relevancy	.183	108	.000
Usefulness	.107	108	.004
Believability	.194	108	.000
Ease of Operation	.149	108	.000
Reputation	.129	108	.000
Value-added	.144	108	.000
Usability	.093	108	.023
Educational Gains	.180	108	.000
Vocational Gains	.163	108	.000
Student Learning Outcomes	.134	108	.000

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Table 4.17 Skewness and Kurtosis values of Variables

Variable	Description		Statistic	Std. Error
IQSDCC	Concise Representation	Skewness	.200	.233
		Kurtosis	.161	.461
IQSDFE	Free of Error	Skewness	.160	.233
		Kurtosis	-.844	.461
IQSD	Soundness	Skewness	.527	.233
		Kurtosis	-.123	.461
IQDP	Dependability (Timeliness)	Skewness	.321	.233
		Kurtosis	-.649	.461
IQUFAA	Appropriate Amount	Skewness	.234	.233
		Kurtosis	-.705	.461
IQUFO	Objectivity	Skewness	-.004	.233
		Kurtosis	-.414	.461
IQUFRL	Relevancy	Skewness	-.093	.233
		Kurtosis	-.432	.461
IQUF	Usefulness	Skewness	.380	.233
		Kurtosis	-.552	.461
IQUBB	Believability	Skewness	.032	.233
		Kurtosis	-.463	.461
IQUBEO	Ease of Operation	Skewness	.221	.233
		Kurtosis	-.701	.461
IQUBRP	Reputation	Skewness	.257	.233
		Kurtosis	-.507	.461
IQUBVA	Value-added	Skewness	.134	.233
		Kurtosis	-.223	.461
IQUB	Usability	Skewness	.452	.233
		Kurtosis	-.382	.461
SLOEG	Educational Gains	Skewness	.216	.233
		Kurtosis	-.636	.461
SLOVG	Vocational Gains	Skewness	.204	.233
		Kurtosis	-.306	.461
SLO	Student Learning Outcomes	Skewness	.243	.233
		Kurtosis	-.426	.461

The normality problem for each variable was characterized by the following skewness and kurtosis as shown in Table 4.17. The skewness and kurtosis values of these variables were all close to zero and ranged between -1 and +1 as explained in the Data Exploratory section of Chapter 3. When the skewness and kutosis values were all close to zero, they showed that these variables were normally distributed to a certain extend. The variables being characterised by moderate positive skews were concise representation (.200, for example), free of error, appropriate amount, Ease of Operation, Reputation, Value-added, Educational Gains, Vocational Gains, and Student Learning Outcomes. These variables' distributions were then transformed by the square root method to make these distributions appeared "more normal" as explained in the Data Exploratory section. Those characterised by substantial positive skews were Soundness (.527, for example), Dependability, Usefulness, and Usability. These distributions were transformed to produce normal distributions by the logarithmic method as recommended by Mertler & Vernatta (2005). Only the Relevancy variable was negatively skewed and its distribution was transformed to produce normal distributions by the 'reflect and square root' method as recommended by Mertler & Vernatta (2005). The skewness of Objectivity was slightly negative and Believability was slightly positive and very close to zero which showed that these variables were quite normally distributed. Thus, these variables were not transformed.

After the square root, logarithmic, and reflect and square root transformations, some distributions were resolved or substantially improved the normality problem. The results were shown in Table 4.18. All the variables which were transformed showed that their skewness values were much closer to zero, except for the Relevancy variable. This indicated the normality of these variables had improved after the transformation, that is, they had been made to be "more normal" in their distributions. The skewness value of Relevancy variable was substantially worsened. Thus, the Relevancy variable was decided not to be transformed.

Table 4.18 Skewness and Kurtosis values of Variables after transformation

Variable	Description	Transformations		Statistic	Std. Error
IQSDCC	Concise Representation	Square root	Skewness	-.066	.233
			Kurtosis	.377	.461
IQSDFE	Free of Error	Square root	Skewness	.014	.233
			Kurtosis	-.826	.461
IQSD	Soundness	Logarithm	Skewness	.200	.233
			Kurtosis	-.429	.461
IQDP	Dependability (Timeliness)	Logarithm	Skewness	.023	.233
			Kurtosis	-.847	.461
IQUFAA	Appropriate Amount	Square root	Skewness	.026	.233
			Kurtosis	-.688	.461
IQUFO	Objectivity	None	Skewness	-.004	.233
			Kurtosis	-.414	.461
IQUFRL	Relevancy	Reflect & square root	Skewness	**-.306**	.228
			Kurtosis	-.511	.453
IQUF	Usefulness	Logarithm	Skewness	.068	.233
			Kurtosis	-.669	.461
IQUBB	Believability	None	Skewness	.032	.233
			Kurtosis	-.463	.461
IQUBEO	Ease of Operation	Square root	Skewness	.056	.233
			Kurtosis	-.728	.461
IQUBRP	Reputation	Square root	Skewness	.073	.233
			Kurtosis	-.461	.461
IQUBVA	Value-added	Square root	Skewness	-.100	.233
			Kurtosis	-.053	.461
IQUB	Usability	Logarithm	Skewness	.134	.233
			Kurtosis	-.494	.461
SLOEG	Educational Gains	Square root	Skewness	.035	.233
			Kurtosis	-.619	.461
SLOVG	Vocational Gains	Square root	Skewness	-.010	.233
			Kurtosis	-.345	.461
SLO	Student Learning Outcomes	Square root	Skewness	.062	.233
			Kurtosis	-.530	.461

After the transformations of most variables, the Kolmogorov-Smirnov statistics were still significant for all variables except for Soundness, Usefulness, and Usability, where the significance levels of these variables were at *p* <0.05 (Table 4.19). The Kolmogorov-Smirnov statistics were not significant for Soundness, Usefulness, and Usability variables since their significance levels were all at *p* >0.05 as shown in Table 4.19. However, based on the skewness values of these variables which were closer to zero, their distributions were much normal. Therefore, the distributions of the Soundness, Usefulness, and Usability variables were indeed, normal.

Table 4.19 Tests of Normality

	Kolmogorov-Smirnov(a)		
	Statistic	df	Sig.
Concise Representation	.197	108	.000
Free of Error	.148	108	.000
Soundness	.080	108	**.088**
Dependability (Timeliness)	.151	108	.000
Appropriate Amount	.182	108	.000
Objectivity	.222	108	.000
Relevancy	.183	108	.000
Usefulness	.082	108	**.073**
Believability	.194	108	.000
Ease of Operation	.148	108	.000
Reputation	.122	108	.000
Value-added	.156	108	.000
Usability	.069	108	**.200**(*)
Educational Gains	.164	108	.000
Vocational Gains	.174	108	.000
Student Learning Outcomes	.129	108	.000

* This is a lower bound of the true significance.

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Table 4.20 provides a variable-by-variable summary of these normality resolutions.

Table 4.20 Summary of Normality Resolution

Variable	Description	Level	Transformations	Normality
IQSDCC	Concise Representation	Lower	Square root	Yes
IQSDFE	Free of Error	Lower	Square root	Yes
IQSD	Soundness	Upper	Logarithm	Yes
IQDP	Dependability (Timeliness)	Lower/Upper	Logarithm	Yes
IQUFAA	Appropriate Amount	Lower	Square root	Yes
IQUFO	Objectivity	Lower	None	Yes
IQUFRL	Relevancy	Lower	None	Yes
IQUF	Usefulness	Upper	Logarithm	Yes
IQUBB	Believability	Lower	None	Yes
IQUBEO	Ease of Operation	Lower	Square root	Yes
IQUBRP	Reputation	Lower	Square root	Yes
IQUBVA	Value-added	Lower	Square root	Yes
IQUB	Usability	Upper	Logarithm	Yes
SLOEG	Educational Gains	Lower	Square root	Yes
SLOVG	Vocational Gains	Lower	Square root	Yes
SLO	Student Learning Outcomes	Upper	Square root	Yes

Next, screening for multivariate outliers was conducted and the Mahalanobis distance was assessed using the 16 variables. The chi-square critical values for 16 degrees of freedom at p = .001 were 39.252 for the upper bound and 3.942 for the lower bound. As shown in Table 4.21, three cases (#11, #31, and #33) had Mahalanobis distance values substantially above the maximum and were excluded from the analysis. There were five cases (#4, #15, #26, #56, and #58) below the lower bound. These cases were investigated to assess whether deletion was appropriate. They were found to have responses very close to the means of the variables based on the remaining 109 samples, but were not otherwise unusual. Based on this assessment, all of these cases were retained.

Table 4.21 Extreme Values

			Case Number	Value
Mahalanobis Distance	Highest	1	11	56.59849
		2	31	47.80628
		3	33	46.86855
		4	18	35.23713
		5	90	33.92451
	Lowest	1	58	1.66935
		2	56	1.66935
		3	26	1.66935
		4	15	1.66935
		5	4	1.66935

Furthermore, a dimension-level factor analysis was conducted, using the procedure described above. The resulting model had four factors that explained 84.72% of the cumulative total variance. In this model, the information quality variables loaded on three factors and the student learning outcomes variables were loaded on a single factor (Table 4.22). Based on this analysis, the discriminant validity of the overall model was confirmed.

Hypothesis Testing – Main Effect

Multiple regression analysis was conducted to test the main-effect hypotheses, H1 through H5 as explained in Chapter 3 under the Main Effect Hypothesis Testing section. However, the first four hypotheses consisted of two parts since the student learning outcomes is categorised by educational gains and vocational gains. Thus, the main-effect hypotheses are further expanded to nine cases:

Table 4.22 Rotated Component Matrix(a)

		Component			
		1	2	3	4
Information Quality	Appropriate Amount	**.907**	.150	.152	.128
	Ease of Operation	**.819**	.264	.269	.214
	Free of Error	**.668**	.479	.232	.285
	Reputation	**.590**	.472	.356	.271
	Believability	.297	**.775**	.342	.230
	Concise Representation	.243	**.744**	.229	.269
	Objectivity	.310	**.694**	.397	.221
	Relevancy	.312	.296	**.801**	.279
	Value-added	.328	.374	**.740**	.333
	Dependability (Timeliness)	.171	.542	**.665**	.256
Student Learning Outcomes	Vocational Gains	.156	.249	.366	**.830**
	Educational Gains	.321	.292	.197	**.826**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 6 iterations.

H1a: Students' perceptions in the soundness of information will be positively related to students' perceptions of their educational gains.

H1b: Students' perceptions in the soundness of information will be positively related to students' perceptions of their vocational gains.

H2a: Students' perceptions in the dependability of information will be positively related to students' perceptions of their educational gains.

H2b: Students' perceptions in the dependability of information will be positively related to students' perceptions of their vocational gains.

H3a: Students' perceptions in the usefulness of information will be positively related to students' perceptions of their educational gains.

H3b: Students' perceptions in the usefulness of information will be positively related to students' perceptions of their vocational gains.

H4a: Students' perceptions in the usability of information will be positively related to students' perceptions of their educational gains.

H4b: Students' perceptions in the usability of information will be positively related to students' perceptions of their vocational gains.

H5: Students' perceptions in information quality will be positively related to students' perceptions of their learning outcomes.

