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Cognitive Aptitude, Personality Traits, and Demographic Background as Performance Predictors in Learning a Complex Enterprise System

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ABSTRACT

This research investigates the influence of cognitive ability, computer aptitude, and demographic factors on performance of learning a complex procedure-oriented Enterprise Resource Planning (ERP) system. Because an ERP system is heavily procedural-, process-, and detail-oriented, the researchers hypothesize that computer aptitude may predict a student's success in learning how to use an ERP system as it can measure the student's ability to (1) prevent or mitigate problems, (2) recognize patterns and/or pay attention to detail and (3) follow complex procedures.

KEYWORDS: Cognitive aptitude, Personality, ERP

I. INTRODUCTION

The objective of the proposed research is to assess the influence of cognitive ability, computer aptitude, and demographic factors on performance while learning a complex procedure-oriented Enterprise Resource Planning (ERP) system. An ERP is a large-scale, complex IT system used to support day-to-day business operations in organizations. The widespread implementation of ERP systems over the last two decades has led to the challenge for companies to recruit a skilled ERP workforce and for universities to educate graduates with ERP knowledge (Charland, et. al., 2015). As both personality traits and cognitive ability are perceived to be correlated with job performance, companies often utilize personality tests along with computer aptitude tests in their quest for skilled IT workers (Lui, et. al., 2008). Because an ERP system is heavily procedural-, process-, and detail-oriented (Tenhiala and Helkio, 2015), the researchers hypothesize that computer aptitude may predict a student's success in learning how to use an ERP system as it can measure the student's ability to (1) prevent or mitigate problems, (2) recognize patterns and/or pay attention to detail and (3) follow complex procedures.

The research model thus hypothesizes that (a) cognitive ability (i.e., computer aptitude as measured by the Berger Aptitude for Programing (B-APT) test) and (b) personality traits (measured by the Mini-International Personality Item Pool (IPIP) instrument) will influence (c)

student success in learning an ERP system (measured by user logged data, assignment grades, course grade, and self-reported learning perception). Other variables in the model include gender, prior knowledge, and cultural/social influence which have been shown in prior research to influence performance.

In summary, the proposed research will provide insights into the factors and attributes that contribute to the successful learning and use of complex ERP systems as well as enable academicians and corporate trainers to design tailored educational experiences appropriate to the characteristics of students.

II. OVERALL AND SPECIFIC OBJECTIVES

To address the need for a skilled ERP workforce (Charland et. al, 2015), the proposed research seeks to develop a predictive model for learning large-scale, complex, procedural-, process-, and detail-oriented enterprise information systems utilizing cognitive ability (i.e., computer aptitude), personality traits, and demographic factors as antecedent variables. The research question is:

> ***Can cognitive ability, personality traits, and demographic factors predict student success in learning a large-scale complex enterprise information system?***

The learning performance predictors included in the proposed study are cognitive ability (Spearmen, 1904; Rowan, 1957; Borzovs, et. al. 2015) and personality (Donnellan, 2006). Other variables such as prior knowledge (Avolio, et. al., 1990; Mcdaniel, et. al, 1998), gender, academic performance (e.g., GPA), and cultural and social influences have also shown influence in IT education and will be included in the research model. An Enterprise Resource Planning (ERP) system is selected to represent large-scale complex enterprise information system because of ERP's wide-adoption and challenges ((Charland, et. al., 2015) facing industry.

III. LITERATURE REVIEW

The lack of ERP-relevant technical, analytical and business process management skills in IT professionals and end-users can hinder the adoption and successful use of such systems (Sumner, Watson, Corbitt, 2006). In fact, most IT failures stem from a lack of user acceptance rather than poor technical quality (Nelson and Cheney, 1987). Research has confirmed that the successful implementation of ERP systems requires effective, reinforced and updated training of personnel (Markus et al., 2000; Gargeya and Brady, 2005).

