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Factors Affecting Information Systems Modeling Ability

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Abstract

This study was initiated to investigate the essential skill factors for system designers in order to build the right information systems. The predicted variables are mathematical modeling skill, verbal modeling skill, general IT knowledge, and general business knowledge. The test was administrated to 43 students majoring in Management Information Systems (MIS) at Hannam University, South Korea. In this study, we used Pearson Correlation Analysis to test the relationships among variables. Overall, our study suggested that there is a strong positive relationship between mathematical and verbal skills and IS modeling ability. A marginal positive relationship between the general IT knowledge and IS modeling ability was also found. Unexpectedly, there was no significant relationship between general business knowledge and IS modeling ability.

Keywords : Information Systems Modeling Ability, Mathematical Modeling Skill, Verbal Modeling Skill, General Business Knowledge, General IT Knowledge, Systems Analysis and Design

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1. Introduction

Every type of business organization always deals with information systems. A good information system is a necessary condition for a better performance in an organization. In order to build a good information system, system designers assume the key role because the blueprint of the whole system is driven by the designer. So, information system designers' modeling ability has a direct impact on system development productivity, which in turn affects organization's performance. Understanding the factors that affect IS modeling ability could help managers to put their emphasis on recruiting and training employees and help academicians to design MIS curriculums.

1.1 Purpose of Study

In this study, we are going to examine the factors that affect information system modeling ability by looking at the predictor variables such as mathematical modeling skill, verbal modeling skill, general IT knowledge, and general business knowledge.

2. Literature Review

2.1 Definition of a Model

In Management Information Systems (MIS), a model is defined as a pictorial representation of reality [Whitten et al., 2000]. A model is generally defined as an illustration of reality [Pidd, 1999]. People interested in using that model observe the reality in order to understand, change, manage, and control it. A model is built around a reality but reflects only parts of it [Kuhne, 2004]. Model can also be regarded as a simplification of a reality for a purpose [Powell, 1995a, 1995b]. Holling [1978] defined a model as a caricature of reality. Many researchers defined "model" in their own perspectives. Kang [2016] defined a model as "an expression of mental image formed as a result of cognitive process by a person who perceives objects with a certain purpose."

2.2 Modeling Skills

Modeling Skill is an ability to abstract the core business tasks, to synthesize these ideas to form a mental image, then to produce an artifact, a model that would represent the business reality [Kang, 2016]. According to Powell [1998], modeling enhances communication among people in the organization, by increasing their sense of commitment, which will result in improving employee's performance. Most career requires modeling as a basic skill since most of the tasks are needed to model a reality. These tasks could be described in the following ways; modeling by language, modeling by visual presentation/ graphics, modeling by mathematics, and modeling by computer programming language. Rasch and Tosi [1992] found that system developer's/designer's ability (knowledge and skill) determine their performance.

〈Table 1〉 Modeling Skills

Skills	Powell	Willemain
General Skills	• Numeracy skills-the ability to reason logically, especially with numbers. Making rough estimate, checking consistency of units and test the plausibility of results. • Design skills-ability to identify key assumptions and represent them by parameters, develop a set of relationships that connect inputs to outputs, draw useful inferences from the outputs. • Interpretation skills-ability to recognize a problem in a complex mess of symptoms, causes, solutions and data; ability to infer patterns and meanings from model solution; ability to translate these patterns into layman's language so as to communicate clearly to decision makers.	Modeler's mind-set (e.g., creativity, sensitivity to client, persistence) Non-technical expertise (e.g., communications and teamwork skills)
Domain-specific skills	• Management science skills-ability to use optimization, simulation, decision analysis and other tools of management science.	OR/MS expertise Subject matter expertise

2.3 What is an Information Systems Designer and IS Modeling Ability?

Information systems designers are information science professionals that help shape how business people interact and get things done through information systems. They play a critical role in developing good business information systems. In this study, the information system designer is defined as a person who recognizes business asset, business activities, and current information systems to analyze them to find problems and design an improved information system.