In each case, stepwise multiple regression was conducted to determine which of the independent variables associated with information quality were predictors of the student learning outcomes dependent variables. Residuals analysis was conducted in each case to determine whether there were systematic violations of the assumptions of multivariate linearity, normality, and homoscedasticity.

Hypothesis 1

H1: Students' perceptions in the soundness of information will be positively related to students' perceptions of their learning outcomes.

The independent variables associated with this hypothesis include concise representation, and freedom from error. The dependent variable, student learning outcomes, represents the statistical mean of the variables for educational gains and vocational gains.

H1a: Students' perceptions in the soundness of information will be positively related to students' perceptions of their educational gains.
H1b: Students' perceptions in the soundness of information will be positively related to students' perceptions of their vocational gains.

To evaluate H1a, stepwise multiple regression analysis was conducted to determine which of the independent variables (concise representation, and freedom from error) were predictors of educational gains of the student learning outcomes. The descriptive statistics for these variables are shown in Table 4.23. Regression results indicate two predictive models.

Table 4.23 Descriptive Statistics for H1a Variables

	M	SD	N
Educational Gains*	1.9566	.16881	108
Concise Representation*	1.9373	.15731	108
Free of Error*	1.9544	.15715	108

* Transformed by calculating the square root

Both models have a tolerance of 0.71 which indicates that there is no multicollinearity problem amongst the variables. Model 1 indicates Free of Error as a significant predictor of Educational Gains, R^2 = .354, R^2_{adj} = .348, F(1,106) = 57.996, p < .001. Model 2 indicates Free of Error and Concise Representation as predictors of Educational Gains, R^2 = .433, R^2_{adj}

= .422, $F(2,105) = 40.048$, $p < .001$. Both Models accounted for 34.8% and 42.2%, respectively, of the variances in Educational Gains. A summary of the regression models is presented in Table 4.24. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.25.

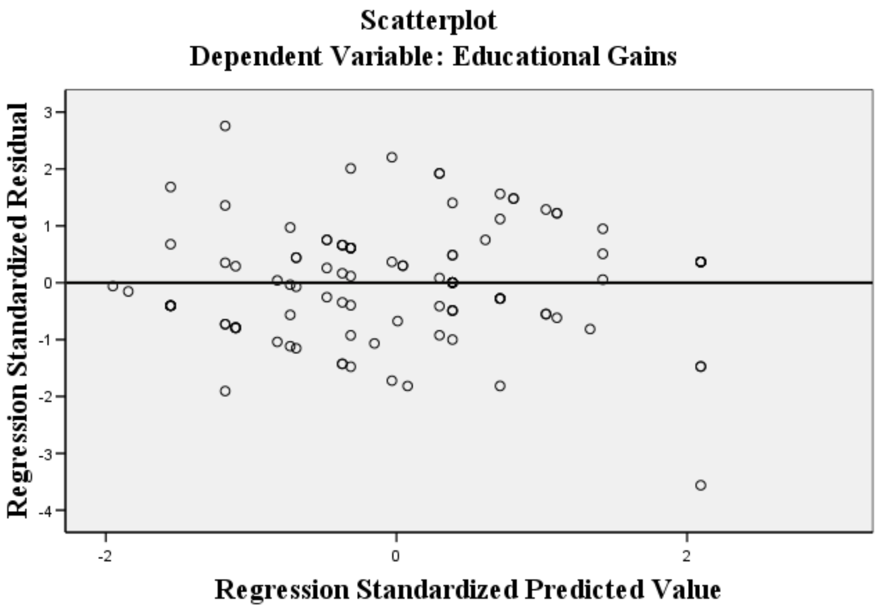
Table 4.24 Model Summary for H1a

Model	Predictor(s)	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	$df1$	$df2$
1	Free of Error	.595	.354	.348	.354	57.996	<.001	1	106
2	Free of Error, Concise Representation	.658	.433	.422	.079	14.638	<.001	1	105

Table 4.25 Coefficients for H1a

Model	Predictor(s)	B	Beta	t	Bivariate r	Partial r
1	Free of Error	.639	.595	7.616	.595	.595
2	Free of Error	.446	.415	4.757	.595	.421
	Concise Representation	.358	.334	3.826	.557	.350

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The linearity assumption is acceptable since a relatively straight line relationship among the points clustering along a horizontal line and the plot is fitted to a roughly rectangular pattern rather than a curvilinear pattern which is obviously nonlinear. In addition, normality assumption is defensible since an even distribution of points is seen both above and below the horizontal line. Furthermore, homoscedasticity assumption is adequate since the values are distributed fairly evenly above and below the plotted reference line. Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H1a_{null}$ is rejected.



To evaluate H1b, stepwise multiple regression analysis was conducted to determine which of the independent variables (concise representation, and freedom from error) were predictors of vocational gains of the student learning outcomes. The descriptive statistics for these variables are shown in Table 4.26. Regression results indicate two predictive models.

Table 4.26 Descriptive Statistics for H1b Variables

	M	SD	N
Vocational Gains*	1.9187	.17168	108
Concise Representation*	1.9373	.15731	108
Free of Error*	1.9544	.15715	108

* Transformed by calculating the square root

Both models have a tolerance of 0.71, which indicates that there is no multicollinearity problem amongst the variables. Model 1 indicates Concise Representation as a significant predictor of Vocational Gains, R^2 = .327, R^2_{adj} = .320, $F(1,106) = 51.436$, $p < .001$. Model 2 indicates Concise Representation and Free of Error as predictors of Vocational Gains, R^2

= .390, R^2_{adj} = .379, $F(2,105) = 33.601$, $p < .001$. Both Models accounted for 32.0% and 37.9%, respectively, of the variances in Vocational Gains. A summary of the regression models is presented in Table 4.27. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.28.

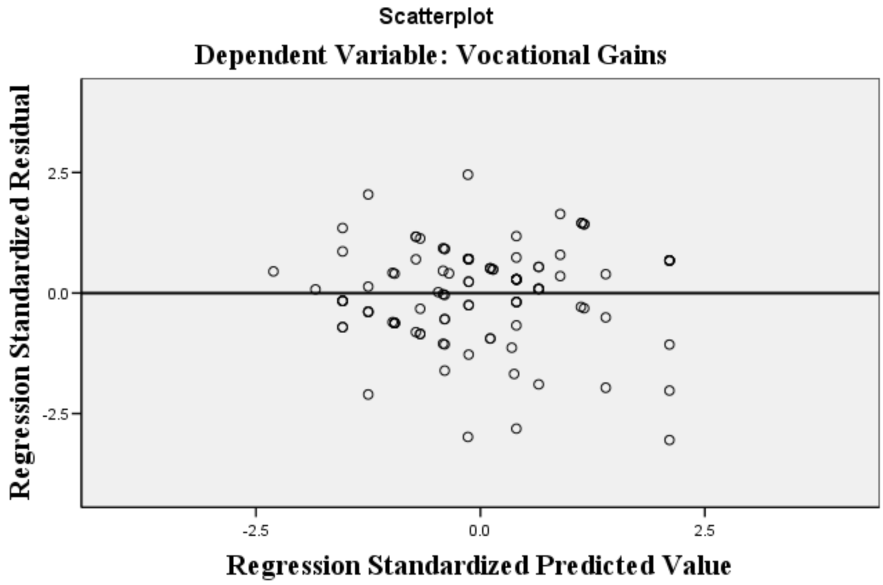
Table 4.27 Model Summary for H1b

Model	Predictor(s)	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	$df1$	$df2$
1	Concise Representation	.572	.327	.320	.327	51.436	<.001	1	106
2	Concise Representation, Free of Error	.625	.390	.379	.064	10.942	=.001	1	105

Table 4.28 Coefficients for H1b

Model	Predictor(s)	*B*	*Beta*	*T*	*Bivariate r*	*Partial r*
1	Concise Representation	.624	.572	7.172	.572	.572
2	Concise Representation	.448	.410	4.539	.572	.405
	Free of Error	.327	.299	3.308	.520	.307

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H1b_{null}$ is rejected.



Hypothesis 2

H2: Students' perceptions in the dependability of information will be positively related to students' perceptions of their learning outcomes.

The independent variable associated with this hypothesis is timeliness. The dependent variable, student learning outcomes, represents the statistical mean of the variables for educational gains and vocational gains.

H2a: Students' perceptions in the dependability of information will be positively related to students' perceptions of their educational gains.

H2b: Students' perceptions in the dependability of information will be positively related to students' perceptions of their vocational gains.

To evaluate H2a, stepwise multiple regression analysis was conducted to determine whether timeliness was the predictor of educational gains of the student learning outcomes. The descriptive statistics for the timeliness variable is shown in Table 4.29.

Table 4.29 Descriptive Statistics for H2a Variables

	M	SD	N
Educational Gains*	1.9566	.16881	108
Timeliness**	.5654	.07324	108

* Transformed by calculating the square root

** Transformed by calculating the logarithm

The model indicates Timeliness as a significant predictor of Educational Gains, R^2 = .320, R^2_{adj} = .314, $F(1,106)$ = 49.908, p < .001. This model which has a tolerance of 1.00, accounted for 31.4% of the variance in Educational Gains. A summary of the regression models is presented in Table 4.30. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.31.

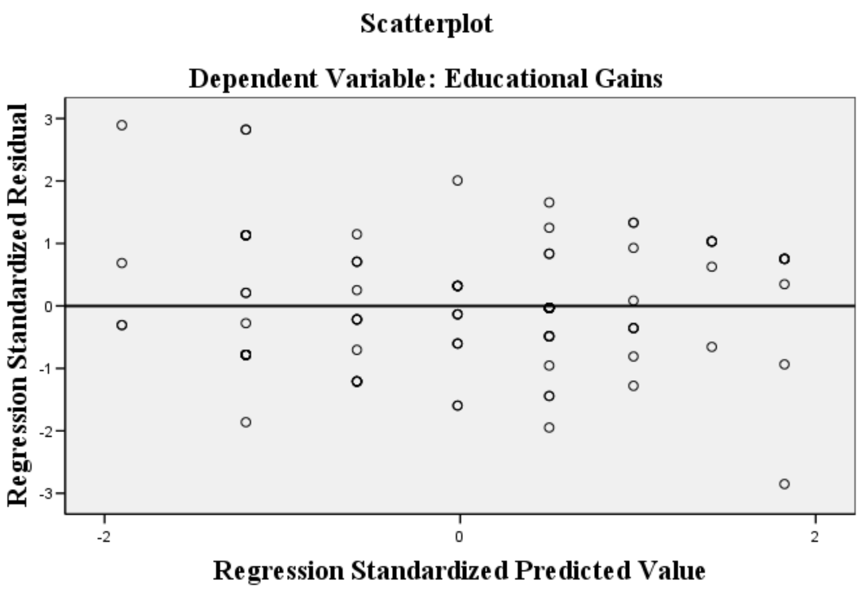
Table 4.30 Model Summary for H2a

Model	Predictor	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	$df1$	$df2$
1	Timeliness	.566	.320	.314	.320	49.908	<.001	1	106

Table 4.31 Coefficients for H2a

Model	Predictor	*B*	*Beta*	*t*	*Bivariate r*	*Partial r*
1	Timeliness	1.304	.566	7.065	.566	.566

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H2a_{null}$ is rejected.



