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EFFECTS OF INDIVIDUAL DIFFERENCE VARIABLES ON A VIRTUAL COMPANION SYSTEM AS AN ADJUNCT TO AN ECONOMICS COURSE

This study designes a MSN virtual companion to examine how specific application design variables within educational software affect the learning process of verbally oriented learners and visually oriented learners. 90 students participated in an economics course that used MSN virtual companion as an adjunct to classroom instructions. The study considers to what extent the two distinct learning modes affect the learning outcomes of two distinct cognitive styles. Each of the two learning modes available within the virtual companion was designed to conform to specific requirements of verbally and visually oriented learners. The results of this study reveal that a matched mode offers far greater benefits to learners than a non-matched mode.

Keywords: *virtual companion; individual cognitive style; MSN platform; economic course*

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РІЗНИЦЯ В ІНДИВІДУАЛЬНОМУ СПРИЙНЯТТІ СИСТЕМИ ВІРТУАЛЬНОГО СУПРОВОДУ У ВИВЧЕННІ ЕКОНОМІЧНИХ ДИСЦИПЛІН

У статті представлено віртуальний месенджер для оцінки того, як особливості розробки програмного забезпечення у галузі освіти впливають на результати навчального процесу для студентів з домінуючим вербальним або візуальним сприйняттям. Учасники експерименту – 90 студентів-економістів, які використовують месенджер в якості доповнення до аудиторних занять. Виявлено ступінь впливу двох різних способів навчання на результати навчання двох типів студентів – з вербальною та візуальною домінантою. Дана різниця у сприйнятті врахована при розробці двох видів месенджера. Результати дослідження вказують на те, що при співпадінні домінанти сприйняття з відповідним інтерфейсом месенджера ефективність навчання суттєво підвищується.

Ключові слова: *віртуальний супровід навчання; індивідуальні особливості сприйняття; платформа MSN; економічна дисципліна.*

Рис. 2. Табл. 6. Літ. 44.

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РАЗНИЦА ИНДИВИДУАЛЬНЫХ ВОСПРИЯТИЙ СИСТЕМЫ ВИРТУАЛЬНОГО СОПРОВОЖДЕНИЯ В ИЗУЧЕНИИ ЭКОНОМИЧЕСКИХ ДИСЦИПЛИН

В статье представлен виртуальный мессенджер для оценки того, как особенности разработки программного обеспечения в сфере образования влияют на результаты учебного процесса для студентов с доминирующим вербальным или визуальным восприятием. Участники эксперимента – 90 студентов, изучающих экономику, которые используют мессенджер в качестве дополнения к аудиторным занятиям. Исследована степень влияния двух различных способов обучения на результаты обучения двух типов студентов – с вербальной и визуальной доминантой. Данная разница в восприятии у

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студентов учтена при разработке двух видов мессенджера. Результаты исследования указывают на то, что при совпадении доминанты восприятия с соответствующим интерфейсом эффективность обучения существенно повышается.

Ключевые слова: *виртуальное сопровождение обучения; индивидуальные особенности восприятия; платформа MSN; экономическая дисциплина.*

Introduction. There is a growing use of instant message based instructions (IMBI) within e-learning programs. This form of instruction offers many benefits such as higher interest, increased participation in coursework and better outcomes (Du & Li, 2010; Lu, Chiou, Day, Ong, & Hsu, 2006; Lan & Jiang, 2009; Sotillo, 2006). When IMBI is used as a supplement to, instead of a replacement for, traditional education, it is generally more effective (Sotillo, 2006), and the interest in using IMBI is certainly increasing. As a component of an integrated curriculum, the use of IMBI in the instructional process can be a Virtual Companion (VC), which includes individual tutorial practice and testing. For instance, Lu et al. (2006) design a VC based on IMBI by using a chatbot technique for English learner on-line coaching. Lan and Jiang (2009) also designed a VC for improving undergraduate programming courses. Du and Li (2010) designed and made use of an IMBI VC to support an e-learning program.

Based on the above mentioned points, the present work aims to design a VC that incorporates best practices in IMBI development and could function as a prototype for other e-learning programs. However, the focus of those studies is on the VC's conversation ability (Brennan, 2006), rather than on users' different cognitive styles (CS) in e-learning programs. Johnson and Aragon (2003) contend that adherence to a combination of 7 principles is a prerequisite to designing a powerful instructional framework for e-learning. According to their research, the recognition of individual differences has been generally taken into consideration in e-learning. Specific individual differences in learning and instruction include cognitive styles, learning styles, cognitive controls, intelligence etc. (Jonassen & Grabowski, 1993).