Ability refers to the relatively stable capabilities that employees possess, which allows them to perform a particular range of related activities [Meredith, 2010]. IS modeling ability is the ability for the designer to capture an existing or desirable business context and to create a mental image illustrating the given context, which then is expressed by appropriate media for some purpose. Furthermore, it requires describing this mental image with an appropriate medium or language to make it communicable among business people and IS people. IS modeling has three major output, which are data, process, and interface design. In a recent study [Getalado et al., 2015], a measurement tool of graphical modeling ability - the ability to represent a reality by using graphs, diagrams and illustrations, was developed and validated. The questionnaires includes items on general diagramming skills, use case diagrams, and data flow diagrams, sequence diagrams, entity relationship diagrams to measure the graphical modeling ability of the information system designers. In this study, their measurement tools will be used to test IS modeling ability.

2.4 Mathematical Modeling Skill

Mathematical modeling skill is an ability of identifying the distinct parts where the problem exists. It includes the ability to decompose the problem into solvable sub-problems and the ability to specify the problems in different forms with varying situations. It also includes the ability to project possible solutions for the problem

[Getalado et al., 2015]. Mathematical modeling skill is someone's insightful readiness to carry through all parts of a mathematical modeling process in a given situation [Blomhøj and Jensen, 2003]. Mathematical modeling is a process that uses mathematics to represent, analyze, make predictions or otherwise, it provides insight to real-world phenomena. Mathematical modeling ability is a required skill for today's IT/IS job in order to solve business problems; and come up with new business solutions.

It is evidenced by operations research and management science that mathematical modeling skill is necessary to solve and create real world business model. Dan and Xie [2011] found a strong positive correlation between mathematical modeling skills and the creative thinking levels of engineering students. According to above background, we came up with the following hypothesis.

Hypothesis 1 : Mathematical modeling skill is positively related with IS modeling ability.

2.5 Verbal Modeling Skill

Verbal modeling skill is defined as an ability to understand what both technical and business people are saying and rephrase it clearer and more understandable to both parties [Getalado et al., 2015]. Verbal ability is an ability to listen to and understand information and ideas presented through spoken words and sentences, and the ability to communicate information and ideas in speaking so others will understand. Allen et al. [2012] defined verbal skill as various capabilities associated with understanding and expressing oral and written communication.

Diethelm et al. [2004] stated that we can define a solution to a given modeling problem by using written or oral language. This could be used to seize and evaluate the mental model of a person. A mental model could be expressed through verbal languages. The ability to get the idea (mental image) where the business and technology problems exist, presented by both business and technology domain is very important. According to Getalado et al. [2015], verbal modeling ability is very important and is needed throughout the whole information systems modeling process.

Satzinger et al. [2007] also emphasized the importance of the ability to communicate with the natural languages in IS modeling. As MIS people's responsibility is to fill the gap between technical people and business people, the ability to verbally communicate is very important. Thus, we came up with the second hypothesis.

Hypothesis 2 : Verbal modeling skill is positively related with IS modeling ability.

2.6 General IT Knowledge

General IT knowledge and skill is defined as an ability to know the available information technology that will best fulfils the needs of an organization [Getalado et al., 2015]. Information technology is defined as the analysis, design, development, application, implementation, support or management of computer-based information systems [Proctor, K. Scott, 2011]. Today, information technology plays an essential role

for most of both public and private organizations in a smoothly functioning. Every manager level in every organization should acquire some level of information technology knowledge in order to do their jobs effectively. They should also ensure that their employees understand the information technology that the organization is using in order to maximize job performance. Every successful organization depends on IT for everyday tasks, manage business process, and use IT for competitive advantage.

Organizations gradually seek IT professionals with a balance of technical and business skills [Benamati et al., 2007]. This link between business and technology is the main characteristic of the MIS field. This is the reason why some universities have their students who majored in MIS or IS included in business department or computer science/information technology department [Getalado et al., 2015]. Thus, MIS curriculums are focused on developing students who can integrate business and technology to solve problems or to design improvement opportunities for organizations. These problem-solving skills connect the link between business problems and technical problems.