To evaluate H2b, stepwise multiple regression analysis was conducted to determine whether timeliness was the predictor of Vocational gains of the student learning outcomes. The descriptive statistics for the timeliness variable is shown in Table 4.32. Regression results indicate one predictive model.

Table 4.32 Descriptive Statistics for H2b Variables			
	M	SD	N
Vocational Gains*	1.9187	.17168	108
Timeliness**	.5654	.07324	108

* Transformed by calculating the square root

** Transformed by calculating the logarithm

The model indicates Timeliness as a significant predictor of Vocational Gains, R^2 = .435, R^2_{adj} = .430, F(1,106) = 81.695, p < .001. This model which has a tolerance of 1.00, accounted for 43.0% of the variance in Vocational Gains. A summary of the regression models is presented in Table 4.33. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.34.

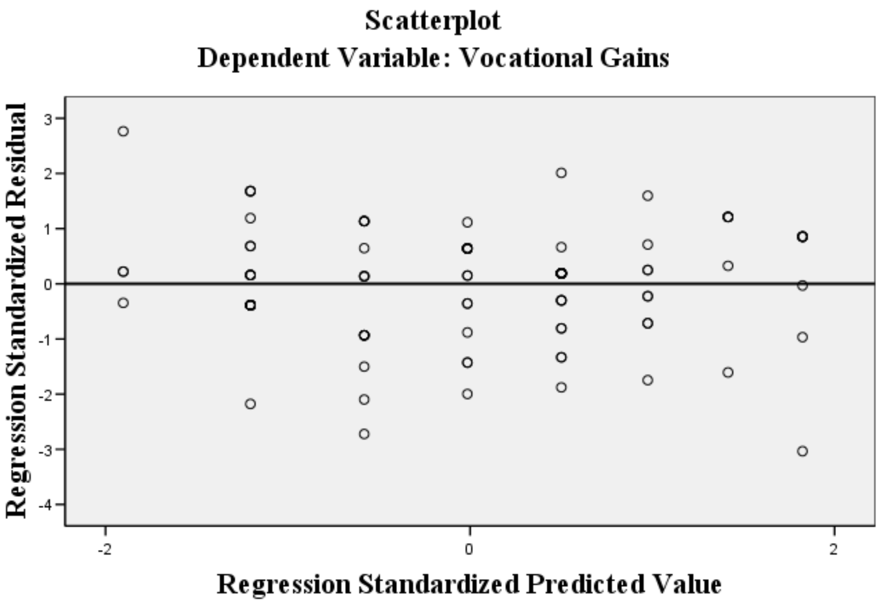
Table 4.33 Model Summary for H2b

Model	Predictor	*R*	R^2	R^2_{adj}	ΔR^2	F_{chg}	*p*	*df1*	*df2*
1	Timeliness	.660	.435	.430	.435	81.695	<.001	1	106

Table 4.34 Coefficients for H2b

Model	Predictor	*B*	*Beta*	*t*	*Bivariate r*	*Partial r*
1	Timeliness	1.547	.660	9.039	.660	.660

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H2b_{null}$ is rejected.



Hypothesis 3

H3: Students' perceptions in the usefulness of information will be positively related to students' perceptions of their learning outcomes.

The independent variables associated with this hypothesis include appropriate amount, objectivity, and relevance. The dependent variable, student learning outcomes, represents the statistical mean of the variables for educational gains and vocational gains.

H3a: Students' perceptions in the usefulness of information will be positively related to students' perceptions of their educational gains.
H3b: Students' perceptions in the usefulness of information will be positively related to students' perceptions of their vocational gains.

To evaluate H3a, stepwise multiple regression analysis was conducted to determine which of the independent variables (appropriate amount, objectivity, and relevance) were predictors of educational gains of the student learning outcomes. The descriptive statistics for these variables are shown in Table 4.35. Regression results indicate two predictive models.

Table 4.35 Descriptive Statistics for H3a Variables

	M	SD	N
Educational Gains*	1.9509	.16663	105
Appropriate Amount*	1.8902	.20475	105
Objectivity	3.7667	.63574	105
Relevancy	3.8238	.67930	105

* Transformed by calculating the square root

Both models have a tolerance of 0.518, which indicate that there is no multicollinearity problem amongst the variables. Model 1 indicates Objectivity as a significant predictor of Educational Gains, R^2 = .371, R^2_{adj} = .365, F(1,103) = 60.859, p < .001. Model 2 indicates

Objectivity and Relevancy as predictors of Educational Gains, R^2 = .424, R^2_{adj} = .413, $F(2,102) = 37.574$, $p < .001$. Both Models accounted for 36.5% and 41.3%, respectively, of the variances in Educational Gains. A summary of the regression models is presented in Table 4.36. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.37.

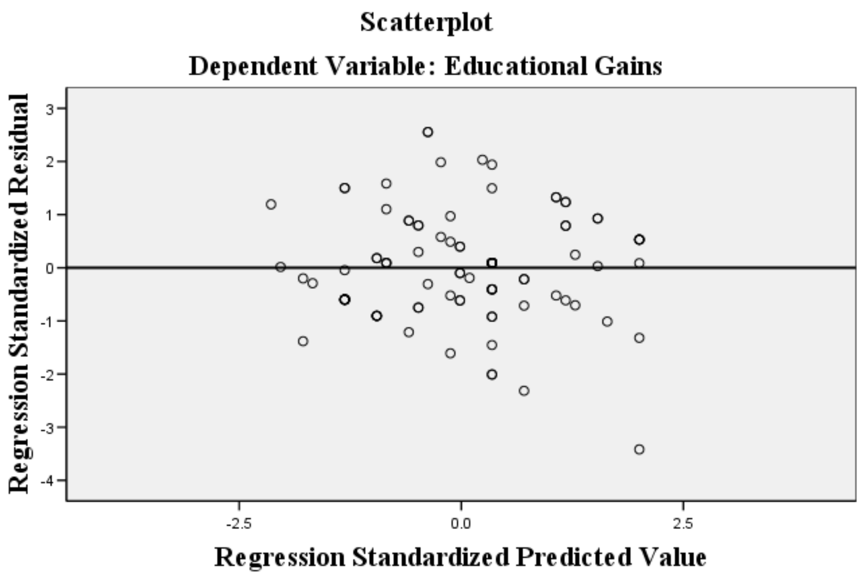
Table 4.36 Model Summary for H3a

Model	**Predictor(s)**	***R***	R^2	R^2_{adj}	ΔR^2	F_{chg}	***p***	***df1***	***df2***
1	Objectivity	.609	.371	.365	.371	60.859	<.001	1	103
2	Objectivity, Relevancy	.651	.424	.413	.053	9.354	=.003	1	102

Table 4.37 Coefficients for H3a

Model	**Predictor(s)**	***B***	***Beta***	***T***	***Bivariate r***	***Partial r***
1	Objectivity	.160	.609	7.801	.609	.609
2	Objectivity	.102	.388	3.714	.609	.345
	Relevancy	.078	.319	3.058	.589	.290

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H3a_{null}$ is rejected.



To evaluate H3b, stepwise multiple regression analysis was conducted to determine which of the independent variables (appropriate amount, objectivity, and relevance) were predictors of vocational gains of the student learning outcomes. The descriptive statistics for these variables are shown in Table 4.38. Regression results indicate one predictive model.

Table 4.38 Descriptive Statistics for H3b Variables

	M	SD	N
Vocational Gains*	1.9131	.16833	105
Appropriate Amount*	1.8902	.20475	105
Objectivity	3.7667	.63574	105
Relevancy	3.8238	.67930	105

* Transformed by calculating the square root

The model indicates Relevancy as a significant predictor of Vocational Gains, R^2 = .399, R^2_{adj} = .394, F(1,103) = 68.501, p < .001. This Model which has a tolerance of 1.00, accounted for 39.4% of the variances in Vocational Gains. A summary of the regression models is presented in Table 4.39. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.40.

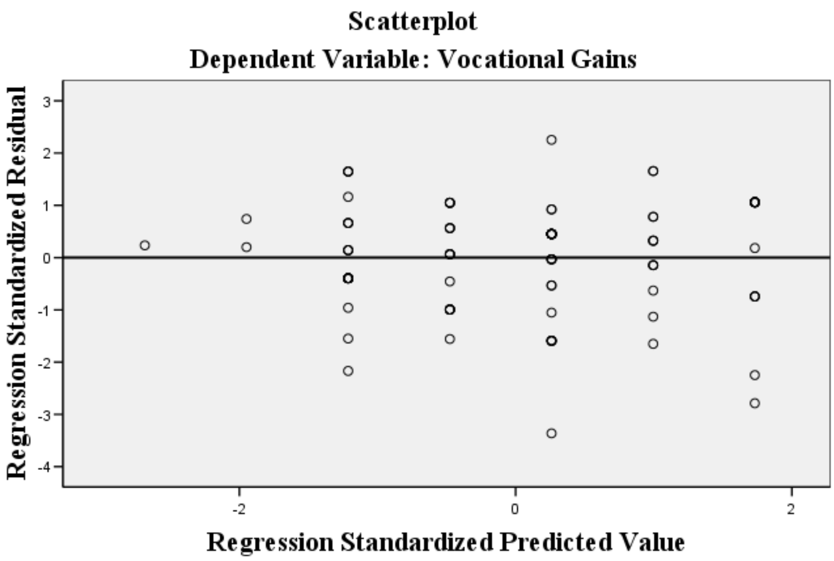
Table 4.39 Model Summary for H3b

Model	Predictor(s)	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	p	$df1$	$df2$
1	Relevancy	.632	.399	.394	.399	68.501	<.001	1	103

Table 4.40 Coefficients for H3b

Model	Predictor(s)	B	$Beta$	t	Bivariate r	Partial r
1	Relevancy	.157	.632	8.277	.632	.632

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H3b_{null}$ is rejected.



Hypothesis 4

H4: Students' perceptions in the usability of information will be positively related to students' perceptions of their learning outcomes.

The independent variables associated with this hypothesis include believability, ease of operation, reputation, and value-added. The dependent variable, student learning outcomes, represents the statistical mean of the variables for educational gains and vocational gains.

H4a: Students' perceptions in the usability of information will be positively related to students' perceptions of their educational gains.

H4b: Students' perceptions in the usability of information will be positively related to students' perceptions of their vocational gains.

To evaluate H4a, stepwise multiple regression analysis was conducted to determine which of the independent variables (believability, ease of operation, reputation, and value-added) were predictors of educational gains of the student learning outcomes. The descriptive statistics for these variables are shown in Table 4.41. Regression results indicate two predictive models.

Table 4.41 Descriptive Statistics for H4a Variables

	M	SD	N
Educational Gains*	1.9566	.16881	108
Believability	3.8843	.65783	108
Ease of Operation*	1.8997	.17430	108
Reputation*	1.9388	.14874	108
Value-added*	1.9398	.16570	108

* Transformed by calculating the square root

The two models are having tolerances of 1.00 and 0.549, respectively, which indicate that there is no multicollinearity problem amongst the variables. Model 1 indicates Value-added as a significant predictor of Educational Gains, R^2 = .440, R^2_{adj} = .435, F(1,106) = 83.415, p < .001. Model 2 indicates Value-added and Reputation as predictors of Educational Gains, R^2 = .477, R^2_{adj} = .467, F(2,105) = 47.792, p < .001. Both Models accounted for 43.5% and 46.7%, respectively, of the variances in Educational Gains. A summary of the regression models is presented in Table 4.42. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.43.