Education and/or training refer to formal efforts to transfer required knowledge. The process of learning is described by Schein (1961) as an unfreezing, moving, and refreezing process. Unfreezing is necessary because the end user comes already replete with ingrained habits of feeling, thought and action. To change an end user through training, his/her normal habits first have to be questioned and disturbed, or unfrozen. Training can do this by focusing attention on needs that end users cannot satisfy by habitual behavior. The trainer then introduces other methods which allow participants to try new ways of behaving, that is, moving. If they find the new behavior more useful in meeting their new needs, the individual will establish continuity by freezing the new behavior. Thus over the past two decades, recognizing the importance of using ERP software as a teaching tool, many colleges and universities have developed courses and academic programs to educate graduates with ERP skills in order to meet market demand (Swartz and Orgill, 2000; Hawking, et. al. 2004).

3.1 Cognitive Ability as an Antecedent of Learning Performance

Predictors of aptitude can be useful in determining antecedents for successful use of systems and tools. For instance, Bock, Yager, and Powell (2003) evaluated the usefulness of the Berger Aptitude for Programming Test (B-APT) as a predictor of entity-relationship (ER) modeling skill for business database designers. Their findings indicated a positive correlation between B-APT results and ER modeling skill. From a practical perspective, this finding indicates that business managers can incorporate use of the B-APT as a potential success indicator when screening computer information technology professionals for selection as database designers. The current research seeks to likewise provide knowledge about the antecedent variables that will contribute to the successful acquisition of ERP skill sets. Ultimately, educating individuals with a high-potential to succeed in using complex enterprise systems will satisfy the market demand for qualified graduates. Identifying skills sets which are predictive of success will also guide students to select the right career options for themselves and will enable them to achieve their professional goals.

A variety of cognitive ability tests have been widely used for selecting employees and predicting job performance (Spearmen, 1904; Rowan, 1957). As early as 1904, C. Spearmen explored the construct of general mental ability (g factor in relation to job performance. When observing research evidence over the past 100 years, g factor predicts not only performance within a job, but also occupational level attained better than any other ability, trait, disposition, or experience; even weighted combinations of job-specific aptitudes don't predict job performance better than the g factor alone (Schmidt & Hunter, 2004). Spearmen's work spurred research to find better predictors of work performance. In 1957, the Rand Corporation's Numerical Analysis Department conducted research on 30 tests, including the Thurstone Primary Mental Abilities (PMA) Test and Thurstone Temperament Schedule, attempting to tackle problems with personnel selection.

Other studies have sought to find relationships between aptitude tests and academic performance. For instance, Rowan (1957) observed a positive correlation between the Primary Mental Abilities Test scores and programming course grades, but cautioned that success in education is a result of many factors and no test should be used without empirical validation. Furthermore, in cognitive ability research, training performance has been found a stronger predictor than supervisory ratings for job performance (Lilienthal & Pearlman, 1983; Pearlman, 1979). Cognitive aptitude and ability tests reveal patterns similar to those found in interviews and are equally valid for job performance and training performance criteria (Schmidt et al., 1985; Schmidt, et. al., 1992).

3.2 Personality Traits as Antecedents of Learning Performance

The Big Five Personality Test has been widely utilized and organizes personality traits into five distinct categories: Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness (Mirza et al. 2015). The mini-IPIP is a 20-item short form of the 50-item International Personality Item Pool of the Big Five test (Goldberg, 1999; Mirza et al. 2015) This 20-item test has also been extensively studied and proven to have acceptable internal consistencies similar to the larger Big Five Personality test. (Donellan, 2006). As the five factors have not been utilized as predictors of ERP learning performance in prior research, the proposed research will extend a well-defined body of personality research to a new application area.

