THE ROLES OF INTRINSIC AND EXTRINSIC MOTIVATION AND PERCEIVED COMPETENCE IN ENHANCING SYSTEM USE AND PERFORMANCE

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Abstract

This study builds on the extant literature on motivation and information systems by examining the mediating role of intrinsic motivation in the relationship between system type and system use, the moderating role of perceived usefulness in the effect of intrinsic motivation on system use, and the moderating role of perceived competence in the impact of system use on performance. This study manipulates three system types; that is, PATH (Principles Aren’t That Hard), Blackboard, and the traditional paper medium, and measures the participant’s intrinsic motivation, perceived usefulness, perceived competence, system use, and performance. PATH incorporates interest-enhancing features, Blackboard has limited interest-enhancing features, and the traditional paper medium does not have these attributes. A total of 173 undergraduate students enrolled in the introductory financial accounting course participated in this study. The structural equation model results provide support for the hypotheses in the research model. An important contribution of this study is development of an educational computer game, PATH, and inclusion of Blackboard and the traditional paper medium to facilitate comparison of the level of intrinsic motivation associated with each system type. Another contribution is administration of the treatment variable (i.e., system type), measurements of the key constructs, and direct assessment of the participants’ performance in the same experimental setting.

Keywords: Intrinsic motivation, Perceived competence, Perceived usefulness, Educational game features, System type, System use, Performance.
1. INTRODUCTION

A National Summit on Educational Games investigates the features of computer games to be incorporated into the U.S. education system and concludes that powerful features of computer games can improve learning and enhance the quality of education. Although previous studies have indicated the beneficial effect of educational computer games on learning performance in various domains including the business field such as strategic management (e.g., Vandercruysse et al. 2012; Wolfe 1997; Wouters et al. 2009; Pasin & Giroux 2011), the findings have not been consistent (Leemkuil & De Jong 2012). An extensive analysis indicates the absence of instructional design in most game-based learning studies and only about 10 percent of the studies can be considered to be based on learning theory (Wu et al. 2012). Instructional design is a necessary but not sufficient condition for enhanced learning; specifically, learner support in a game-based learning environment is essential for obtaining the beneficial effects of learning (Garris et al. 2002; Knotts & Keys 1997; O'Neil et al. 2005). Computer simulation can act as a platform for enhancing game-based learning (Leemkuil and De Jong 2012). The game-based strategy is more effective at enhancing learning compared to the case-based approach (Wolfe 1997) and the traditional approach where mastery of decision-making ability is essential for solving complex and dynamic problems (Pasin & Giroux 2011). However, the evidence on assessment of business games is primarily anecdotal, descriptive or judgmental (Bell et al. 2008; Salas et al. 2009). Thus, empirical studies are needed to assist the formation of meaningful conclusions on the positive influence of educational computer games on performance.

Empirical evidence is needed to assist the design of effective games to obtain positive educational objectives and outcomes (De Freitas 2006). Increased efforts have been directed at exploring advantageous game features such as fantasy, interactivity, and sensory stimuli of value to education (Law & Sun 2012). The present study builds on previous research by designing a computer game named Principles Aren’t That Hard (PATH) to facilitate learning of complex abstract accounting concepts which requires higher order cognition, an area where empirical work is scarce. The current study includes Blackboard and the traditional paper medium as additional system types for comparison purposes. Specifically, system type is a treatment condition. This experimental treatment is necessary for measuring the level of intrinsic motivation associated with each system type. We propose and test a research model that investigates (1) the mediating effect of intrinsic motivation in the relationship between system type (i.e., PATH, Blackboard or the traditional paper medium) and system use, (2) the moderating role of perceived usefulness in the effect of intrinsic motivation on system use, and (3) the moderating role of perceived competence in the impact of system use on performance.

Intrinsically motivated individuals perform a task or activity out of interest and enjoyment (Deci & Ryan 1985), and this engagement is likely to be sustainable (Deci & Ryan 2000). A unique characteristic of educational computer games is sustainability of user attention and acquisition of essential information for fulfilling the objectives of learning. Interesting-enhancing features facilitate intrinsic motivation which increase user engagement in and sustainability of system use. PATH, an educational computer game approach, incorporates interest-enhancing features such as interesting computer simulation, enhanced user-computer interaction, appealing interface design, and immediate system feedback (available in certain PATH modules). Hence, intrinsic motivation is predicted to be highest for PATH users. Blackboard, a widely used tool, has limited interest-enhancing features compared to PATH. In particular, Blackboard does not have an educational game context or simulation for facilitating user-system interaction. Thus, the intrinsic motivation of Blackboard users is expected to be lower than that of PATH users. Further, since the linear presentation format of the traditional paper method lacks interest-enhancing features, intrinsic motivation is predicted to be lowest for this group of users.