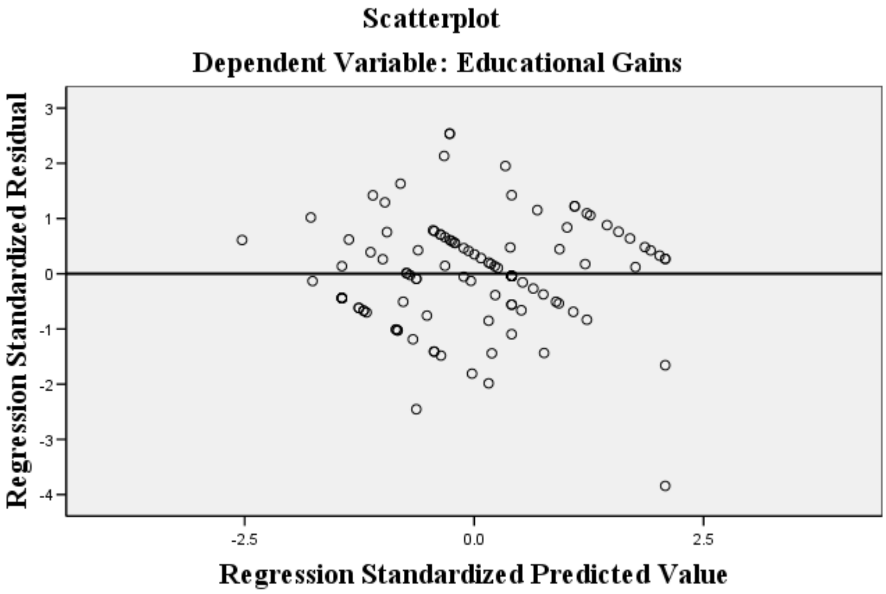
Table 4.42 Model Summary for H4a

Model	**Predictor(s)**	***R***	R^2	R^2_{adj}	ΔR^2	F_{chg}	***p***	***df1***	***df2***
1	Value-added	.664	.440	.435	.440	83.415	<.001	1	106
2	Value-added, Reputation	.690	.477	.467	.036	7.251	=.008	1	105

Table 4.43 Coefficients for H4a

Model	**Predictor(s)**	***B***	***Beta***	***t***	***Bivariate r***	***Partial r***
1	Value-added	.676	.664	9.133	.664	.664
2	Value-added	.501	.491	5.158	.664	.450
	Reputation	.291	.257	2.693	.586	.254

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H4_{null}$ is rejected.



To evaluate H4b stepwise multiple regression analysis was conducted to determine which of the independent variables (believability, ease of operation, reputation, and value-added) were predictors of vocational gains of the student learning outcomes. The descriptive statistics for these variables are shown in Table 4.44. Regression results indicate one predictive model.

Table 4.44 Descriptive Statistics for H4b Variables

	M	SD	N
Vocational Gains*	1.9187	.17168	108
Believability	3.8843	.65783	108
Ease of Operation*	1.8997	.17430	108
Reputation*	1.9388	.14874	108
Value-added*	1.9398	.16570	108

* Transformed by calculating the square root

The model indicates Value-added as a significant predictor of Vocational Gains, R^2 = .476, R^2_{adj} = .471, F(1,106) = 99.119, p < .001. This Model which has a tolerance of 1.00, accounted for 47.1% of the variances in Vocational Gains. A summary of the regression model is presented in Table 4.45. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.46.

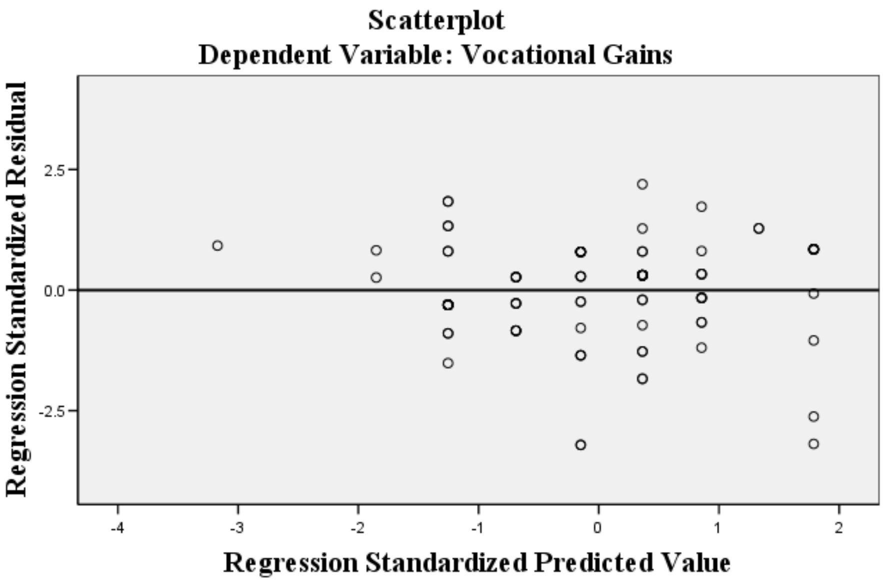
Table 4.45 Model Summary for H4b

Model	Predictor(s)	R	R^2	R^2_{adj}	ΔR^2	F_{chg}	P	*df1*	*df2*
1	Value-added	.690	.476	.471	.476	96.119	<.001	1	106

Table 4.46 Coefficients for H4b

Model	Predictor(s)	*B*	*Beta*	*t*	*Bivariate r*	*Partial r*
1	Value-added	.714	.690	9.804	.690	.690

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H4b_{null}$ is rejected.



Hypothesis 5

H5: Students' perceptions in information quality will be positively related to students' perceptions of their learning outcomes.

The independent variables associated with this hypothesis include soundness, dependability, usefulness, and usability. The dependent variable, student learning outcomes, represents the statistical mean of the variables for educational gains and vocational gains.

To evaluate H5, stepwise multiple regression analysis was conducted to determine which of the independent variables (soundness, dependability, usefulness, and usability) were predictors of student learning outcomes. The descriptive statistics for these variables are shown in Table 4.47. Regression results indicate two predictive models.

Table 4.47 Descriptive Statistics for H5 Variables

	M	SD	N
Student Learning Outcomes*	1.9385	.16168	108
Soundness**	.5768	.06099	108
Dependability**	.5654	.07324	108
Usefulness**	.5669	.06621	108
Usability**	.5724	.06143	108

* Transformed by calculating the square root
** Transformed by calculating the logarithm

The two models are having tolerances of 1.00 and 0.412, respectively, which indicate that there is no multicollinearity problem amongst the variables. Model 1 indicates Usability as a significant predictor of student learning outcomes, R^2 = .498, R^2_{adj} = .494, $F(1,106)$ =

105.356, p < .001. Model 2 indicates Usability and Dependability as predictors of student learning outcomes, R^2 = .524, R^2_{adj} = .515, $F(2,105)$ = 57.784, p < .001.Both Models accounted for 49.4% and 51.5%, respectively, of the variances in student learning outcomes. A summary of the regression models is presented in Table 4.48. The bivariate and partial correlation coefficients between the predictor and the dependent variable are presented in Table 4.49.

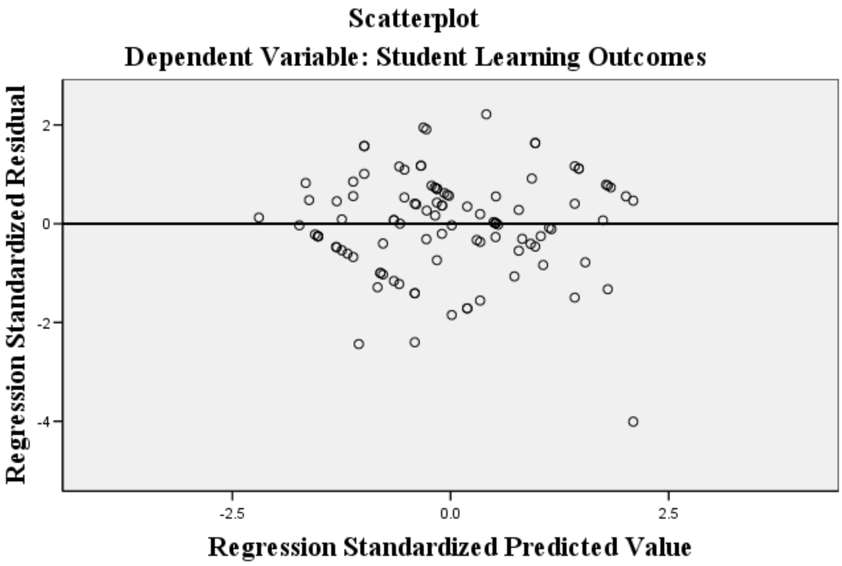
Table 4.48 Model Summary for H5

Model	**Predictor(s)**	***R***	R^2	R^2_{adj}	ΔR^2	F_{chg}	***p***	***df1***	***df2***
1	Usability	.706	.498	.494	.498	105.356	<.001	1	106
2	Usability, Dependability	.724	.524	.515	.025	5.620	=.020	1	105

Table 4.49 Coefficients for H5

Model	**Predictor(s)**	***B***	***Beta***	***t***	***Bivariate r***	***Partial r***
1	Usability	1.858	.706	10.264	.706	.706
2	Usability,	1.356	.515	4.910	.706	.432
	Dependability	.549	.249	2.371	.644	.225

Analysis of the residuals revealed no evidence of violations of the assumptions of linearity, normality, or homoscedasticity as shown in the scatterplot below. The explanations for the acceptance of linearity, normality, or homoscedasticity are the same as explained for Hypothesis 1 (H1). Hence the results of the multiple regression analysis are accepted as tenable and the null hypothesis $H5_{null}$ is rejected.



Summary of Main Effect Hypothesis Testing

The analysis above reveals support for all five of the originally proposed main effect hypotheses. Table 4.50 provides a recap of the support for these hypotheses.

Including both the quadrant level and the dimension level, there were a total of 13 hypothesized predictor variables. At the quadrant level, each of the four variables is a significant predictor. At the dimension level, all the nine variables are significant predictors.

Table 4.51 provides a summary of these predictor variables and their significant relationships.

Chapter 4 has presented the results of research investigating the relationship between information quality and student learning outcomes. The results of a Web-based survey were analyzed in this chapter. Support was found for all the main-effect hypotheses as shown in the summary above.