To recognize the diversity of individual cognitive differences among learners is to accept that no instructional method is adaptive to the array of CS. Contemporary researchers propose instructors to obtain various teaching skills for online teaching (Brower, 2003; Easton, 2003). Presenting learning materials that disregard learners' needs can, in some circumstances, have a profoundly detrimental effect on the learner's ability and desire to learn. Drummond (2000) believes that ignoring learners' CS is one of the main reasons of the opposite learning effects. Dunn and Dunn (1994) find that teaching methods and material formats adaptive to learners' CS can improve both the students' learning outcomes and their attitude toward learning. A well-designed IMBI system must fit learners' CS to enhance both the efficacy and the satisfaction of the learning experience.

This study uses the chatbot system techniques to develop a VC and ace individual cognitive differences in IMBI environment into consideration. Cognitive theory has introduced a very wide and helpful classification to explain individual cognitive differences. Childers, Houston and Heckler (1985) developed a scale which distinguishes between the processing style of verbally oriented people (VBOP) and that of visually oriented people (VIOP). VBOP prefer and tend to participate in verbal infor-

mation processing. They enjoy work that needs to make use of words. In contrast, people who prefer and tend to engage in visual information processing enjoy a style of mental processing that consists of mental pictures and images. Studies regarding more traditional educational environments have successfully employed this model, but there are inconclusive and, at times, contradictory results from the research that has used this model to study the performance of learners who interact with new technologies to complete a learning task (Dillon & Gabbard, 1998). There is a need for a great deal of research to study different CS of learners and the most beneficial instruction method for each CS.

According to the statistics reported by InsightXplorer Ltd. in March, 2008, the most popular IM system in Taiwan was MSN Messenger which had over 8 mln. users. Since MSN Messenger is very popular (Hsu, 2007; Kinzie, Whitaker, & Hofer, 2005), has a high recognition factor and is easy to use, this paper utilized chatbot techniques based on the MSN Messenger platform to design a VC system. This system was created to provide a learning format ideally adaptive to an individual learner's CS and by extension, improve traditional classroom instructions.

Literature Review

VC system. Chan and Baskin (1998) first suggested that VCs can be a partner to accompany learners in the e-learning environment. In the learning project, a VC plays the part of a third participant. This addition considerably changes the dynamics of the traditional binary relationship which includes only an instructor and a learner. Since VC is Internet based, the knowledge acquisition can be facilitated at any time and from almost any location.

Webb (1982) found that learning outcomes can be increased through supplementary guidance and information sharing among companions. By interacting with VCs, learners become more involved in their learning situation which enhances their concentration, engagement, and attention (Hsu et al., 2007). Without interacting with learning companions in an e-learning environment, learners feel isolated (Hong, 2002) and their sense of learning satisfaction declines (Hiltz & Wellman, 1997; Rovai, 2002; Rovai & Wighting, 2005). Arbaugh (2002) also clarified that the relationship between learning satisfaction and interaction among learners, the instructor and VCs was positively connected. Many studies (El-Bishouty, Ogata & Yano, 2007; Kim & Baylor, 2006) and common sense point out that study goals are easier to reach through encouragement, explanation, interpretation, instruction and demonstration via interactive relationship between learning companions. Although including a VC component in a learning project is not an overriding factor that determines a learner's success, it provides related material and alternative approaches to concepts that might not be offered within classroom due to time constraints. This body of knowledge and support can significantly increase learners' acquisition of knowledge and skills.

Tremendous differences of CS among learners are a fundamental parameter in designing a VC environment. To make the format of a VC system successfully applicable to all learners, there must be more than one method of assistance. Renzulli (1994) suggested that when the instruction format fits the learner's CS, it makes the learner acquire knowledge more easily, enjoy the learning process more and the learner's attitude toward the project will be positively affected (Dunn & Dunn, 1994). Drummond (2000) emphatically stated that offering varied format adaptive to a vari-

ety of CS will not decrease the desired learning outcomes. She and Fisher (2003) discovered that when instruction methods and learners' CS are consistent with each other, the learner's concept of a subject will be influenced by the instruction method more than by any other factor. Apparently, the efficacy of a VC system greatly depends on the choice of numerous formats adaptive to users' CS.