Despite the importance of interesting educational game features in promoting learning of technical materials such as accounting, it is imperative that researchers and practitioners recognize that the purpose of educational computer games is to focus on instruction rather than entertainment. Therefore, educational computer games should be designed to obtain desirable learning outcomes and specific learning goals. An
educational computer game is not a transformation of an entertainment game or the traditional paper medium. Instead, educational computer games should entail educational value with an appropriate level of fun to motivate increased engagement in the games (De Freitas 2006). The value perceived in the educational computer games (i.e., perceived usefulness) is another determining factor of system use, an important construct that has received extensive attention in previous research (Saadé & Bahli 2005; Johnson et al. 2008). In addition, consistent with Davis et al. (1992), this study examines perceived usefulness as a type of extrinsic motivation which affects the strength of intrinsic motivation on system use. Further, the inconsistent findings of previous research (e.g., Hou 2012; Leemkuil & DeJong 2012; Szajna 1993) suggest that system use may not necessarily lead to positive learning outcomes. The current study provides insight into the contradictory results by identifying perceived competence as a moderator which influences the strength of system use on performance.

A total of 173 undergraduate students enrolled in the introductory financial accounting course participated in this study. They completed their homework using PATH, Blackboard, or the traditional paper medium. The experiment spanned an entire semester. Since this study proposes and tests a research model, structural equation modeling (SEM) is used to test the hypotheses. The results provide support for the hypotheses in the research model.

This study contributes to the extant literature on intrinsic motivation, system use, and performance. Specifically, the present study identifies intrinsic motivation as a significant factor where engagement in and increased usage of an educational computer system such as PATH is necessary for obtaining the benefits of this game-based learning strategy. PATH includes an instructional design which focuses on the educational game context for facilitating learning of technical materials. In an experimental setting, we measure the participants’ intrinsic motivation pertaining to each system type; namely, PATH, Blackboard and the traditional paper medium. This approach facilitates the formation of meaningful inferences on the level of intrinsic motivation associated with each system type. Further, the extant literature has investigated the positive impact of perceived usefulness on system use (e.g., Saadé & Bahli 2005; Johnson et al. 2008). This study extends previous research by examining perceived usefulness as a form of extrinsic motivation which interacts with intrinsic motivation to exert a positive effect on system use. The present study illustrates a situation where intrinsic motivation is not undermined by extrinsic motivation due to the positive information content inherent in the perceived usefulness construct which increases system use. In addition, perceived competence has been proposed as a process variable or mediator in prior motivation studies (e.g., Elliot & Harackiewicz 1994; Harackiewicz & Elliot 1993, 1998; Harackiewicz & Larsen 1986). The current study builds on previous motivation research by examining perceived competence as a moderator which affects the strength of system use on performance. Specifically, the moderating effect of perceived competence may shed light on the inconsistent results reported in prior research on the impact of system use on performance.

The next section explains the theory that leads to the hypotheses. The following two sections address the experimental approach for testing the hypotheses and the results respectively. Finally, the implications of this study and suggestions for future research are discussed.

2. THEORY AND HYPOTHESES

2.1 Educational Computer Games-PATH

Computer games and simulations assist users to develop abilities, master a new skill, accomplish a challenging activity, and understand learning materials (Meece et al. 2006). Computer games also improve decision-making and problem-solving skills (Wolf 1972) and provide training for reasoning algorithms (von Ahn & Dabbish 2008). Researchers and practitioners are exploring advantageous features of computer games and simulations for education purpose (Law & Sun 2012). For example, Civilization, a computer game on how world civilizations develop and grow, has been used to teach history,
geography, science, arts, etc. in classrooms around the world. Teachers have also used SimCity, a city planning computer game, to reinforce concepts relating to physics (Kirriemuir & McFarlane 2003). In addition, computer simulation can be introduced in introductory courses to enhance learning of basic concepts and to reinforce skills in upper-level courses (Butler et al. 1979).

A review of the literature identifies the following game features: fantasy, goals, sensory stimuli, challenge, and control (Garris et al. 2002). These features are of educational interest because they are more engaging and immersive than the traditional paper format. Instructional content embedded in fantasy contexts promotes student interest and learning (Cordova & Lepper 1996). Fantasies facilitate focused attention and self-absorption when users are immersed in the games (Garris et al. 2002). Sound effects, dynamic graphics, and other sensory stimuli enhance fantasy and attention (Malone & Lepper 1987; Garris et al. 2002). For example, students choose to return to practice activities that include dynamic graphics (Rieber 1991). User-friendly interface and simulation also increase user interaction and cognitive processing, resulting in enhanced learning (Bryant & Hunton 2000). Sensory stimuli can be used effectively as feedback for performance (Malone 1980; Wilson et al. 2009). Performance feedback and score keeping enable one to track progress toward desired goals (Garris et al. 2002). Challenging features such as scores and reward (e.g., bonus questions and the concept of “lives”) reinforce positive behavior. Empirical studies reveal that challenge is associated with improved performance (Keller & Bless 2008). Hence, goals are meaningful when activities are linked to valued personal competencies, embedded in absorbing fantasy scenarios, or facilitated via competitive motivations. Specifically, embedding activities in fantasy contexts allows one to encounter imaginary situations that differ from our knowledge of how things work in the real world which stimulates curiosity (Garris et al. 2002).