Table 4.50 Summary of Support for Main Effect Hypotheses

	Hypotheses	**Support for p <.001**
H1a	Students' perceptions in the soundness of information will be positively related to students' perceptions of their educational gains.	Yes
H1b	Students' perceptions in the soundness of information will be positively related to students' perceptions of their vocational gains.	Yes
H2a	Students' perceptions in the dependability of information will be positively related to students' perceptions of their educational gains.	Yes
H2b	Students' perceptions in the dependability of information will be positively related to students' perceptions of their vocational gains.	Yes
H3a	Students' perceptions in the usefulness of information will be positively related to students' perceptions of their educational gains.	Yes
H3b	Students' perceptions in the usefulness of information will be positively related to students' perceptions of their vocational gains.	Yes
H4a	Students' perceptions in the usability of information will be positively related to students' perceptions of their educational gains.	Yes
H4b	Students' perceptions in the usability of information will be positively related to students' perceptions of their vocational gains.	Yes
H5	Students' perceptions in information quality will be positively related to students' perceptions of their learning outcomes.	Yes

Table 4.51 Summary of Predictor Variables

Predictor Variable	Criterion variable	Hypothesis (β)
Concise Representation	Educational Gains	H1a (.334)
	Vocational Gains	H1b (.572 & .410)
Free of Error	Educational Gains	H1a (.595, .415)
	Vocational Gains	H1b (.229)
Soundness	None	
Timeliness	Educational Gains	H2a (.566)
	Vocational Gains	H2b (.660)
Dependability	Student Learning Outcomes	H5 (.249)
Appropriate Amount	None	
Objectivity	Educational Gains	H3a (.609 & .388)
Relevancy	Educational Gains	H3a (.319)
	Vocational Gains	H3b (.632)
Usefulness	None	
Believability	None	
Ease of Operation	None	
Reputation	Educational Gains	H4a (.257)
Value-added	Educational Gains	H4a (.664 & .491)
	Vocational Gains	H4b (.690)
Usability	Student Learning Outcomes	H5 (.706 & .515)

Chapter 5
Results, Conclusions, and Recommendations

Introduction

In the climate of demand for accountability and improvements in student learning outcomes, educational institutions are seeking to understand how they can be more effective in collecting, disseminating and sharing knowledge and understand how to transform that knowledge into effective decision making and action to ensure improvements in student learning outcomes. This research was undertaken to apply knowledge management practices and examine its possible relation to student learning outcomes through the e-learning environment and the communities of practice (CoPs). It explored the nature of relationship between knowledge quality and student learning outcomes by presenting a conceptual model of the relationship and providing an empirical analysis of the ability to predict student learning outcomes based on quality knowledge management. In addition, this research presented conceptual analysis of developing communities of practice (CoPs) to ensure effective knowledge transfer to improve student learning.

Summary of the Study

This study has investigated the possible impact of knowledge management practices on student learning outcomes by creating quality knowledge through the e-learning environment and developing communities of practices (CoPs) for effective knowledge transfer. A literature review revealed that knowledge management is still a nascent organisational practice. It is generally described as broadly as any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organisations (Prusak, 1997). A significant part of the knowledge management theory and practice aligns the definition of knowledge to two models: the DIKW model which places data, information, knowledge and wisdom into an increasing useful pyramid; and Nonaka’s (1994) reformulation of Polanyi’s (1966, Prusak (1997)) distinction between tacit and explicit knowledge. Kidwell et al. (2000) argued that knowledge starts as *data*—raw facts and numbers. Everything outside the mind that can be manipulated in any way can be defined as 'data'. *Information* is data put into context of relevance to the recipient. It is when human place them in context through interpretation that might seek to highlight patterns, causes, or relationships. Information can be shared or hoarded. Information is readily captured in documents or in databases; even large amounts are fairly easy to retrieve with modern information technology systems. When information is combined with experience and judgment, it becomes *knowledge* (i.e. what we know). Knowledge can be highly subjective and hard to codify. Knowledge can be shared with others by exchanging information in appropriate contexts.

Nonaka’s reformulation of Polanyi’s “tacit knowledge” denoted a particular knowledge that is difficult to express, that is, difficult to articulate. Tacit knowledge is difficult to codify and it consists of skills and competencies, experiences, relationships, beliefs and values, and ideas. It is highly personal and embedded in peoples mind. According to Kidwell et al. (2000), tacit knowledge is know-how and learning embedded within the minds of the people in an organization. It involves perceptions, insights, experiences, and craftsmanship. Tacit knowledge is personal, context-specific, difficult to formalize, difficult to communicate, and more difficult to transfer. On the other hand, Nonaka & Takeuchi (1995) defined explicit knowledge or codified knowledge as knowledge that can be articulated and in formal language including grammatical statements, mathematical expressions, specifications, and in manuals. Such explicit knowledge, they concluded, can be transmitted easily and formally across individuals. Choo (1998) suggested that explicit knowledge is knowledge that is made manifest through language, symbols, objects, and artefacts. Explicit knowledge can further be object based, i.e., found as patents, software code, databases, technical drawings and blueprints, chemical and mathematical formulas, business plans, and statistical reports, or rule based, i.e., expressed as rules, routines, and procedures. Moreover, Marwick (2001), Stenmark (2002), Petrides & Nodine (2003) and Wilson (2002) argued that explicit knowledge is not knowledge but information. Organisations tend to depend primarily on this sort of explicit and articulated knowledge, written down in memos and illustrated with graphs and used in decision-making processes, or institutionalised as operating procedures, Choo observed. Explicit knowledge is formal knowledge that is easy to transfer from educators to learners. It is frequently articulated in the form of syllabuses, study guides, and course materials. Explicit knowledge is packaged, easily codified, communicable, and transferable (Kidwell et al., 2000). Thus, explicit knowledge is processed, transmitted and stored in databases with relative ease. In this thesis, explicit knowledge and information shall then be used interchangeably.

For a truly effective knowledge management system, it must address both the creation and transfer of explicit as well as tacit knowledge. As argued earlier, since it is the information that would be transferred in the process, the educator expert must elicit his or her tacit knowledge as mental model and convert it into information. We should try to codify tacit knowledge and convert it into high quality explicit knowledge or information. Again, Diemers (2000) argued that the success of the transformational process of converting educator's tacit knowledge into explicit knowledge to be internalised by the learner as tacit knowledge is very much dependent on information quality as the medium for the transformational process. This is to ensure that learners are able to derive quality tacit knowledge from this information which is obviously very important and should be considered a conceptual cornerstone of any knowledge management theory (Diemers, 2000). In this thesis, we have defined the measurable criteria by implementing Kahn et al., (2002) Product and Service Performance Model for Information Quality (PSP/IQ) as the tool (as shown in Table 2.4) to measure information quality. According to Lee et al. (2002), the PSP/IQ model organizes the key information quality dimensions so that meaningful decisions can be made about improving information quality.

In 2002, Lee et al. (2002) developed an Information Quality measurement instrument, known as the Information Quality Assessment (IQA) for measuring, analyzing, and improving IQ in organizations". The IQA measures stakeholders (information consumers, producers, and custodians) perceptions of each dimension as tabulated in Table 2.3. With the 16 dimensions as shown in Table 2.3, Huang et al. (1999) and Lee et al. (2002), generated 69 questionnaire items to measure the various information quality dimensions. This instrument has been used as the basis of several studies requiring information quality measurement (Huang et al., 1999; Kahn et al., 2002; Lee et al., 2002). This information quality measurement concept has been extended to the PSP/IQ model (Kahn et al., 2002). By using the IQA to measure the dimensions, the quadrant measurements of sound, dependable, useful and usable information are derived by calculating the mean scores for the dimensions associated with each quadrant (Kahn et al., 2002; Lee et al., 2002). This resulted in the measurement of information quality consisting of only four numbers for the four quadrants.

The primary function of knowledge management is to codify [tacit knowledge into explicit knowledge (information)] and capture knowledge [explicit knowledge (information) into tacit knowledge] (Sorensen & Lundh-Snis, 2001). One of the most important roles of educators is to transfer their knowledge to learners. Thus, educators (as senders) attempt to transfer and codify explicit and tacit knowledge to learners (as receivers). One of the ways where this can take place is through the e-learning environment. However, educators face the difficulty of codifying tacit knowledge into explicit knowledge for learners' retrieval and of facilitating them to acquire the tacit knowledge. One aspect of the educators' role in the course development process of e-learning is to improve the course material (information) quality so that students' learning experiences can be enhanced. When learners are accessing quality material through the e-learning environment, it is easier for educators to direct them to appropriate information based on their needs. If designed properly, e-learning systems can be used to determine learners' needs and current level of expertise, and to assign appropriate quality material for learners to select from to achieve the desired learning outcomes. Learning occurs when learners go through the sequence of instruction (information), to complete the learning activities, and to achieve learning outcomes and objectives through the e-learning environment (Ally, 2002; Ritchie & Hoffman, 1997). Learners should be informed of the learning outcomes clearly in the e-learning material, so that they know what is expected of them and will be able to gauge when they have achieved the learning outcomes. Ideally, the "learning outcomes are translated into course content (information) …that will enable a student to achieve those outcomes" (Davis, 2004: 133). It must be the learning outcomes and not technology that drive the content of the e-learning material. To ensure ongoing improvement on the student learning outcomes, an evaluation process for the effectiveness of the e-learning material, based on achievement of the learning outcomes and students' feedback have to be in place.

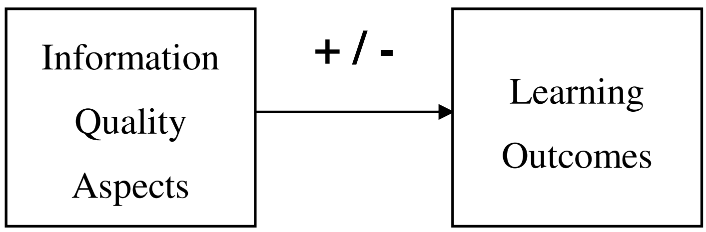
There are different types of measures used to assess Student Learning Outcomes. Experts in the field (Angelo, 1999; Dietel, Herman, & Knuth, 1991; Huba & Freed, 2000; Maki, 2002;

Palomba & Banta, 1999) have recommended multiple assessment measures to be utilised in order to obtain a clearer understanding of what students have learned and to compensate for biases or weaknesses in any single assessment instrument. The ability to draw accurate conclusions and inferences about student achievement of expected outcomes is directly related to the measures and methods used during the assessment process; poor methods and instruments can lead to unreliable results and misleading conclusions. Maki (2004) identifies that there are several methods of assessment that provide direct or indirect evidence of student learning. Assessments of students' success can be brought to bear on the content and presentation through the e-learning environment, so as to enhance student learning outcomes. Therefore, one of the strategies identified by Maki (1998) in using assessment to improve student learning outcomes is to “revise [instructional] content to assure appropriate attention to areas that need increased attention”. In this study, the indirect method of a self-reported survey of students is used to assess their learning outcomes. However, Maki (2004) cautions indirect methods should not be used as the sole evidence of student learning. On the other hand, a number of researchers argue that the student self-reports do provide a comprehensive indicator of students’ learning outcomes. Despite the difficulty to fix with any certainty the closeness of the correspondence between other measures of cognitive outcomes and students’ self-reports, there is considerable support from earlier research evidence in the literature that students are credible reporters (Anaya, 1999; Baird, 1976; Berdie, 1971; Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984).

Educators need to become effective facilitators of e-learning and create quality e-learning material to improve student learning outcomes. Educational institutions should develop and implement a scientific research agenda related to the use of e-learning with students. This agenda should determine which instructional design practices are required to create quality material in order to optimize student achievement and authentic learning outcomes. Quality e-learning information that promote effective e-learning outcomes currently are not recognized, generally understood, or agreed upon by e-learning producers, consumers, and education policy leaders. There is an important gap in the research literature, in that the linkage between information quality and student learning outcomes has only been minimally examined to date, with relatively little theoretical grounding.