Chatbot system. A chatbot system refers to the software used to chat with users in a written language (Mauldin, 1994).There are various terms used to represent chatbot systems: machine conversation systems, virtual agents and chatterbots. Brennan (2006) proposed the definition of a chatbot system as "an artificial construct that is designed to converse with human beings using natural language as input and output". The goal of a chatbot system is to simulate human conversation; the chatbot architecture provides integration of a language model with computational algorithms to emulate informal communication between a computer and a user. Initially, chatbots were built for fun, and simple keyword matching techniques were used to search a match to a user input, such as ELIZA (Weizenbaum, 1966) and PARRY (Colby, Weber, & Hilf, 1971). In 1970-1980s numerous researches were conducted on the text and natural-language interface before the appearance of graphical user interfaces such as Cliff and Atwell (1987), and Wilensky et al. (1988). Since then, several new chatbot architectures have been developed, such as, ELIZABETH (Abu Shawar & Atwell, 2002), Jabberwacky (Fryer & Carpenter, 2006) and ALICE (2010). As chatbot design became more and more sophisticated, they were adopted and used to support learning. For instance, Fryer and Carpenter (2006) adopted a chatbot for language acquisition and Robin (2007) utilized one to enhance listening comprehension.

Research Method

Experiment system – VC system. VC system is a chatbot system which interacts with others through recognition of certain commands tied to its statistical information gathering or through conversational pattern-matching techniques (Brennan, 2006). VC systems can help instructors provide extra-class assistance to their students. While it is an Internet based program, it is not restricted by location or time. VC systems support students practice by real-time two-way interaction. The design of the program is based on a question and answer format. When a user selects an incorrect answer to a given question, two guidance modes (GM), a verbally oriented guidance mode (VBGM) and a visually oriented guidance mode (VIGM) provided by the VC system, will assist users to find and comprehend the correct answer.

The VBGM supplies information and content related to the incorrectly answered items through a verbally oriented format. As shown in Figure 1, when a learner gives an incorrect answer to a question posed by the VC system (block A), the correct answer will be supplied by the VC system in a verbally oriented format (block B). The VIGM uses a visually oriented format to provide information and content related to the question that was incorrectly answered. The correct answer is provided in the visually oriented format (block C) by the VC system.

Experiment design. This paper utilizes the contents of an economics course as the basis for the instructions, and the results of the students' examination as a measurement tool to discover how learning outcomes are influenced by different GM of the VC system. The experiment included 4 stages. Firstly, students took a prior knowledge test of the economics course (Prior-test) and the questionnaire on styles of process-

ing scales (SPS) to determine their CS. Secondly, students were grouped according to their CS and were then randomly assigned to one of two GM of the VC system. Thirdly, the VC system was introduced to them in the context of their economics course. In class, one instructor delivered the course and the students were required to use the VC system after class. Finally, students were given an examination for the course (Post-exam) and answered a questionnaire regarding the VC system satisfaction levels (VCSL).

Figure 1. **VBGM and VIGM of VC**

The divergent modes of VC system were the independent variable of the study and the learning outcomes (grades of the post-exam and VCSL) were the dependent variables. Although a user's satisfaction with a given system has great effect on their level of success within a given course, there are other results besides satisfaction. By completing the questionnaire, a user's sense of satisfaction or dissatisfaction with the system can be better understood. Within the field of educational information systems there is a sustained and vibrant discussion regarding the use of satisfaction levels to determine the success of these systems (Zviran & Erlich, 2003). Satisfaction was adopted as an integral success measurement by contemporary research on impact of e-learning environments in higher education (Bekele & Menchaca, 2008; Bekele, 2010). The measurement of students' holistic perspective towards their experience of using the VC system is the operational definition of satisfaction for this study. According to the related literature on satisfaction (Sahin & Shelley, 2008; Lin, Huang, Joe, & Ma, 2008), a questionnaire was modified and used in this study to discover the learners' perception of the VC system.

The participants. The experiment subjects were the 90 students in 2 classes who had the economics course. This body consisted of 68.3% male students and 31.7% female ones. At the beginning of the experiment, the study subjects took the SPS to determine their CS. 44 participants were classified as VBOP; 46 participants were classified as VIOP. The subjects in each CS group were then randomly assigned to either the VBGM or the VIGM. The grouping of subjects is shown in Table 1.