This study designs an educational computer game, PATH, which incorporates game and simulation features to promote motivation for learning, cognitive and affective learning, and interactivity (O’Neil et al. 2005). Users can also progress through the PATH modules at their own pace, leading to increased perception of autonomy. The intangible reward systems (e.g., bonus questions and the concept of lives) as well as challenging features embedded in PATH are postulated to enhance learning and performance. Challenging features that facilitates objective outcomes and performance feedback help students to interpret their success in achievement situations (Meece et al. 2006). Further, the explanation and/or performance feedback incorporated into PATH assists users to monitor their progress and promote positive attitude toward learning. Immediate scoring also communicates specific goals and current performance which facilitate commitment and self-improvement (Locke & Latham 1990). When performance is below desired goals, individuals respond to the feedback-standard discrepancy by increasing their effort to attain the standard (Garris et al. 2002).

2.2 The Mediating Role of Intrinsic Motivation

Intrinsic motivation pertains to performance of an activity for the sake of pleasure and satisfaction inherent in the activity itself (Deci 1971; Deci & Ryan 1985). When individuals are intrinsically motivated, they are willing to devote effort because of the interest and enjoyment derived from engagement in an activity (Ryan & Deci 2000). Thus, intrinsic motivation exerts a more powerful and sustainable influence on individual behavior than external rewards (Deci & Ryan 2000). This study predicts that use of a particular system type; that is, PATH, Blackboard or the traditional paper medium creates different levels of intrinsic motivation. Specifically, PATH users are expected to exhibit the highest intrinsic motivation followed by Blackboard and the traditional medium users. PATH comprises interest-enhancing features such as computer simulation, interactivity, and appealing interface design. In contrast, Blackboard has limited interest-enhancing features while the traditional paper medium lacks interest-enhancing features. The interactivity embedded in PATH has a positive influence on individuals’

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1 Interactivity is defined as a characteristic that allows individuals to adjust the instruction to conform to their needs and capabilities (Weller 1988). Interactive systems provide a variety of features of user control; the most common is
attitude toward the learning content because this favorable format for imparting knowledge increases user control and motivation (Kettanurak et al. 2001). An interactive learning environment enhances satisfaction (Liaw & Huang 2013).

Information systems research has investigated the pivotal role of intrinsic motivation in system usage (e.g., Davis et al. 1992; Malone 1981a, 1981b, Webster & Martocchio 1992; Venkatesh & Speier 1999, 2000; Venkatesh 2000). Motivation theory has also been adapted extensively to fit specific contexts to promote understanding of adoption and use of technology (e.g., Davis et al. 1992; Venkatesh & Speier 1999). Interfaces that reduce cognitive effort or incorporate a certain degree of challenge promote the level of interest in a task which enhances system usage (Pilke 2004). Previous research has also explored levers such as autonomous job design and socialization tactics to enhance intrinsic motivation to increase system usage (Ke et al. 2013). Consistent with prior research (e.g., Deci 1975; Venkatesh 2000), this study postulates that intrinsic motivation has a positive impact on system usage. The expected positive relationships between system type (i.e., PATH, Blackboard, or the traditional paper medium) and intrinsic motivation, and between intrinsic motivation and system usage suggest the presence of a mediating effect of intrinsic motivation in the relationship between system type and system use. This leads to the first hypothesis as follows:

H1: Intrinsic motivation mediates the effect of system type on system use.

2.3 The Moderating Role of Perceived Usefulness

Perceived usefulness refers to the belief that use of a system or technology will enhance one’s performance (Davis 1989). Previous research has reported a positive relationship between perceived usefulness and system use (Saadé & Bahli 2005; Johnson et al. 2008). Technology can add value to users by expanding the quality or quantity of information, and allowing users to manage and control their learning process by taking advantage of the technology’s increased flexibility and convenience in learning (i.e., technology removes the constraints associated with time and place) (Johnson et al. 2008). Enhanced learning ensues when users have greater control over the pace, flow, and interaction with a system (Wydra 1980; Johnson et al. 2008). A meta-analysis concludes that training transfer occurs when one perceives value in the training activity (Alliger et al. 1997). Users are also likely to use technology when they see the value of such usage; that is, enhanced learning and increased control over the learning process (Hornik et al. 2007).