This gap should be filled with people possessing the sufficient domain knowledge in both business and information technology [Getalado et al., 2015]. Technology knowledge and skills that will be acquired by MIS students in their major courses will guide them in modeling in systems analysis and design methodology. Sub-domains of information technology knowledge can be measured by the student GPA of programming language, database management systems, software engineering [Getalado et al., 2015]. According to previous and background studies, we came up with the third hypothesis.

Hypothesis 3 : General IT knowledge is positively related with IS modeling ability

2.7 General Business Knowledge

General Business knowledge is the ability to comprehend business situations and to find both problems and solutions in an organization [Getalado et al., 2015]. Martin Modell [1996] defined Business knowledge as a thorough understanding of the general business functions and the specific areas under analysis. Business knowledge can be developed at any level; however, the higher the level at which the analyst begins, the more comprehensive and meaningful that knowledge becomes.

An example given by Martin Modell [1996] clearly define business knowledge. He interprets business knowledge and functions by analogy with the automobile. In the example, it is possible to understand how an automobile works by studying its component parts such as the engine, the transmission, the braking system, the steering mechanism, or the exhaust system. To understand more on how an automobile works, it is very important to understand how the various parts interact with each other; e.g., how the exhaust system ventilates the engine and how power is transmitted to the drive wheels by the transmission. General business knowledge is typically manifested by a set of business functions, such as business strategy, marketing, orga-

nizational behavior, human resource management, accounting, financial management, customer relationship management, and production management, etc.

The increasing emphasis on applying information technology to serve business goals and the need to re-engineer business process before the adoption of new information technology requires IS professionals to possess in-depth business knowledge and skills [Lee et al., 1995]. In their study, they found out business knowledge was considered the most important skill in the future. They predicted that the most important IS activity in the future will be to analyze business problems and IS solutions. Thus, we came up with the following hypothesis.

Hypothesis 4 : General business knowledge is positively related with IS modeling ability.

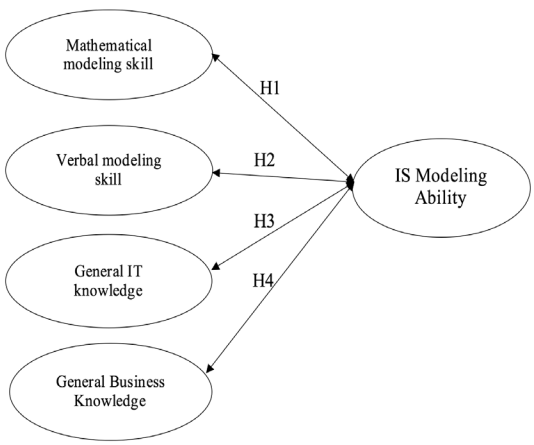
3. Research Model and Methodology

3.1 Research Model

Information technology and business problem-solving skills are identified as the most important characteristic of MIS students to be recruited in the field, identified by MIS advisory board [Ferratt et al., 2010]. These two skills will fulfill the gap between business domain and technology domain to solve the real world organizational problems. Hence, in order to overcome the problems and misunderstanding between these two drivers are to build a model.

In information system development, system analysis and design phases are the most important. Most of the systems failures occurred due to the problems encountered during these two phases [Ivari et al., 2005]. System planning/analysis and design phases are easier to accomplish with modeling skill and ability rather than textual representations. All types of system analysis and design methodologies, including structured methodology, information engineering, and object-oriented methodology involve modeling to get an architecture of the system.

Based on the previous studies, the researcher conceptualizes the following skills and knowledge to be essential requirements for systems analysis and design as shown in <Figure 1>.



〈Figure 1〉 Hypothesized Research Model

3.2 Research Methodology

In this study, the measurement tools developed by Getalado et al. [2015] will be used to measure IS modeling ability. Mathematical modeling skill and verbal modeling skill questionnaire, as validated their reliability and validity, developed by Getalado et al. [2015], will also be used to measure those two skills.