Research Results and Discussions

The effect of prior-test. Using the contents of the economics course, a self-developed examination was adopted as a prior-test to determine if the participants' prior knowledge of the given material covered in the economics course was significantly different. One-way ANOVA was used to analyze the prior-test grades to examine if any group had significantly different prior knowledge of the economics course, as shown in Table 1. The results suggest there was no significant difference in the groups' prior knowledge, $F(3,86) = 0.481$, $p = .696$. That is, before participating in the learning activity, the prior economic course knowledge of the students was equivalent.

Table 1. **Descriptive statistics of students' grades in prior-test**

CS	GM of VC	N	Prior-test mean / S.D.	F-value
VBOP	VBGM	22	33.86/7.193	0.481
	VIGM	22	34.36/9.090	
VIOP	VBGM	23	32.17/8.726	
	VIGM	23	32.04/6.951	

Learning outcomes of the post-exam and VCSL. Table 2 shows the descriptive statistics of the students' learning outcomes. To discover how the variables of different GM offered in a VC and the variables of students' CS affect learning outcomes (post-exam and VCSL), this study uses the GM of a VC and CS as independent variables, and adopted learning outcomes as dependent variables to conduct the two-way ANOVA, as shown in Table 3.

Table 2. **Descriptive statistics of the students' learning outcomes**

CS	GM of VC	Post-exam mean / S.D.	VCSL mean / S.D.
VBOP	VBGM	75.73/7.211	3.63/0.485
	VIGM	70.29/9.479	3.37/0.402
VIOP	VBGM	70.08/7.812	3.30/0.362
	VIGM	78.07/9.944	3.35/0.344

Table 3. **Two-way ANOVA of the students' learning outcomes on post-exam and VCSL**

	Post-exam				VCSL			
Source	SS	df	MS	F-value	SS	df	MS	F-value
CS	25.499	1	25.499	0.338	0.249	1	0.249	1.549
GM of VC	36.700	1	36.700	0.486	0.024	1	0.024	0.147
CS × GM of VC	1013.699	1	1013.699	13.418***	1.151	1	1.151	7.173**
Error	6497.050	86	75.547		13.804	86	0.161	

**p < .01. ***p < .001.

As shown in Table 3, the results show that both the main effects of CS on post-exam and VCSL [F(1,86)=0.338, p=.563; F(1,86)=1.549, p=.217] and GM of the VC on the post-exam and VCSL [F(1,86)=0.486, p=.488; F(1,86)=0.147, p=.703] were not statistically significant. There were significant effects of the interaction between CS and GM of the VC on the Post-exam and VCSL [F(1,86)=13.418, p<.001; F(1,86)=7.173, p=.009], and they could also be found at the estimated mar-

ginal means plot in Figure 2. These results illustrate the interactive effect of the CS and GM of VC on learning outcomes.

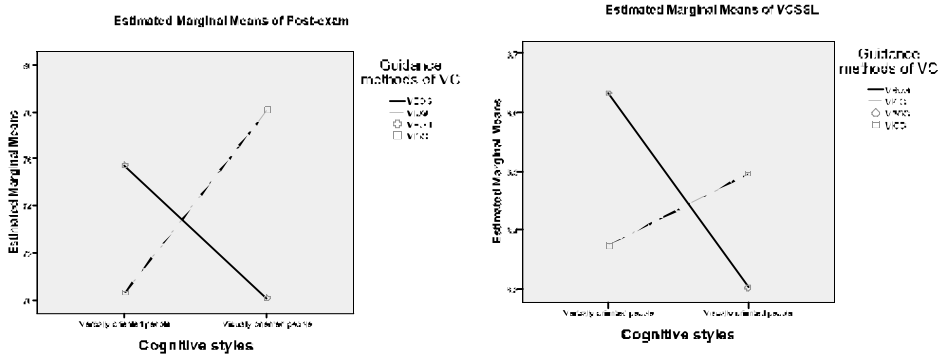

Figure 2. **Means plot of learning outcomes for the interaction between CS and GM of VC**

To discover further the interactive effect between CS and GM of the VC, simple main effect was used as the post-hoc analysis (Weinberg & Abramowitz, 2002), as shown in Tables 4-5. Table 4 illustrates the relationship between GM and CS. Specifically, that when the GM of VC was VBGM, learning outcomes (post-exam and VCSL) of VBOP were higher than those of VIOP [F(1,43)=6.337, p=.016; F(1,43)=6.797, p=.013]. It also illustrates a similar relationship for the other group. Namely, that when the GM was VIGM, learning outcomes (post-exam) of VIOP were higher than those of VBOP [F(1,43)=7.202, p=.010].