Perceived usefulness is considered as a type of extrinsic motivation (Davis et al. 1992). Motivation theory suggests that human behaviors are driven by both intrinsic motivation and extrinsic motivation, and extrinsic motivation can either facilitate or undermine the effect of intrinsic motivation on individual behavior (Ryan & Deci 2000). When people are rewarded for the performance of an interesting activity, they exhibit less interest in and willingness to work on the same activity upon termination of the reward compared to those who had participated in the activity without any reward (Deci & Ryan 1987). Deci and Ryan (1980) define this phenomenon as the undermining effect, and contend that this occurs when rewards are expected (Lepper et al. 1973), salient (Ross 1975), and contingent on task engagement (Ryan et al. 1983). Prior motivation studies reveal that participants consider material rewards (Deci, 1971, 1972), threats of punishment (Deci & Cascio 1972), evaluations (Smith 1974), deadlines (Amabile et al. 1976), imposed goals (Mossholder 1980), and good player awards (Lepper et al. 1973) as factors with a controlling function that undermine intrinsic motivation. Although one’s intrinsic task interest may be debilitated by the prospect of reward during task performance, this effect may be offset by enhanced performance motivated by the expectation of reward (Deci & Ryan 1985b). While extrinsic rewards may debilitate intrinsic motivation when the controlling aspect of the evaluative contingencies is elicited,
extrinsic incentives can promote intrinsic motivation when the evaluative outcome provides competency information to the user (Harackiewicz et al. 1984).

The extant literature has examined the impact of perceived usefulness on system use (e.g., Adams et al. 1992; Davis 1989; Hendrickson et al. 1993; Segars & Grover 1993; Subramanian 1994; Szajna 1994). The present study is different from prior research in that we examine the moderating role of perceived usefulness in the relationship between intrinsic motivation and system use. Specifically, this study provides insight into how higher (lower) perceived usefulness will strengthen (weaken) the positive impact of intrinsic motivation on system use. Thus,

H2: The effect of intrinsic motivation on system use is stronger when perceived usefulness is higher than lower.

2.4 The Moderating Role of Perceived Competence

Despite the advantages of educational computer games in enhancing learning, the literature is equivocal on the relationship between system use and learning outcome (Leemkuil & DeJong 2012). In addition, while some studies report a positive effect of system use on individual performance (Doll & Torkzadeh 1998; Goodhue & Thompson 1995; Igbaria & Tan 1997; Liedner & Elam 1993; Doll & Torkzadeh 1990; Hou 2012), other studies find a negative impact (Pentland 1989; Szajna 1993) or an insignificant effect (Gelderman 1998; Lucas & Spitler 1999) of system use on performance. The current study attempts to provide insight into the contradictory results of system use on performance by identifying perceived competence as a moderator that strengthens this relationship.

Perceived competence refers to feelings or perceptions of competence with respect to an activity or domain (Deci & Ryan 1980; 1985). The extant intrinsic motivation research has demonstrated perceived competence as an important process variable (Bandura & Schunk 1981; Elliot & Harackiewicz 1994; Harackiewicz & Elliot 1993, 1998; Harackiewicz & Larsen 1986; Harackiewicz et al. 1984; Harackiewicz et al. 1985; Manderlink & Harackiewicz 1984; Reeve & Deci 1996; Sansone 1986, 1989; Sansone et al. 1989). Prior research also suggests that perceived competence is a mediator of intrinsic motivation (Bandura 1982; Deci & Ryan 1980; Harackiewicz & Sansone 1991) which exerts an enhancing and sustaining influence on interest/enjoyment (Elliot et al. 2000).

In school-setting educational research, perceived competence is a significant predictor of domain-specific academic performance, after controlling for achievement test scores (Miserandino 1996). When competence or autonomy is perceived as unfulfilled, participants report negative affect and withdrawal behavior; consequently, their performance is impaired (Miserandino 1996). Previous studies also report a positive relationship between the level of task performance and perceived competence regardless of the presence of external rewards (Arnold 1985). Since individuals are intrinsically motivated when they believe they are able to perform well in a task (Harackiewicz et al. 1985), perceived competence plays a significant role in individual performance, especially when the learning materials are challenging.

In the context of course materials-mediated computer technology, it is essential that individuals acquire knowledge, comfort, and confidence so that technology can be leveraged for maximum benefit (Bandura 1997; Johnson et al. 2008). Perceived competence enhances goal attainments and provides individuals with a sense of need satisfaction from engagement in an activity which they feel competent at (Deci & Ryan 2000).

While prior motivation research has examined perceived competence as a process or mediator of intrinsic motivation, this study promotes understanding of the moderating role of perceived competence in the effect of system use on performance. Specifically, the present study contends that participants will increase usage of the system when their perceived competence at using the system is enhanced, leading to improved performance. The moderating impact of perceived competence may provide insight into the
inconsistent findings on the relationship between system use and performance. The final hypothesis is formally stated as follows:

H3: The effect of system use on performance is stronger when perceived competence is higher than lower.