〈Table 2〉 Questions in the Modeling Assessment Tool

Test Set	Sub-Skills	No. of items	Weighted sum of Scores
First Test	Mathematical modeling skill	7	20
Second Test	Verbal modeling skill	7	20
Third Test (IS Modeling Ability)	General Diagramming Skills (DS)	3	10
	Sequence Diagram (SD)	3	10
	Entity Relationship Diagram (ERD)	4	10
	Use Case Diagram (USECASE)	2	10
	Data Flow Diagram (DFD)	2	10
	Modeling on a Situation (MOD)	2	10

General IT knowledge and general business knowledge will be measured by student's GPA on each specific courses. Student GPAs are averaged; the average scores in subjects they took. Some student took 13 subjects; some other students took around 10. For general IT knowledge measurement, the GPA from the following courses are used;

1. System Analysis and Design
2. Database Management
3. Enterprise Resource Planning (ERP)
4. Business Programming
5. Internet Programming Basics
6. Visual BASIC
7. Decision Support Systems (DSS)
8. Web DB Construction
9. Information Systems Project
10. Computer Operating Systems
11. JAVA Programming and
12. Computer Communication.

For general business knowledge measurement, the GPA from the following courses are used;

1. Introduction to Business Management
2. Strategies for Management
3. Micro Economics
4. Accounting
5. Human Resource Management
6. Marketing
7. Production Management
8. International Trade
9. Management Science
10. Business Presentation
11. Introduction to MIS
12. Electronic Commerce
13. Start-up Business.

The researcher collected data from 43 students majoring in Management Information Systems at a university in South Korea. The students' demographic data such as major, year level, age, and gender is shown in <Table 3>.

〈Table 3〉 Description of Respondents

Characteristics		Frequency	Percent
Gender	Male	28	65.12
	Female	15	34.88
Year Level	Freshmen	-	-
	Sophomore	-	-
	Junior	35	81.4
	Senior	8	18.6

In this study, Pearson's Correlation Coefficient analysis was used to test our hypothesis since we want to see the simple correlation between the predictor variables and designers' IS modeling ability. This statistical method will test the significance of relationships between paired variables. We want to examine if there is a relationship between student's mathematical modeling skill, verbal modeling skill, general IT knowledge, and general business knowledge and their IS modeling ability. The strength of the relationship is indicated by the correlation coefficient (r). The significance of the relationship is expressed in probability levels : p (significant at p = .05 in this study). We didn't take care of multi-collinearity among predictor variables since there were no theoretical correlations among them in the previous studies.

4. Study Results and Discussions

Pearson's correlation coefficient analysis was used to see the relationship between IS Modeling ability and various predictors. <Table 4> summarizes the descriptive statistics and analysis results.

The aim of this study is to specify what skill/factors influence information system's modeling ability. In other words, what are the essential skills required for information systems designer/modeler to produce the right information systems? The study revealed that, as shown in <Table 4>, as we predicted, a significant positive relationship between the verbal modeling skill and IS modeling ability exists. Likewise, mathematical modeling skill is also significantly related with IS modeling skill.

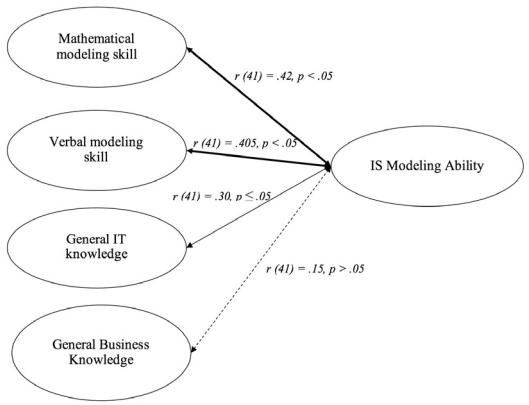
The study showed that there is a marginally significant relationship between the general IT knowledge and IS modeling ability. General IT knowledge is too comprehensive and broad to capture the concept. In this study, therefore, we used a surrogate measure by averaging the score of 12 subjects offered in the MIS curriculum. Due to the time limit, we could collect aggregated data from only 43 students at either junior