The concepts discussed above form the basis of a conceptual framework, which is used in this study for evaluating the possible relationship between information quality and student learning outcomes.

The central element of this framework is the possible strategic relationship as shown generically in Figure 2.2. Through the e-learning environment, educators need to create quality knowledge (information) which is positively related to students' perceptions of their learning outcomes. The framework is the possible strategic relationship between quality information and student learning outcomes.



Refer to Figure 2.2 on page 63.

The conceptual framework defined above was thus combined to form the research model as shown in Figure 2.3. The four information quality quadrants from the PSP/IQ model (Lee et al., 2002) are shown on the left and the learning outcomes is shown on the right. Taken together, four relationships (R1 through R4) result, and were investigated as the set of five main effect hypotheses, addressing the first research question:

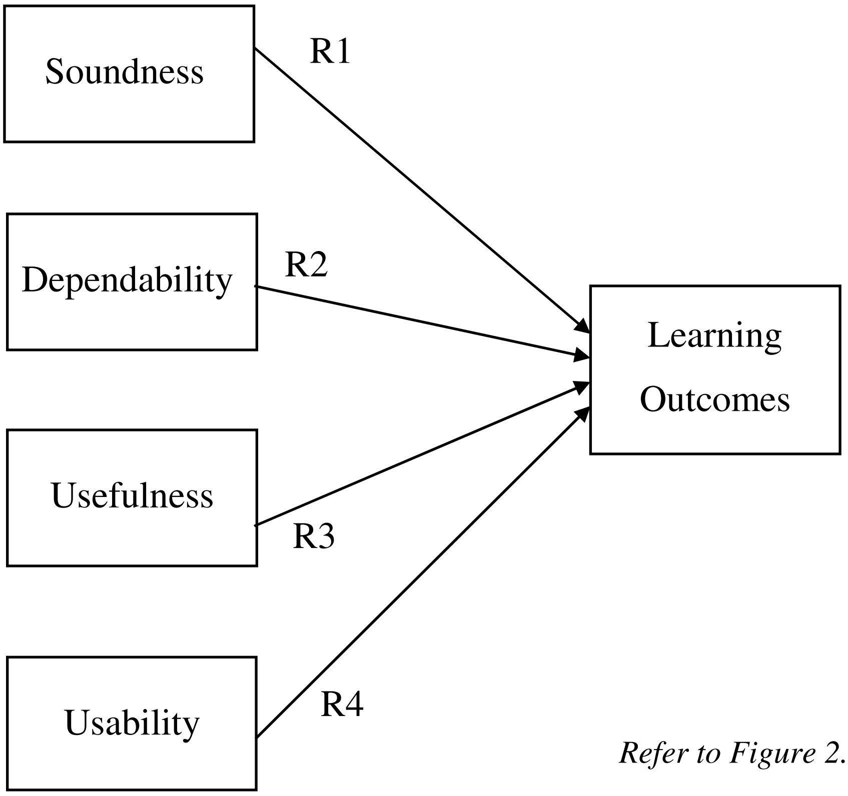
How can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?

- *How to measure knowledge quality as presented on the e-learning environment.*
- *What is the nature of the relationship between students' perceptions of information quality and learning outcomes?*
- *What interaction effects exist between different aspects of information quality and learning outcomes?*

Each of these hypotheses was investigated using the results of the Blackboard Web-based Course Management System for which 134 responses were received. The survey items and operationalised variables for information quality were taken from prior literature (Kahn et al., 2002 and Lee et al., 2002). However, the student learning outcomes survey items and operationalised variables were new, thus both the convergent and discriminant validity were determined. Overall, the construct validity of the resulting instrument was confirmed through data analysis. The main effect hypotheses were investigated using stepwise multiple regression analysis.

The second research question is:

How can we develop communities of practice to ensure effective transfer of tacit knowledge to improve student learning?



Refer to Figure 2.3 on page 65.

The transfer of tacit knowledge through communities of practice to improve student learning was examined in terms of its theoretical grounding and current lines of research. We have conceptually reviewed that communities of practice can effectively transfer sustained tacit knowledge. Tacit knowledge which resides in expert educators and inseparable from its historical and social locations of practice is very difficult to express, codify and transfer to junior educators and students. Building communities of practice can solve the transfer of tacit knowledge between members (Wenger, 1998; O'Dell & Grayson, 1998; Liedtka, 1999; Hildreth et al., 2002; Büchel & Raub, 2002; Wenger et al., 2002). Once tacit knowledge has been shared within the CoPs, it would enable educators to improve student learning. There is much literature (Vescio et al., 2008; Berry et al., 2005; Bolam et al., 2005; Hollins et al., 2004; Louis & Marks, 1998; Phillips, 2003; Strahan, 2003; Supovitz, 2002; Supovitz & Christman, 2003) which provides many examples in support of student learning improvement when educators participate in CoPs focusing on instructional practices.

To develop and support CoPs, institutions must provide them with specific structure, strategies and supports (Supovitz & Christman, 2003) to enable them to improve student learning.

Discussion of the Results

Main Effect Results

Each of the five main effect hypotheses was supported with statistically significant results. For these analyses, although anywhere from one to four independent variables were specified, one or two variable(s) provided sufficient contribution to R^2 to meet the selection criteria for the stepwise analysis. Consequently, those analyses resulted in a simple regression model with a single predictor variable were shown in Chapter 4 (Table 4.24, Model 1; Table 4.27, Model 1; Table 4.30, Model 1; Table 4.33, Model 1; Table 4.36, Model 1; Table 4.39, Model 1; Table 4.42, Model 1; Table 4.45, Model 1; and Table 4.48, Model 1). The remaining analyses resulted in regression models with two predictors were shown in Table 4.24, Model 2; Table 4.27, Model 2; Table 4.36, Model 2; Table 4.42, Model 2; and Table 4.48, Model 2 of Chapter 4.

Significance of Level of Analysis

The hypotheses for this study considered information quality at two different levels, using the PSP/IQ model (Kahn et al., 2002; Lee et al., 2002) as the basis. Four of the hypotheses considered one PSP/IQ quadrant at a time, using the individual dimensions associated with that quadrant as independent variables. The remaining hypothesis considered information quality as a whole, using the quadrants as independent variables.

An unexpected finding from this study was that these two levels of analysis produced inconsistent results that in some cases were contradictory. Considering the Soundness quadrant over the entire data set as an example, two of the dimensions (Free of Error and Concise Representation) were significant predictors of Educational and Vocational Gains, yet Soundness as a whole was not a significant predictor of Student Learning Outcomes. As another example, two of the dimensions (Objectivity and Relevancy) that contribute to the Usefulness quadrant are significant predictors of Educational Gains, and one of the dimensions (Relevancy) that contributes to the Usefulness quadrant is a significant predictor of Vocational Gains, over the entire data set. However, the Usefulness quadrant does not significantly predict Student Learning Outcomes.

Taken together, these apparent discrepancies raise questions concerning the practice of aggregating measurements to produce a simpler set of information quality metrics. As stated in chapters 2 and 3, the PSP/IQ model was applied to produce a measure of information quality consisting of the four quadrant measurements of soundness, dependability, usefulness and usability by aggregating the results of the 40 items and 16 dimensions measured by the IQA measurement instrument. Therefore, if the goal is merely to provide a simpler measure of overall information quality, then aggregation is a suitable mechanism. However, if the goal has to do with predicting Student Learning Outcomes, then it appears that aggregation may result in a distortion of the relationship. In addition, as revealed by Cohen et al. (2003) in the 'Limitations of the Study' section, stepwise regression research has been found in some cases to omit predictors from the model that would have produced statistically significant results with other regression techniques.

Predictive Models

The predictive models themselves were not complex, in that half of these models are simple linear regression models with only a single predictor variable each. The most complex models have only two predictors each. Table 5.1, which is an adaptation of the PSP/IQ model, summarizes the predictive models for Educational Gains for the entire data set, illustrating the simplicity of these models. Dimensions that did not significantly predict the dependent variable are not included in this figure. The letters "n.s." after a quadrant name indicate a non-significant result for the quadrant as a whole to predict Student Learning Outcomes. The numbers shown after each dimension or quadrant name are the beta coefficients for the respective variables. As shown, at the dimension level, three of the four quadrants have two dimensions as a significant predictor variable, and one quadrant has one. At the quadrant level, two aggregate quadrant measures are predictors of Student Learning Outcomes. Table 5.2 provides a similar summary of the predictive models for Vocational Gains using the entire data set.

	Conforms to Specifications	**Meets or Exceeds Consumer Expectations**
Product Quality	<u>Soundness (n. s.)</u> Free-of-Error (.595) Concise Representation (.334)	<u>Usefulness (n. s.)</u> Objectivity (.609) Relevancy (.319)
Service Quality	<u>Dependability (.249)</u> Timeliness (.566)	<u>Usability (.706)</u> Reputation (.257) Value-Added (.664)

Table 5.1 Summary of predictive models of Educational Gains (entire data set)

Despite the complex nature of the overall relationship and the seemingly contradictory nature of certain predictors under certain conditions, a clearly discernable set of patterns is evident among these relationships. First, there is a small set of variables that consistently show up in the models, namely, Free of Error, Concise Representation, Timeliness, Relevancy, and Value-Added. They appear to be positive predictors of Student Learning Outcomes.

	Conforms to Specifications	**Meets or Exceeds Consumer Expectations**
Product Quality	Soundness (n. s.) Free-of-Error (.299) Concise Representation (.572)	Usefulness (n. s.) Relevancy (.632)
Service Quality	Dependability (.249) Timeliness (.660)	Usability (.706) Value-Added (.690)

Table 5.2 Summary of predictive models of Vocational Gains (entire data set)

Furthermore, two additional dimensions, Objectivity and Reputation, appear in the models as the second predictors of Educational Gains, along with Relevancy and Value-Added, respectively, when analysing the whole data set.

Conclusions

One of the most important roles of educators is to transfer their knowledge to learners. Thus, educators (as senders) attempt to transfer and codify explicit and tacit knowledge to learners (as receivers). In this study, the setting for this knowledge transfer is through the e-learning environment. However, educators face the difficulty of codifying tacit knowledge into explicit knowledge for learners' retrieval and of facilitating them to acquire the tacit knowledge. One aspect of the educators' role in the course development process of e-learning is to improve the course material (information) quality so that students' learning experiences can be enhanced to improve the desired learning outcomes.

The research for this study has demonstrated that the relationship between the quality of information and student learning outcomes is systematically measurable and that this relationship is, for the most part, positive. The empirical results of this research demonstrate that the quality of information has a quantifiable relationship to the achievement in student learning outcomes. In addition, these results also contribute to the knowledge management literature by demonstrating that tacit knowledge can be made explicit to a certain extend.

The research for this study has also conceptual reviewed that through communities of practice, sustained tacit knowledge can be effectively transferred between educators and students to improve learning. To develop and support CoPs, institutions must provide them with specific structure, strategies and supports (Supovitz & Christman, 2003).

Implications for Educators

Educators can benefit from this study, although the results should be considered somewhat preliminary. Firstly, this research demonstrates to educators examining various aspects of the relationship between knowledge transfer in the e-learning environment and student learning outcomes. Researchers may also benefit by considering the specific empirical findings of this research in the development of research models examining this or similar phenomena. Although the interpretation of these findings should be limited as discussed below, and although the empirical results cannot be generalized beyond the population represented by this sample, this analysis has clearly demonstrated the ability to predict certain student learning outcomes based on the measurement of certain information quality characteristics. As such, these findings can provide a useful starting point for subsequent empirical examination.