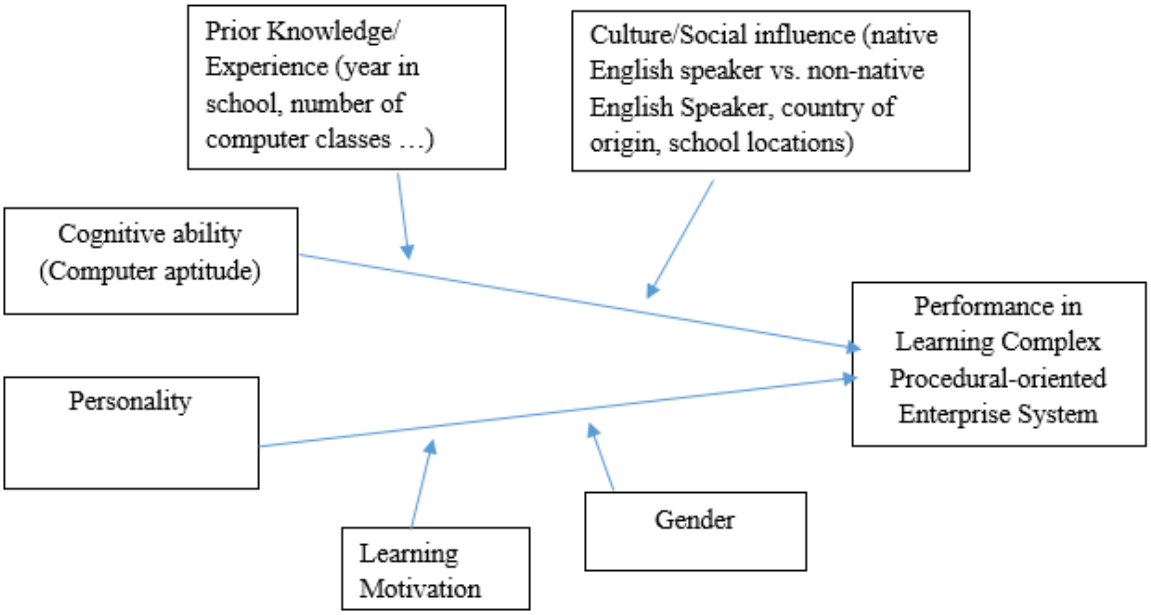
3.3 Demographic Characteristics as Antecedents of Learning Performance

Research has also provided empirical evidence that experience is a predictor of performance (Avolio, et. al., 1990; Schmidt & Hunter, 1998), but that the relationship between these two measures is moderated by length of experience and job complexity (Mcdaniel, et. al. 1998). Gender (Wawrzynski, 2003; Li, et. al., 2015). Furthermore, cultural and social influence as measured by geographic origin (Wawrzynski, 2003; Fatemifar, et. al.,2015) and academic experience (Cheung & Kan, 2002; Wawrzynski, 2003) are demographic characteristics that are known to moderate academic performance.

IV. RESEARCH DESIGN AND HYPOTHESES

The research model, as shown in Figure 1, hypothesizes that (a) cognitive ability (i.e., computer aptitude) and (b) personality traits will influence (c) student success in learning an ERP system. Other variables in the model include prior knowledge, learning motivation, cultural/social influence, and demographic characteristics such as gender which have been shown to influence performance in prior research.

Figure 1. Research Model



The following hypotheses have been developed for the proposed research:

H1. Cognitive ability is positively related to learning performance

H2. Personality traits (Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness) are positively related to learning performance

H3. Gender moderates the relationships between cognitive ability and learning performance as well as between personality traits and learning performance

H4. Learning motivation moderates the relationships between cognitive ability and learning performance as well as between personality traits and learning performance

H5. Demographic characteristics and cultural/social influences moderate the relationship between cognitive ability and learning performance

Computer aptitude test be assessed through Berger Aptitude Test which is the most widely adopted computer aptitude in industry, to assess a person's (1) "logical thinking and problem solving" which shows a person's ability to prevent or mitigate problems, and (2) "pattern and syntax recognition" which shows the ability to recognize patterns and or pay close attention to detail and finally, (3) the ability to "follow complex procedures" which shows the capability to organize, process events or objects in a logical sequence" (Borzovs, et. al. 2015).

Personality traits will be assessed through the Mini-IPIP, is a 20-item short form of the 50-item International Personality Item Pool of the Big Five test (Goldberg, 1999) that was created to measure four items of each Big Five personality trait test (Goldberg, 1999; Mirza et al. 2015). The five traits of Extraversion (outgoing/energetic versus solitary/refined), Agreeableness (friendly/compassionate versus analytical/detached), Conscientiousness (efficient/organized versus easy-going/careless), Neuroticism (sensitive/nervous versus secure/confident) and Openness (inventive/curious versus consistent/cautious) can each influence ERP learning performance as such systems are complex, as well as procedure-based, process-based and detail-based. In prior research, Extraversion has been found to predict learning styles whereas Neuroticism has been found to be negatively related to academic success. Likewise, Conscientiousness has been shown to predicts academic performance while openness and agreeableness foster collaborative learning (Poropat, 2009).