3. EXPERIMENTAL METHOD
3.1 Participants
A total of 173 participants enrolled in four sections of the financial accounting course at a university participated in the study. Students in two sections (87) of the course used PATH while the remaining two sections used Blackboard (46) and the traditional paper medium (40) respectively to complete their homework. About 72 percent of the participants were females and their average age was 20.

3.2 Procedures
The experiment entailed a longitudinal study that spanned an entire semester. The experiment involved homework materials provided to participants via the following systems: PATH, Blackboard, or the traditional medium (i.e., paper). The PATH group received a CD containing 10 modules of PATH (i.e., the 10 homework assignments) during the first day of class. The Blackboard group accessed the homework assignments via Blackboard. The homework assignments were in the format of multiple-choice questions. All the questions were programmed in a database on Blackboard. At the end of each homework assignment, Blackboard showed the correct answers, incorrect answers and explanations. The paper group received the homework assignments (in the form of multiple-choice questions) from the instructor in class.

One of the authors administered the experiment during the semester. The experiment started with several tasks on the first day of class. Except for the homework section, participants received the same syllabus. The instructor informed the participants that the purpose of the study was to examine how students learned the course materials. The instructor also assured the participants that the study would not affect their work during the semester. Participants were told that all the consent forms would be kept in a sealed envelope and analysis of the data would not commence until after all the final course grades had been submitted. Participants then completed a 10-item questionnaire that assessed their prior knowledge in accounting. Finally, they completed a questionnaire that collected data on their computer proficiency, demographic information, and questions pertaining to their interest in accounting and prior exposure to PATH. Participants who were absent during the first day of class were given the materials at the start of the next class and requested to complete the questionnaires outside the classroom. This procedure was necessary to ensure that the participants understand and complete the required materials before they received their first instruction. During the last day of class, participants completed the intrinsic motivation, perceived usefulness, and perceived competence scales. They also responded to questions on the course, instructor, interest in accounting, and intention to major in accounting. The questionnaire was similar for all participants, except for the wordings of the type of delivery systems (i.e., PATH, Blackboard or paper) that they used to complete their homework.

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2 The ANOVA results show that prior accounting knowledge, interest in accounting, and intention to major in accounting are comparable across the treatment groups prior to the experiment.
3 As discussed later, this study employs SEM to test the hypotheses. SEM does not make distributional assumptions about exogenous (i.e., independent) variables (Kline 2005). Thus, the unequal sample sizes in the three treatment conditions do not affect the SEM results.
4 Gender does not have any effect on the results.
4. DATA ANALYSIS

4.1 Constructs

The Intrinsic Motivation Inventory (IMI) has been used in several studies (e.g., Ryan 1982; Ryan et al. 1983; Plant & Ryan 1985; Ryan et al. 1990; Ryan et al. 1991; Deci et al. 1994). We modified the interest/enjoyment, perceived usefulness, and perceived competence subscales (developed by Deci, Ryan and colleagues) to fit the context of our study. Deci, Ryan, and colleagues consider the interest/enjoyment scale as a self-report measure of intrinsic motivation and the only scale that assesses intrinsic motivation (http://www.selfdeterminationtheory.org/questionnaires/10-questionnaires/50). Consistent with this reasoning process, this study uses the interest/enjoyment as a self-report measure of intrinsic motivation.

The treatment variable, system type, refers to PATH, Blackboard, or the traditional paper medium. System use pertains to the participants’ reported usage of their respective system to complete the homework. Performance, an observed variable, is measured by each participant’s score (ranging from zero to 10) on questions that assessed their competency in the course materials after usage of their respective systems.

4.2 Results

Structural equation modeling (SEM) is employed to test the hypotheses proposed in the research model. SEM is particularly useful when the theoretical model involves relationships among the latent constructs and relationships between the latent constructs and the indicators of these constructs (Edwards & Bagozzi 2000). SEM does not make distributional assumptions about exogenous (i.e., independent) variables (Kline 2005). Thus, the unequal sample sizes in the three treatment conditions (i.e., PATH, Blackboard and paper) do not affect the SEM results. The research model comprises three latent constructs; namely, intrinsic motivation, perceived usefulness, and perceived competence. System type, system use, and performance are manifest variables. The descriptive statistics as well as the Cronbach’s alpha reliability results for the three latent constructs are presented in Table 1.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Scale End-points</th>
<th>Means (Std Dev)</th>
<th>Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intrinsic Motivation (Cronbach’s alpha=0.924)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IM1 While I was using (PATH, Blackboard or paper) to do homework, I was thinking about how much I enjoyed it</td>
<td>- not at all true - very true</td>
<td>2.96 (1.57)</td>
<td>0.724</td>
</tr>
<tr>
<td>IM2 I found using (PATH, Blackboard or paper) to do homework very interesting.</td>
<td>- not at all true - very true</td>
<td>4.12 (1.73)</td>
<td>0.858</td>
</tr>
<tr>
<td>IM3 Using (PATH, Blackboard or paper) to do homework was fun.</td>
<td>- not at all true - very true</td>
<td>3.35 (1.82)</td>
<td>0.815</td>
</tr>
<tr>
<td>IM4 I enjoyed very much using (PATH, Blackboard or paper) to do homework.</td>
<td>- not at all true - very true</td>
<td>3.86 (1.82)</td>
<td>0.783</td>
</tr>
<tr>
<td>IM5 I thought it was very boring to use (PATH, Blackboard or paper) to do homework.</td>
<td>- not at all true - very true</td>
<td>4.40 (1.62)</td>
<td>0.542</td>
</tr>
<tr>
<td>IM6 I thought using (PATH, Blackboard or paper) to do homework was very interesting.</td>
<td>- not at all true - very true</td>
<td>3.99 (1.52)</td>
<td>0.812</td>
</tr>
<tr>
<td>IM7 I would describe using (PATH, Blackboard or paper) to do</td>
<td>- not at all true</td>
<td>3.49</td>
<td>0.922</td>
</tr>
</tbody>
</table>