Secondly, this research demonstrates that students' perceptions in the five information quality dimensions (Free of Error, Concise Representation, Timeliness, Relevancy and Value-added) identified as significant predictors is likely to be associated with students' positive perceptions of their learning outcomes of the type considered in this study.

Thirdly, this research contributes to the education literature a systematic means of creating and measuring quality e-learning material with the aim of improving student learning outcomes. The focus is on transferring educator's tacit knowledge to students so that they can acquire the requisite tacit knowledge. This specific contribution makes the research valuable.

As noted, this should be considered somewhat preliminary from an educator's standpoint. The reason for this statement is two-fold. First, this study did not examine cause and effect, leaving open the possibility that other factors may be at play. Second, the fact that some information quality dimensions were not included in the list should not be interpreted as them having no meaningful, practical effect. Instead, this should be interpreted simply as a lack of evidence in this case.

Communities of practice should be developed to transfer sustained tacit knowledge between educators and students to improve learning.

Implications to Learning Theory

The contemporary approaches to learning consist of three major theories. They are the behaviourist theory, social learning theory and cognitive theory (Ormrod, 1999). In this thesis, the author has focussed the empirical study based on the cognitive theory. The first research question (how can we create quality knowledge through the e-learning environment which is positively related to students' perceptions of their learning outcomes?) was conducted based on the information processing theory aspect of the cognitive theory. This could be an additional limitation to the study since the author has taken a very specific definition of learning which emphasises the role of data, information and knowledge (explicit and tacit). This could be a contested area with the other two competing learning approaches. Similar empirical studies can also be conducted based on the other two theories, in particularly, the motivation of students and the social contexts in which they are in i.e. e-learning environment and communities of practice, to improve their learning outcomes. Ormrod (1999) recommends that these three theories should be used to guide the design of classroom environments, the content to be learned and the instruction.

Limitations of the Study

A number of limitations of this study were described in chapter 3. To the extent practical, steps were taken to minimize or mitigate the effect of these limitations.

Nonetheless, some important limitations remain and are discussed in this section. Most notable among these is the fact that the assessment of student learning outcomes for this research was conducted using student self-report. Although this alternative way of assessing the change in students is not perfect, research generally supports the view that students' self-reports of their learning outcomes are both valid and reliable (Baird, 1976; Berdie, 1971;

Gershuny & Robinson, 1988; Kuh et al., 2001; Pace, 1985; Pike, 1995; Pohlmann & Beggs, 1974; Turner & Martin, 1984). Experts in the field (Angelo, 1999; Dietel, Herman, & Knuth, 1991; Huba & Freed, 2000; Maki, 2002; Palomba & Banta, 1999) have recommended multiple assessment measures to be utilised in order to obtain a clearer understanding of what students have learned and to compensate for biases or weaknesses in any single assessment instrument. Nonetheless, self-report was chosen for this study due primarily to the inexpensiveness and more practical to survey students and ask them to report on how much they think they have learned. The penalty for this choice is the lack of the ability to draw accurate conclusions and inferences about student achievement of expected outcomes. Student learning outcomes is directly related to the measures and methods used during the assessment process; poor methods and instruments can lead to unreliable results and misleading conclusions.

Secondly, main effects hypothesis testing for this research was conducted using stepwise regression. This technique is considered appropriate for exploratory research (Mertler & Vannatta, 2005), but has also been sharply criticized as being limited in power and applicability (Cohen et al., 2003). Nonetheless, it was chosen for this study due primarily to the lack of available theoretical basis for sequencing the regression analysis any differently. The penalty for this choice is the lack of explanatory power. As Cohen et al. (2003) point out, stepwise regression is limited in its power to predictive models only, and it should not be relied upon exclusively or routinely for the development explanatory theories. In particular, they note that stepwise regression research has been shown in some cases to omit predictors from the model that would have produced statistically significant results with other regression techniques. For this reason, the ability to draw conclusions from this research is similarly limited.

Recommendations for Future Research

This study has revealed the presence of an empirically measurable, systematic relationship between explicit knowledge (information) quality and student learning outcomes through the e-learning environment. As such, this study indicates that further research in this area is likely to yield meaningful results.

Several lines of research are recommended based on the findings of this study. First, research similar to this study, but including other methods to measure student learning outcomes is highly recommended. Maki (2004) has identified a comprehensive list of methods to measure SLOs. She divides them into three types: direct methods, indirect methods and Authentic, performance-based methods. Such studies may reveal additional relationships not evident in this study.

Researchers are also encouraged to conduct research similar to this study, but using different measurements of student learning outcomes. Additional work on improving the instrument used to measure student learning outcomes is warranted. Only upon the completion of additional studies will there be sufficient evidence to draw conclusions regarding the potential effect on the relationships between information quality and student learning outcomes.

Second, research similar to this study, but using a different regression model or a different analytical approach, such as path analysis, is highly recommended. Such a study could build directly on the findings of this research by adding explanatory power to the analysis.

In addition to the contributions and extensions identified above, this research also raises some questions. Most notably, by finding substantially different and apparently conflicting regression models at the dimension level versus the PSP/IQ quadrant level, this research draws into question the appropriateness of the pursuit of increasingly simple metrics for information quality (Lee et al., 2002; Pipino et al., 2002; Pipino et al., 2005; Wang et al., 1995). Admittedly, the evidence from this research is limited, and may be indicative of other effects not measured at an observable level within the scope of this effort. As such, further research is encouraged to better understand the effect aggregation has on the ability to predict and explain the relationship between information quality and student learning outcomes.

Finally, it is highly recommended to conduct empirical studies on the effectiveness of knowledge transfer to improve student learning through the development of communities of practice.

Definition of terms

Learning environment is defined as "the place and setting where learning occurs; it is not limited to a physical classroom which includes the characteristics of the setting". http://www.teach-nology.com/glossary/terms/l/

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Appendix I: Sixty-nine (69) Information Quality Questionnaire Items

(Items labelled with "(R)" are reverse coded)

1. Accessibility.

1. This information is easily retrievable.
2. This information is easily accessible.
3. This information is easily obtainable.
4. This information is quickly accessible when needed.

2. Appropriate Amount.

5. This information is of sufficient volume for our needs.
6. The amount of information does not match our needs. (R)
7. The amount of information is not sufficient for our needs. (R)
8. The amount of information is neither too much nor too little.

3. Believability.

9. This information is believable.
10. This information is of doubtful credibility. (R)
11. This information is trustworthy.
12. This information is credible.

4. Completeness.

13. This information includes all necessary values.
14. This information is incomplete. (R)
15. This information is complete.
16. This information is sufficiently complete for our needs.
17. This information covers the needs of our tasks.
18. This information has sufficient breadth and depth for our tasks.

5. Concise Representation.

19. This information is formatted compactly.
20. This information is presented concisely.
21. This information is presented in a compact form.
22. The representation of this information is compact and concise.

6. Consistent Representation.

23. This information is consistently presented in the same format.
24. This information is not presented consistently. (R)
25. This information is presented consistently.
26. This information is represented in a consistent format.

7. Ease of Operation.

27. This information is easy to manipulate to meet our needs.
28. This information is easy to aggregate.
29. This information is difficult to manipulate to meet our needs. (R)
30. This information is difficult to aggregate. (R)
31. This information is easy to combine with other information.

8. Free of Error.

32. This information is correct.
33. This information is incorrect. (R)

34. This information is accurate.
35. This information is reliable.

9. Interpretability.

36. It is easy to interpret what this information means.
37. This information is difficult to interpret. (R)
38. It is difficult to interpret the coded information. (R)
39. This information is easily interpretable.
40. The measurement units for this information are clear.

10. Objectivity.

41. This information was objectively collected.
42. This information is based on facts.
43. This information is objective.
44. This information presents an impartial view.

11. Relevancy.

45. This information is useful to our work.
46. This information is relevant to our work.
47. This information is appropriate for our work.
48. This information is applicable to our work.

12. Reputation.

49. This information has a poor reputation for quality. (R)
50. This information has a good reputation.
51. This information has a reputation for quality.
52. This information comes from good sources.

13. Security.

53. This information is protected against unauthorized access.
54. This information is not protected with adequate security. (R)
55. Access to this information is sufficiently restricted.
56. This information can only be accessed by people who should see it.

14. Timeliness.

57. This information is sufficiently current for our work.
58. This information is not sufficiently timely. (R)
59. This information is not sufficiently current for our work. (R)
60. This information is sufficiently timely.
61. This information is sufficiently up-to-date for our work.

15. Understandability.

62. This information is easy to understand.
63. The meaning of this information is difficult to understand. (R)
64. This information is easy to comprehend.
65. The meaning of this information is easy to understand.

16. Value-Added

66. This information provides a major benefit to our work.
67. The information does not add value to our work. (R)
68. Using this information increases the value of our work.
69. This information adds value to our tasks.

Appendix II: Information Quality Survey Instrument

MM3826 : ORGANISATIONAL MANAGEMENT (MM3826) > CONTROL PANEL > PREVIEW ASSESSMENT: INFORMATION QUALITY SURVEY

Preview Assessment: Information Quality Survey

Name Information Quality Survey

Instructions Please check on the appropriate radio button of the rating from 1 to 5 which reflects closest to your view for each question.

	Not at All		Average		Completely
Rating	1	2	3	4	5

Upon the completion of **all** questions, please click the **save** button at the end of the survey. After saving, please click the **submit** button.

Question 1

This information is easy to manipulate to meet our needs.

Not at All **Average** **Completely**

1. 1 2. 2 3. 3 4. 4 5. 5

Question 2

It is easy to interpret what this information means.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 3

This information is consistently presented in the same format.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 4

This information is incomplete.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 5

This information is not presented consistently.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 6

This information has a poor reputation for quality.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 7

This information is complete.

Not at All **Average** **Completely**

1. 1 2. 2 3. 3 4. 4 5. 5

Question 8

This information is presented concisely.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 9

This information is easy to understand.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 10

This information is believable.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 11

This information is useful to our work.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 12

This information is easily accessible.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 13

This information has a good reputation.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 14

This information is sufficiently current for our work.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 15

This information is difficult to interpret.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 16

This information is not protected with adequate security.

Not at All **Average** **Completely**

1. 1 2. 2 3. 3 4. 4 5. 5

Question 17

The amount of information does not match our needs.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 18

This information is difficult to manipulate to meet our needs.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 19

This information is difficult to aggregate.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 20

The amount of information is not sufficient for our needs.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 21

This information is incorrect.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 22

This information is easily interpretable.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 23

This information is accurate.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 24

Access to this information is sufficiently restricted.

1. 1 2. 2 3. 3 4. 4 5. 5

Question 25

This information is presented consistently.

Not at All **Average** **Completely**

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 26

This information has a reputation for quality.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 27

This information is not easy to comprehend.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 28

This information is based on facts.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 29

This information is sufficiently complete for our needs.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 30

This information is trustworthy.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 31

Using this information increases the value of our work.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 32

This information is presented in a compact form.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 33

This information adds value to our tasks.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 34

This information is objective.