Table 4. **Simple main effects of CS at each level of GM of VC**

Learning outcomes	Source	VBOP Marginal Mean/S.E.	VIOP Marginal Mean/S.E.	F-value
Post-exam	CS at VBGM	75.727/1.604	70.078/1.569	6.337*
	CS at VIGM	70.291/2.072	78.070/2.027	7.202*
VCSL	CS at VBGM	3.633/0.091	3.301/0.089	6.797*
	CS at VIGM	3.374/0.080	3.495/0.078	1.184

*p < .05.

As shown in Table 5, the learning outcomes (post-exam) of VBOP in VBGM were also better than in VIGM [F(1,44)=4.584, p=.038]. It also shows that the post-exam of VIOP in VIGM was better than in VBGM [F(1,44)=9.185, p=.004].

Table 5. **Simple main effects of GM of VC at each level of CS**

Learning outcomes	Source	VBGM Marginal Mean/S.E.	VIGM Marginal Mean/S.E.	F-value
Post-exam	GM at VBOP	75.727/1.796	70.291/1.796	4.584*
	GM at VIOP	70.078/1.865	78.070/1.865	9.185**
VCSL	GM at VBOP	3.633/0.095	3.375/0.095	3.712
	GM at VIOP	3.301/0.074	3.495/0.074	3.473

*p < .05. **p < .01.

Learning outcomes of matched /non-matched groups

There are similarities between these results and the findings of Chen, Hsieh and Kinshuk (2008). According to the later, statements regarding the matching principle of CS and GM of VC, the combination of CS and GM of VC was categorized as matched/non-matched groups. Learners in the matched group included VBOP who were guided by using VBGM, and VIOP who were guided by using VIGM. Learners assigned to the non-matched group were VBOP who were guided in VIGM, and VIOP who were guided in VBGM.

As shown in Table 6, this paper used one-way ANOVA to test the learning outcomes of the matched and non-matched group learners. The results show that the learning outcomes of the matched group learners on the post-exam were significantly higher than those of the non-matched group learners [$F(1,88)=13.722$, $p<.001$]. That is, when the CS of learners match with the associated GM, it significantly increases the learner's score in the Post-exam within a VC learning context. The VCSL [$F(1,88)=7.156$, $p=.009$] also illustrated that the learning outcomes of the matched group was significantly better than that of the non-matched group.

Table 6. **Descriptive data and ANOVA of the learning outcomes**

Groups / Learning outcomes	Matched Group		Non-matched Group		F-value
	N	mean / S.D.	N	mean / S.D.	
Post-exam	45	76.92/8.699	45	70.18/8.568	13.722***
VCSL	45	3.56/0.420	45	3.34/0.379	7.156**

**p < .01. ***p < .001.

Conclusion. Technology plays an increasingly prominent role in providing extra-classroom learning assistance. Starting with the suggestion that all learners use different cognitive approaches to gather and comprehend information, and that the scale of verbally oriented versus visually oriented people is one of the most popular classifications of CS, this paper tried to analyze quantitatively the role of multi guidance mode functions in a VC system. In particular, it analyzed if there is a measureable effect on the learners' ability to absorb and comprehend information when they are offered the choice of GM of VBGM and VIGM. Hence, this study aimed to discover further how the design features of a VC influence learning efficacy. The VC system used in this experiment was built specifically for this study and it was also designed to assist learners studying the economics course.

The findings show that learners' learning outcomes increase when the GM of the VC, VBGM or VIGM fits their specific CS. Previous studies based on traditional instruction formats (not Internet-based), such as Dunn and Dunn (1994), also suggested that when the instruction and teaching materials fit learners' individual CS, they can increase the learning outcomes and enhance learners' positive attitude to learning.

The results of this study are unequivocal and parallel to the findings of Meyer (2003) that a successful e-learning environment is greatly associated with learners' CS. Any VC system that tries to efficiently and productively assist learners must identify and combine design features that correspond to certain CS. When learners are provided a learning platform that matches their unique CS, they can obtain more

benefits from a VC system and experience higher levels of satisfaction while using the system. There is some extent of mutual reinforcement between increased comprehension of an offered knowledge set and increased satisfaction in using a VC system. It would follow that this relationship itself generates elevated results. The more comfortable learners experience in using a VC system the more they are likely to make use of it and gain benefits from using the system.

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