5 A latent construct is a theoretical construct measured by multiple indicators. A latent construct cannot be measured directly.

6 A manifest (observed) variable can be observed directly; therefore, it does not behave like an indicator of a latent construct.
Perceived Usefulness (Cronbach’s alpha=0.850)

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
<th>Mean (SD)</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU1 I believe that using (PATH, Blackboard or paper) to do homework was of some value to me.</td>
<td>not at all true</td>
<td>5.78 (1.25)</td>
<td>0.683</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU2 I think that using (PATH, Blackboard or paper) to do homework is useful.</td>
<td>not at all true</td>
<td>5.65 (1.32)</td>
<td>0.801</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU3 I think using (PATH, Blackboard or paper) to do homework is important.</td>
<td>not at all true</td>
<td>5.20 (1.46)</td>
<td>0.645</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
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<tr>
<td>PU4 I would be willing to use (PATH, Blackboard or paper) to do homework again because it has some value to me.</td>
<td>not at all true</td>
<td>5.17 (1.64)</td>
<td>0.547</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU5 I think that using (PATH, Blackboard or paper) to do homework is helpful.</td>
<td>not at all true</td>
<td>5.54 (1.38)</td>
<td>0.717</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU6 I believe that using (PATH, Blackboard or paper) to do homework could be beneficial to me.</td>
<td>not at all true</td>
<td>5.53 (1.31)</td>
<td>0.723</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
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</table>

Perceived Competence (Cronbach’s alpha=0.839)

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
<th>Mean (SD)</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1 I think I am pretty good at using (PATH, Blackboard or paper) to do homework.</td>
<td>not at all true</td>
<td>5.90 (1.28)</td>
<td>0.626</td>
</tr>
<tr>
<td></td>
<td>very true</td>
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<tr>
<td>PC2 I think I did pretty well at using (PATH, Blackboard or paper) to do homework, compared to other students.</td>
<td>not at all true</td>
<td>4.55 (1.44)</td>
<td>0.664</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC3 I am satisfied with my performance at using (PATH, Blackboard or paper) to do homework.</td>
<td>not at all true</td>
<td>5.18 (1.69)</td>
<td>0.712</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC4 I felt pretty skilled at using (PATH, Blackboard or paper) to do homework.</td>
<td>not at all true</td>
<td>4.91 (1.42)</td>
<td>0.897</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC5 After using (PATH, Blackboard or paper) to do homework for a while, I felt pretty competent.</td>
<td>not at all true</td>
<td>5.26 (1.43)</td>
<td>0.681</td>
</tr>
<tr>
<td></td>
<td>very true</td>
<td></td>
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</tbody>
</table>

Table 1: Scales and Descriptive Statistics

The SEM test involves two steps; namely, the measurement model and structural model. The measurement model examines the relationships among the latent constructs and the indicators of these constructs. The structural model tests the hypothesized relationships among the latent constructs as well as the relationships among the latent constructs and other manifest variables. A valid and reliable measurement model provides assurance of the validity of the relationships indicated in the structural model.