Not at All **Average** **Completely**

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 35

This information is sufficiently timely.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 36

This information is easily obtainable.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 37

This information is applicable to our work.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 38

This information is sufficiently up-to-date for our work.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 39

This information is correct.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 40

This information provides a major benefit to our work.

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 41

Gaining a broad general education about capitalism, entrepreneurship, and Small and Medium Enterprises

☐ 1. 1 ☐ 2. 2 ☐ 3. 3 ☐ 4. 4 ☐ 5. 5

Question 42

Gaining an understanding of the basic economic system and the roles of the individual, capital and profit

Not at All **Average** **Completely**

1. 1 2. 2 3. 3 4. 4 5. 5

Question 43

Gaining an understanding of entrepreneurship and the legal forms of business

1. 1 2. 2 3. 3 4. 4 5. 5

Question 44

Gaining an understanding of the roles of the Small and Medium Enterprises in Singapore

1. 1 2. 2 3. 3 4. 4 5. 5

Question 45

Acquiring knowledge and skills applicable to a manager in a business enterprise

1. 1 2. 2 3. 3 4. 4 5. 5

Question 46

Acquiring background and specialisation for further education in business studies

1. 1 2. 2 3. 3 4. 4 5. 5

Question 47

Gaining a range of information that may be relevant to a career as a manager

1. 1 2. 2 3. 3 4. 4 5. 5

Question 48

Gaining a strong sense of the responsibility of a business enterprise

1. 1 2. 2 3. 3 4. 4 5. 5

Appendix III: Text label Code

Quadrants/ Dimensions	Items	Text label Code
Soundness		
Completeness	This information is incomplete. (R)	**SDCP1**
	This information is complete.	**SDCP2**
	This information is sufficiently complete for our needs.	**SDCP3**
Concise Representation	This information is presented concisely.	**SDCC1**
	This information is presented in a compact form.	**SDCC2**
Consistent Representation	This information is not presented consistently. (R)	**SDCR1**
	This information is presented consistently.	**SDCR2**
	This information is consistently presented in the same format.	**SDCR3**
Free of Error	This information is correct.	**SDFE1**
	This information is incorrect. (R)	**SDFE2**
	This information is accurate.	**SDFE3**
Dependability		
Security	This information is not protected with adequate security. (R)	**DPS1**
	Access to this information is sufficiently restricted.	**DPS2**
Timeliness	This information is sufficiently current for our work.	**DPT1**
	This information is sufficiently timely.	**DPT2**
	This information is sufficiently up-to-date for our work.	**DPT3**
Usefulness		
Appropriate Amount	The amount of information does not match our needs. (R)	**UFAA1**
	The amount of information is not sufficient for our needs. (R)	**UFAA2**
Interpretability	It is easy to interpret what this information means.	**UFI1**
	This information is difficult to interpret. (R)	**UFI2**
	This information is easily interpretable.	**UFI3**
Objectivity	This information is based on facts.	**UFO1**
	This information is objective.	**UFO2**
Relevancy	This information is useful to our work.	**UFRL1**
	This information is applicable to our work.	**UFRL2**
Understandability	This information is easy to understand.	**UFU1**
	This information is not easy to comprehend.(R)	**UFU2**

Usability		
Accessibility	This information is easily accessible.	**UBAC1**
	This information is easily obtainable.	**UBAC2**
Believability	This information is believable.	**UBB1**
	This information is trustworthy.	**UBB2**
Ease of Operation	This information is easy to manipulate to meet our needs.	**UBEO1**
	This information is difficult to aggregate. (R)	**UBEO2**
	This information is difficult to manipulate to meet our needs. (R)	**UBEO3**
Reputation	This information has a poor reputation for quality. (R)	**UBRP1**
	This information has a good reputation.	**UBRP2**
	This information has a reputation for quality.	**UBRP3**
Value-Added	This information provides a major benefit to our work.	**UBVA1**
	Using this information increases the value of our work.	**UBVA2**
	This information adds value to our tasks.	**UBVA3**
Student Learning Outcomes		
Educational Gains	Gaining a broad general education about capitalism, entre-preneurship & SMEs	**SLOED1**
	Gaining an understanding of the basic economic system & the roles of the individual, capital & profit	**SLOED2**
	Gaining an understanding of entrepreneurship and the legal forms of business	**SLOED3**
	Acquiring background and specialisation for further education in business studies	**SLOED4**
Vocational Gains	Acquiring knowledge and skills applicable to a manager in a business enterprise	**SLOVO1**
	Gaining a range of information that may be relevant to a career as a manager	**SLOVO2**
	Gaining a strong sense of the responsibility of a business enterprise	**SLOVO3**
	Gaining an understanding of the roles of the Small and Medium Enterprises in Singapore	**SLOVO4**

Appendix IV: Univariate Analysis – Steps for Screening Grouped Data

(Mertler and Vannatta, 2005: 62-63)

Examination & Process	SPSS Procedure	Technique for "Fixing"
Missing Data • Examine missing data for each variable.	• Run **Frequency** for categorical variables. 1. **Analyze...Descriptive Statistics...Frequencies.** 2. Move IVs to Variables box. 3. OK. • Run **Descriptives** for quantitative variables. 1. **Analyze...Descriptive Statistics…Descriptives.** 2. Move quantitative variables to Variables box. 3. **Options**. 4. Check **Mean**, **Standard Deviation**, **Kurtosis**, and **Skewness**. 5. **Continue**. 6. **OK.**	• Less than 5% missing cases use List-wise default. • 5-15% missing cases → replace missing Values with estimated value by conducting **Transform.** 1. **Transform…Replace Missing Values.** 2. Identify variable to be transformed and move to New Variable Box. 3. Identify new variable name (this occurs automatically). 4. Select method of replacement (e.g., mean, median). 5. **OK.** • More than 15% missing cases → delete variable from analysis.
Univariate Outliers • Examine outliers for quantitative variable within each group.	• Run **Explore**. 1. **Analyze...Descriptive Statistics…Explore.** 2. Move DVs to Dependent List box. 3. Move IVs to Factor List box. 4. **Statistics.** 5. Check **Descriptives** and **Outliers**. 6. **Continue.** 7. **Plots.** 8. Check **Boxplots** and **Stem-and-leaf.** 9. **Continue.** 10.**OK.**	• More than 90-10 split between categories → delete variable from analysis. • Small # of outliers → delete severe outliers • Small to moderate # of outliers → replace with accepted minimum or maximum value by conducting **Recode**. 1. **Transform...Recode...Into Different Variables**. 2. Select variable to be transformed and move to Input Variable → Output Variable box. 3. Type in new variable name under Output Variable Name box. 4. **Change**. 5. **Old and New Values**. 6. Identify value to be changed under Old Value. 7. Under New Value, identify appropriate new value. 8. **Add**. 9. After all necessary values have been re-coded, check **All Other Values** under Old Value. 10.Check **Copy Old Value(s)** under New Value. 11.**Add**. 12.**Continue**. 13.**OK**.
Univariate Normality • Examine normality for quantitative variable within each group.	• Run **Explore**. 1. **Analyze...Descriptive Statistics...Explore.** 2. Move DVs to Dependent List box. 3. Move IVs to Factor List box. 4. **Statistics**. 5. Check **Descriptives**. 6. **Continue**. 7. **Plots**.	• Transform variable using **Compute**. 1. **Transform...Compute**. 2. Under Target Variable, identify new variable name. 3. Identify appropriate function and move to Numeric Expression(s) box. 4. Identify variable to be transformed and

	8. Check **Histograms** and **Normality Plots with tests.** 9. **Continue** 10.**OK.**	move within the function equation (in place of ?). 5. **OK**.
Univariate Homoscedasticity • Examine homogeneity of Variances between/among groups.	• Conduct *t*-test or ANOVA using **Compare Means** to run Levene's Test.	• p value is significant at .05 → reevaluate univariate normality and consider trans-Formation.

Appendix V: 129 of 134 responses had values for all the 48 target items

(students 2, 39, 43, 84 and 98 were having incomplete responses)

	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8	Q-9	Q-10	Q-11	Q-12	Q-13	Q-14	Q-15	Q-16	Q-17	Q-18	Q-19	Q-20	Q-21
STD_1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4
STD_2	3	5	<Unanswered>	3	3	2	4	5	5	5	3	4	4	4	3	3	3	3	3	3	3
STD_3	4	4	4	2	4	2	4	4	2	3	4	3	4	3	3	3	2	2	3	2	1
STD_4	4	4	4	2	2	2	4	4	4	4	3	3	3	4	2	3	2	2	3	2	2
STD_5	4	3	4	4	4	3	4	3	3	4	3	4	4	4	3	4	3	3	4	3	3
STD_6	4	4	4	2	2	2	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2
STD_7	3	3	3	2	2	2	3	3	3	3	3	3	3	4	1	3	3	2	2	3	3
STD_8	3	3	3	3	3	3	4	2	4	3	3	3	2	4	3	3	4	3	4	3	2
STD_9	4	4	4	2	2	2	5	5	4	3	4	5	3	3	3	2	1	3	3	3	2
STD_10	4	4	4	3	2	3	3	4	4	4	4	4	3	4	2	2	2	3	3	3	1
STD_11	3	4	4	2	2	2	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2
STD_12	4	4	4	2	2	3	3	3	4	3	4	4	4	3	2	4	3	4	4	2	2
STD_13	4	3	3	2	2	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	2
STD_14	3	3	4	1	1	3	3	4	3	3	2	3	3	3	3	4	4	2	3	2	3
STD_15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
STD_16	4	4	3	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
STD_17	3	3	3	1	1	1	3	3	4	4	4	4	4	4	4	1	1	1	2	1	1
STD_18	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
STD_19	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
STD_20	4	4	4	1	2	2	2	4	4	4	4	4	4	4	2	2	2	2	2	2	2
STD_21	5	5	5	1	1	1	5	5	5	5	5	5	5	5	1	5	1	1	1	1	1
STD_22	4	5	5	2	1	1	4	4	5	5	5	5	4	4	1	1	1	1	1	1	1
STD_23	2	2	3	4	3	3	2	2	2	4	4	5	3	3	4	3	4	4	3	3	3
STD_24	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
STD_25	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
STD_26	3	3	5	2	1	3	4	5	3	4	2	5	3	2	4	1	3	3	3	4	2
STD_27	4	5	5	1	1	2	5	5	5	5	5	5	5	5	1	3	2	1	3	4	1

	Q-22	Q-23	Q-24	Q-25	Q-26	Q-27	Q-28	Q-29	Q-30	Q-31	Q-32	Q-33	Q-34	Q-35	Q-36	Q-37	Q-38	Q-39	Q-40	Q-41	Q-42	Q-43	Q-44	Q-45	Q-46	Q-47	Q-48
STD_1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
STD_2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
STD_3	2	3	3	3	4	5	5	3	3	5	4	4	4	3	4	3	4	4	4	3	3	4	4	3	3	4	4
STD_4	3	3	3	4	4	3	4	4	4	4	3	3	3	3	4	3	4	4	3	4	4	4	4	4	3	3	3
STD_5	4	4	3	4	3	3	4	3	4	3	3	3	4	4	3	4	4	4	4	3	3	4	4	3	4	4	3
STD_6	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
STD_7	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3
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