In addition to self-reported learning motivation, the research will also measure learning motivation by the number of non-task related ERP transaction codes executed by users as such behavior may indicate that the user is trying to explore the system for additional learning.

Finally, learning performance will be measured by computer user log, assignment grade, course grade, and self-reported learning perception. A sample user log is shown in Figure 2. The proposed study will collect more parameters enabling richer analyses.

Figure 2. Computer User Log

Date	Time	User	Terminal	TCode	Program	Security Audit Log message text
8/17/2016	19:33:40	MSTERP77	RCV40VER	SESSION_MANAGEF	SAPMSYST	Logon Failed (Reason = 1, Type = A)
8/17/2016	19:33:44	MSTERP77	RCV40VER	SESSION_MANAGEF	SAPMSYST	Logon Failed (Reason = 1, Type = A)
8/23/2016	17:37:07	MSTERP76	RCV32VER	SESSION_MANAGEF	SAPMSYST	Logon Successful (Type=A)
8/23/2016	17:37:24	MSTERP76	RCV32VER	SESSION_MANAGEF	SAPLSMTR_NAVIGATION	User Logoff
8/25/2016	16:08:25	MSTERP76	RCV31VER	SESSION_MANAGEF	SAPMSYST	Logon Successful (Type=A)
8/25/2016	16:09:20	MSTERP76	RCV31VER	SESSION_MANAGEF	SAPLSMTR_NAVIGATION	User Logoff
8/25/2016	18:25:11	MSTERP76	RCV11VER	SESSION_MANAGEF	SAPMSYST	Logon Successful (Type=A)
8/25/2016	18:28:21	MSTERP76	RCV11VER	VA01	SAPLSMTR_NAVIGATION	Transaction VA01 Started
8/25/2016	18:31:08	MSTERP76	RCV11VER	VA01	SAPLSMTR_NAVIGATION	Transaction VA01 Started
8/25/2016	18:31:44	MSTERP76	RCV11VER	VA01	SAPLSMTR_NAVIGATION	Transaction VA01 Started
8/25/2016	18:33:11	MSTERP76	RCV11VER	SU3	SAPLSMTR_NAVIGATION	Transaction SU3 Started
8/25/2016	18:46:12	MSTERP76	RCV11VER	S_ALR_87012328	SAPLSMTR_NAVIGATION	Transaction S_ALR_87012328 Started

Research data will be collected from students enrolled in ERP classes ranging from introductory to advanced levels at UMSL and Missouri S&T for the duration of this research project. The researchers at both institutions will create a collaboration and course sharing structure to utilize common learning exercises and Missouri S&T's ERP platform for the purpose of this project.

The data will be collected over three or more semesters to account for the instructor differences.

UMSL and Missouri S&T have been selected as settings for the research in order to capture cultural and social influences on students. Missouri S&T located in a rural small town whereas UMSL is located in St. Louis, a major U.S. city with over 40 companies that use ERP systems in their business. Thus in contrast to Missouri S&T students, UMSL students have greater exposure to major companies, employers, job opportunities, and cultural diversity. Moreover, UMSL's student base consists of more non-traditional students who often work full- or part-time and commute to campus.

V. SIGNIFICANCE OF THE RESEARCH

With ERP systems implemented in almost all major companies, the enormous potential for positively influencing ERP learning performance makes this project significant. This research will provide insights into the factors and attributes contributing to the successful learning and use of complex enterprise systems. It will also enable academicians and companies to tailor educational and corporate training experiences to the characteristics of students and employees for greater learning success.

The novelty of the research lies in its use of user log data to assess and predict learning motivation and learning performance. User log data captured in an ERP system consist of user id, access point, program accessed, operations and transactions executed, duration of each access, operation, and transaction, which are information pertinent to real-time security audits. As a result, user logs have been widely used in security audit and fraud detection. The use of user logs is a novel way to reduce the cost and time in data collection and obtain high quality objective data because such data inherently captured in an ERP system.

The second novelty of, the research will provide insights through the novel use of data visualization and data analytics to propose individually customized advising, education, and training strategies depending on the student's traits. As an example of user log data analysis, Figure 3 shows patterns in a visualization model of the number of tasks performed (i.e., number of ERP transaction codes executed) by students in a selected time period from a class.