The Mplus Version 7.0 software recommended by Muthen and Muthen (2007) is used to test the SEM models in this study. The measurement model can be evaluated by testing the measures of each construct individually or testing the measures of all the constructs simultaneously (Cheng 2001). The second approach is preferred by researchers because discriminant validity (correlations among the indicators of different constructs) as well as convergent validity can be statistically tested in the model. Thus, confirmatory factor analysis is performed with the three latent constructs and their measures (i.e., indicators). Further, inter-correlations among the latent constructs are allowed (Cheng 2001). Mplus provides model fit indices to measure the validity and reliability of the model. The model fit indices (CFI=0.960, RMSEA=0.058, SRMR=0.069) reveal a good model fit for the measurement model (with the three latent constructs and their measures). As illustrated in table 1 above, the factor loadings of the three latent constructs (i.e., intrinsic motivation, perceived usefulness, and perceived competence) are sufficiently high and statistically significant (p=0.000). Prior research has suggested various cut-offs for factor loadings starting from 0.4 regardless of sample size (Stevens 1992) to more stringent cut-offs treating 0.32 as poor, 0.45 as fair, 0.55 as good, 0.63 as very good, and 0.71 as excellent (Comrey & Lee 1992; Tabachnick & Fidell 2007). Previous studies also indicate that a reliable factor has four or more
factor loadings of 0.6 or above, regardless of sample size (Field 2005, Guadagnoli & Velicer 1988). Rules of thumb are present to evaluate the practical significance of standardized loadings with lower cut-off values for a large sample size; that is, 0.5 for a sample size of 120, and 0.45 for a sample size of 150 (Hair et al. 1998). Nevertheless, each of the three latent construct in Figure 2 has four or more factor loadings above 0.6 and all the factor loadings are above 0.542 for the given sample size of 173. Hence, the results demonstrate a highly reliable measurement model and assure the quality of the subsequent structural model.

Next, the structural model is tested. The model fit indices (i.e., CFI, RMSEA and SRMR) are not available because the model involves an interaction between a latent variable and a manifest variable. Hence, the model fit for the structural model is assessed by comparing the Akaike information criterion (AIC) and Bayesian information criterion (BIC) values of the model with and the model without the latent interaction term. Specifically, smaller AIC and BIC values indicate a better model fit (Burnham & Anderson 2004). The fit indices for the model without the interaction term (CFI=0.957; RMSEA=0.050; SRMR=0.074) suggest a good model fit. In addition, the model with the interaction term (i.e., the structural model) has smaller AIC and BIC values\(^7\), indicating a better model fit. Thus, the structural model meets the requirement of a good model fit.

![Figure 1: Model Results](image_url)

The hypothesized relationships in the structural model are evaluated and the results are shown in Figure 1. Hypothesis 1 proposes that intrinsic motivation mediates the effect of system type on system use. This mediation effect is tested using the SEM indirect effect function. Specifically, an indirect effect tests the mediating effect of one or more variables on the relationship between two variables (Weston & Gore 2006). A full mediating effect is obtained when the relationship between two variables (i.e., direct effect) is not significant in the presence of the significant indirect effect. A partial mediator is present when both the direct and indirect effects remain significant. This indirect effect method is consistent with the theoretical logic of Baron and Kenney’s (1986) three-step process. As depicted in Figure 1, the path from system type to intrinsic motivation is significant (coefficient=0.645, p=0.000). The link from intrinsic motivation to system use is also significant (coefficient=0.290, p=0.012). Further, the indirect effect of system type on system use via intrinsic motivation is significant (coefficient=0.187, p=0.015), indicating the mediating role of intrinsic motivation, while the direct effect still remains significant.

\(^7\) The AIC and BIC values for the model with (without) the interaction term is 9350.397 (9744.405) and 9595.053 (9999.321).
(coefficient=0.224, p=0.027). These results suggest the partial mediating effect of intrinsic motivation on the relationship between system type and system use; hence, hypothesis 1 is supported.

Hypothesis 2 posits that perceived usefulness moderates the effect of intrinsic motivation on system use. This hypothesis is supported by the significant positive interaction effect of intrinsic motivation and perceived usefulness on system use (coefficient=0.244, p=0.003). Specifically, the impact of intrinsic motivation on system use is stronger when perceived usefulness is higher than lower. Hypothesis 3 states that perceived competence moderates the effect of system use on performance. This hypothesis is also supported by the significant positive interaction effect of system use and perceived competence on performance (coefficient=0.184, p=0.000). The results suggest that the impact of system use on performance is stronger when perceived competence is higher than lower.

4.3 Additional Analysis

A supplementary analysis is performed by including the participants’ demographic information such as age, gender, school year, GPA, and their pretest performance as covariates in the research model. These variables do not have a significant effect (untabulated) on the results of the research model.

The participants’ performance prior to (i.e., pretest) and after (i.e., posttest, the measure of performance in the current study) usage of the systems are compared and the t-test results reveal that posttest performance (mean of 5.85) is significantly (p=0.000) higher than pretest (mean of 1.07), indicating an overall positive learning effect from pretest to posttest. In addition, pretest performance does not vary significantly among the three treatment groups of PATH, Blackboard and the traditional medium (F=0.087; p=0.971; means of 1.06, 1.13, and 1.03 respectively). This result further suggests that pretest performance does not have a significant influence on the overall model results.