〈Table 4〉 Correlations Table

		Math	Verbal	IT	Business	IS Modeling Ability
M	Pearson Correlation	1	.449**	0.142	-0.018	.420**
	Sig. (2-tailed)		0.003	0.363	0.91	0.005
	N	43	43	43	43	43
V	Pearson Correlation	.449**	1	0.181	0.028	.405**
	Sig. (2-tailed)	0.003		0.245	0.858	0.007
	N	43	43	43	43	43
IT	Pearson Correlation	0.142	0.181	1	.724**	0.299
	Sig. (2-tailed)	0.363	0.245		0	0.051
	N	43	43	43	43	43
B	Pearson Correlation	-0.018	0.028	.724**	1	0.15
	Sig. (2-tailed)	0.91	0.858	0		0.339
	N	43	43	43	43	43

**Correlation is significant at the 0.05 level (2-tailed).

or senior level, who are presumed to finish reasonable number of subjects both in business and information technology area. Because most participants took 10 to 13 subjects both in business and information technology area, we ignore the width of their knowledge. According to Cohen [1977], when the sample size increases, the p-value may decreases. In the future study, by collecting more samples, we may find a strong correlation between the general IT knowledge and IS modeling ability. However, even though we increase the sample size, we cannot expect a high correlation between the general business knowledge and IS modeling ability. The tested research model is depicted in <Figure 2>.



〈Figure 2〉 Result of Hypotheses Test

5. Conclusion

5.1 Major Findings and Contribution to Research

Modeling ability has been widely studied in other research fields such as mathematics, science, management science, operations research, but not much in the field of management information systems. Several studies in those fields included finding out the modeling skills or ability that are essential in understanding and practicing the theories in those areas of specialization. They have also tried to measure the modeling skills of the student to test if they are fit to the major they are taking or to test whether they would be successful in enriching the body of knowledge in their areas of specialization.

Systems analysis and design involve modeling different requirements, circumstances, scenarios, and design of information system. The researcher studied the related researches on modeling, examined different kinds of assumptions, and identified the four major factors to test the IS modeling ability of students. The assessment tool that was used in this study were already tested and validated its reliability and validity by Getalado et al. [2015]. Based on the literature review, we hypothesized four factors affecting the system developers' IS modeling ability.

Statistically speaking, only two hypotheses were accepted and validated to find factors affecting IS modeling ability. Mathematical and verbal modeling skill are good explainer of the variance in IS modeling ability. Exceptionally, according to our data (with significant level p = 0.05), we can assume general IT knowledge explains IS modeling ability. Even though their significant level (p = 0.051) is little bit low, this can be solved by increasing the sample size. General IT knowledge will be a good indicator to test and examine in the future research study. Generally MIS people have assumed that business knowledge may contribute to IS modeling ability. But, unlike common sense, our study

showed there is no statistically significant relationship between general business knowledge and IS modeling skill. This may be due to narrowly defined IS modeling ability which emphasizes graphical representation skill for simple business scenario.

5.2 Limitations and Implications for Future Study

This study is just a beginning of the research on IS modeling ability of people who are interested in the analysis, design, and development of information systems. Major limitation in this study is on the small sample size due to a time constraint. More samples will improve the study results. Another limitation of this study is that we used surrogate measure, GPA, to measure general business knowledge and general IT knowledge. In the future study, if possible, direct measurement tools assessing general IT knowledge and business knowledge may improve the statistical analysis of the research model. Furthermore, the study's result can be significantly improved by establishing test-retest research design, which will strengthen the validity of the research model.

This study has gone some way towards enhancing our understanding of information systems modeling. The present findings might help students, professors, and academia on their own senses. The students can use the test to help them assess their IS modeling ability. The result can guide them where to focus in order to improve their overall system analysis and design ability. The results of the study can be a useful guide to professors on how they should go about the class and design MIS curriculum. The practitioners in the IS field may be benefited by applying the study results to recruiting and evaluating their employees and developing their career programs.

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