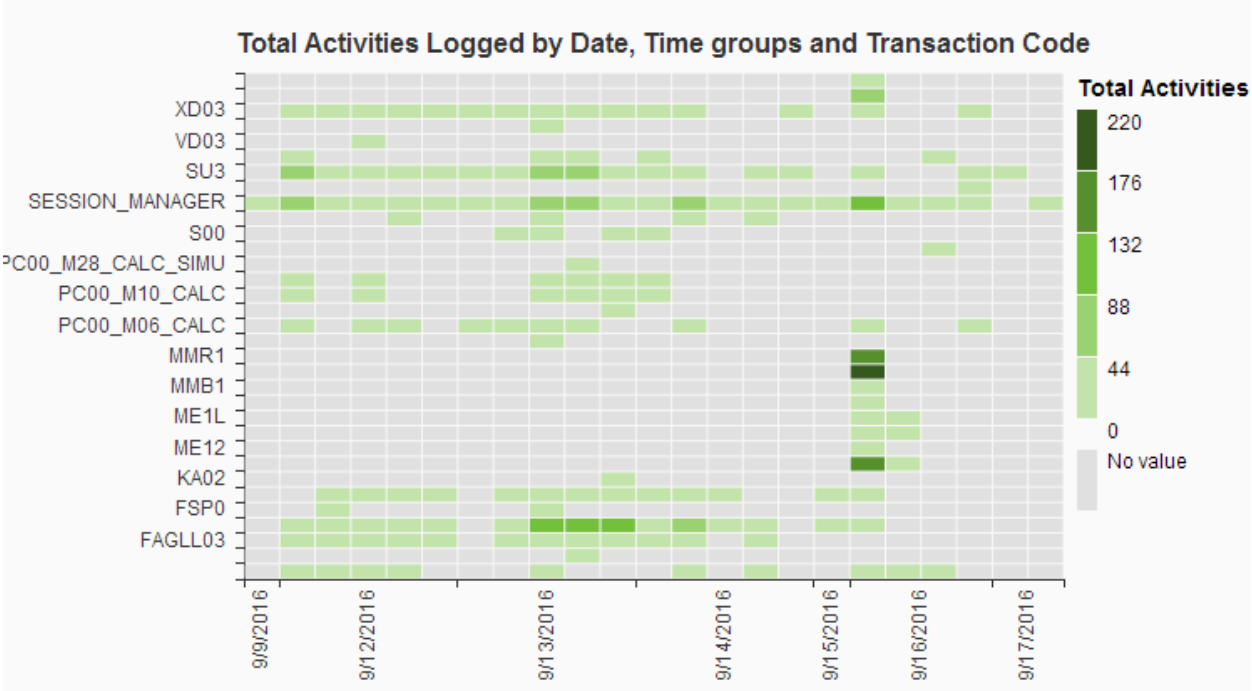
From the visualization, an academician or corporate educator may derive following observations and then develop customized advising or instructional strategies for students or employees.

- Why do some students perform tasks that are not required in an assignment?
  - Are those additional tasks performed to correct errors?
    - If so, what role does a student's computer aptitude and personality play in perform tasks accurately? Will a student with higher computer aptitude score have fewer errors? Will a student with an extraversion personality trait have more errors than those with conscientiousness and neuroticism traits?
    - If not, are those students trying to explore the system for additional learning?
      - If so, what motivate those students to explore? What role does a student's computer aptitude and personality play in such behavior? Will a student with an openness personality trait more inclined to additional learning and explorations than a student with a conscientiousness trait?

- Do students who start early on their assignments have better performance than those who start late?

- If so, what role does a student's computer aptitude and personality have in such behavior? Will a student with higher computer aptitude score often start early? Will a student with a conscientiousness trait often start early?

Figure 3 Sample Computer User Log Analysis



Another novelty of this research is the inclusion of both cognitive and personality traits as predicting variables of learning performance in a large scale enterprise system study. Another novelty of the research is the inclusion students from both university located in metropolitan area and in rural area to capture cultural and social influences resulted from business environment awareness, job market, employment opportunities, working status, cultural and ethnicity diversity.

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