The planned contrast comparison results show that the PATH group exhibits the highest intrinsic motivation (mean of 4.54). The average intrinsic motivation score of PATH users is 1.13 (p=0.000) higher than the average intrinsic motivation score of Blackboard users, and 1.99 (p=0.000) higher than the average intrinsic motivation score of the traditional paper users. The average intrinsic motivation score for the Blackboard users is 0.86 (p=0.001) higher than the average intrinsic motivation score of the traditional paper users.

Further analysis reveals a positive effect of intrinsic motivation on the participants’ evaluation of the instructor (p=0.000), perceived competence for learning (p=0.000), and understanding of the materials (p=0.000). Additional analysis indicates a significant positive effect of intrinsic motivation on interest in accounting (p=0.000) and intention to major in accounting (p=0.013). The findings also suggest that interest in accounting has a significant effect on intention to major in accounting (p=0.000).

5. DISCUSSION

The present study manipulates the system types; measures intrinsic motivation, perceived usefulness, and perceived competence; and assesses the participants’ performance directly in a longitudinal experimental study spanning an entire semester. A significant contribution of this study is development of an educational computer game, PATH, which comprises an instructional design that enhances intrinsic motivation. The features of PATH are designed to promote positive learning experience by assisting students to master technical (accounting) materials. Motivational features of computer games are incorporated into PATH to deliver materials in an interactive, fun, engaging, and challenging manner to stimulate interest in learning (Garris et al. 2002). Students engage in active interaction with the computerized tutorial, exercise control of receipt of feedback from the program, and

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8 The participants’ scores on questions that assessed their competency in the course materials were measured before the study (i.e., pretest performance) and after the study (i.e., posttest performance).
learn at their own pace. PATH incorporates game attributes for enhancing intrinsic motivation with positive effects on attitudinal outcomes such as evaluation of the instructor, perceived competence for learning, understanding of the materials, interest in accounting, and intention to major in accounting. For comparison purposes, we include two additional system types; that is, Blackboard and the traditional paper medium, to provide additional insight into the findings. The results support our contention that the interest-enhancing features in PATH lead to the highest level of intrinsic motivation relative to Blackboard and traditional paper users. The limited interest-enhancing features in Blackboard enable these users to experience a higher level of intrinsic motivation than the traditional paper users. The traditional medium users exhibit the lowest level of intrinsic motivation because of the uninteresting, inflexible, and linear format of the paper format.

The results reveal that intrinsic motivation partially mediates the effect of system type on system use, demonstrating the important role of intrinsic motivation in explaining how system type influences system use. The findings also indicate that the effect of intrinsic motivation on system use is stronger when perceived usefulness is higher than lower. When users perceive a system to be useful for attaining their goals, this form of extrinsic motivation facilitates rather than debilitates intrinsic motivation which further enhances system use. Additionally, the results suggest that the impact of system use on performance is stronger when perceived competence is higher than lower. This study’s identification of perceived competence as a moderator provides some insight into the inconsistent findings reported in previous research on the effect of system use on performance. Finally, an important contribution of this study is use of an objective outcome measure. Specifically, performance is measured by each participant’s total number of correct answers to questions on the content materials.

**Implications, Limitations, and Suggestions for Future Research**

This study helps educators understand the benefits of delivering materials in a creative and motivation-enhancing manner to promote learning and performance. Researchers can develop effective strategies to help students learn materials that they frequently perceive as boring and difficult. Designers can also incorporate motivational and creativity-enhancing features into systems to satisfy the users’ needs for these activities (Selker 2005). Further, human-computer-interaction research recognizes the importance of enjoyment and fun in user interfaces (Shneiderman 2004). Interface designs that facilitate high quality human-computer interaction are crucial for sustaining the individuals’ interest in the materials and facilitating their learning process. Indeed, enhancing flow (i.e., optimal user experience) is an important objective of user interface design.

Games evoke a sense of personal control when users can select strategies, manage the direction of an activity, and make decisions that directly affect outcome, even if the actions are not instructionally relevant (Garris, et al. 2002). Future work can examine whether enhanced motivation and learning occur when students are given control over elements of the instructional program (Cordova & Lepper 1996). Future work can also investigate other game attributes that have positive effects on performance. Finally, researchers can help designers understand whether individual attributes influence features to be incorporated into educational computer games which affect learning outcomes.

As for any study, there are limitations in this study. One limitation is use of subjective usability measure; that is, the participants’ reported usage of the media. Subjective usability measures pertain to the user’s perception of or an attitude toward an interface, interaction, or outcome. Objective measures are gathered, discussed, validated, and independent of user perception (Hornbaek 2006). Both subjective and objective usability measures must be examined to ensure that the same conclusions are reached about usability. One prior study conducted a meta-analysis of employee performance and indicated that subjective and objective measures may capture different aspects of performance (Bommer et al. 1995). Future research can gather objective usability data such as actual system usage to determine whether similar findings are obtained.
References


http://www.selfdeterminationtheory.org/questionnaires/10-questionnaires/50.


