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INTEGRATING INFORMATION TECHNOLOGY AND TEACHING BASED ON DIFFUSION OF INNOVATION PERSPECTIVE: THE FAILURE CASE OF VISTA OPERATING SYSTEM

Countries all over the world are actively promoting information technology education and encouraging teachers to integrate information technology into their teaching. However, not all innovative technological products are adopted by consumers as expected. Taking the previous generation of Microsoft's Windows Vista Operating System as example, its product life lasted only 2 years. Therefore, by combining the paradigm of innovation-decision process proposed by Rogers (1995) and technology acceptance model (TAM) proposed by Davis (1989), this research established a decision-making model of teachers using VISTA. The purpose is to understand the crux of why VISTA was unable to become widely adopted as an information technology in teaching. The results indicate that teachers found VISTA low in compatibility, and subsequently regarded the original XP operating system as more advantageous; thereby highlighting their perception that VISTA lacked functionality. Furthermore, the teachers found the installation and operation of VISTA complex and difficult to use.

Keywords: *information technology; diffusion of innovation; technology acceptance model (TAM); VISTA computer operating system; structural equation modeling (SEM).*

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ІНТЕГРУВАННЯ ІНФОРМАЦІЙНИХ СИСТЕМ У ВИКЛАДАННЯ НА ОСНОВІ ПОШИРЕННЯ ІННОВАЦІЙНИХ ПЕРСПЕКТИВ: НА ПРИКЛАДІ НЕВДАЛОГО ФУНКЦІОНУВАННЯ ОПЕРАЦІЙНОЇ СИСТЕМИ VISTA

У статті проаналізовано освіту на основі інформаційних технологій і залучення їх вчителями в освітній процес. Не всі інноваційні технологічні продукти сприймаються споживачами так, як задумано. Наприклад, термін використання попереднього покоління операційної системи Windows — Vista — склав лише 2 роки. Автори розглянули модель ухвалення рішень вчителями відносно Vista на основі комбінації парадигми процесу інноваційного рішення (Роджерс, 1995) і моделі сприйняття технології (Девіс, 1989). Результати показали, що викладачі вважають Vista погано сумісною з іншим програмним забезпеченням і надають перевагу попередній версії Windows XP як більш відповідній потребам у порівнянні з менш функціональною Vista. Крім того, викладачі вважали процес установлення і використання Vista занадто складним.

Ключові слова: *інформаційні технології; поширення інновацій; модель сприйняття технології; операційна система Vista; моделювання структурними рівняннями.*

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ИНТЕГРИРОВАНИЕ ИНФОРМАЦИОННЫХ СИСТЕМ И ПРЕПОДАВАНИЕ НА ОСНОВЕ РАСПРОСТРАНЕНИЯ ИННОВАЦИОННЫХ ПЕРСПЕКТИВ: НА ПРИМЕРЕ НЕУДАЧНОГО ФУНКЦИОНИРОВАНИЯ ОПЕРАЦИОННОЙ СИСТЕМЫ VISTA

В статье проведен анализ образования на основе информационных технологий и привлечения их учителями в образовательный процесс. Не все инновационные технологические продукты воспринимаются потребителями так, как было задумано. Например, срок использования предыдущего поколения операционной системы Windows — Vista — составил только 2 года. Авторы рассмотрели модель принятия решений учителями относительно Vista на основе комбинации парадигмы процесса инновационного решения (Роджерс, 1995) и модели восприятия технологии (Дэвис, 1989). Результаты показали, что преподаватели считают Vista плохо совместимой с другим программным обеспечением и предпочитают предыдущую Windows XP как более отвечающую потребностям по сравнению с менее функциональной Vista. Кроме того, преподаватели посчитали процесс установки и использования Vista слишком сложным и трудным для использования.

Ключевые слова: *информационные технологии; распространение инноваций; модель восприятия технологии; операционная система Vista; моделирование структурными уравнениями.*

Introduction. Information technology become one of the most rapidly developing technologies in the late XX century. It has far-reaching impact on human societies, such as mobile Internet, personal digital assistant (PDA), e-Mall, Internet auctions and shopping, video conferencing, Internet TV, distance learning and e-learning, once again proving the tremendous influence that rapidly developing information technology has on the lives of people.

In order to make information technology a common knowledge, information education or application of information technologies in education has already become an issue of concern in modern education. Since the US President Clinton proposed the National Information Infrastructure: Agenda for Action (NII) in 1993, many countries have hastened to invest in the development of their nation's information education and establishing infrastructure to greet the information technology era. For example, Japan's Information New Deal, Singapore's IT2000, Hong Kong's 5-Year Strategy and Taiwan's Information Education Infrastructure are intended to fully promote information education. As a result, information technology has been gradually introduced in schools. Information technology tools that were provided to teachers characteristically highlight lesson content through diversified methods, and have become indispensable teaching tools. Given the emerging external criteria for integrating information technology into teaching in recent years, in 1997, Pelgrum (2001) conducted a comparative analysis of information technology integration in secondary level teaching in 26 countries. He gathered information on 10 application obstacles (Table 1) experienced by the teachers worldwide when integrating information technology into their teaching. These are further classified into 5 categories,

namely "teacher obstacle in information technology ability," "time obstacle," "integration obstacle in teaching," "facilities and resource obstacle" and "administrative support obstacle."

Table 1. **10 obstacles to application when integrating information technology into teaching**

Description of Obstacle	%
1. Inadequate number of computers.	70
2. Teachers' lack of relevant knowledge and ability in computer use.	66
3. Difficulty integrating information technology and teaching content.	58
4. Insufficient computer time for students.	58
5. Inadequate accessories.	57
6. Inadequate application software.	54
7. Insufficient preparation time for teachers.	54
8. Inadequate Internet bandwidth resulting in inability to go online at the same time.	53
9. Lack of administrative management and supervision.	52
10. Lack of technical support.	51

Source: Pelgrum (2001).

In other words, when integrating information technology into teaching, countries all over the world are limited by many obstacles, resulting in less than expected outcome. In terms of computer operating systems, schools must rely on computer operating systems as their foundation for promoting technology education, and to respond to such diversity of needs, new operating systems must be constantly created. Taking Windows Vista, Microsoft's previous generation of operating system, as an example, when it was globally launched on January 30, 2007, it was the corporation's newest flagship product, and promoted through its compatibility with personal computers or notebook computers. However, regardless its powerful functions, more attractive user interface, safer system mechanism and better management function than in Windows XP, and its more aggressive promotion and sales subsidies, sales fell far short of expectations. Its market penetration was less than 10%, therefore prone to disappearing from existence at any time and being replaced by the newly marketed Windows 7 operating system. Worth pondering, this lesson in history should also cause businesses to evaluate whether the same mistakes will be repeated if rapidly developing information technology was to be integrated into the so-called innovative teaching.

In his study of the phenomenon of the diffusion of innovative products, Rogers (1995) believed that after a product enters a market, it should be given some time for diffusion; however, before a product reaches maturity, an invisible chasm must be crossed over. If this chasm could be easily crossed, then the product can embrace the mass market; if a new product falls into the chasm, its diffusion fails and it will easily disappear from the market. For any information technology to become integrated into teaching there is yet another chasm to be crossed before it can be widely diffused. As such, using Windows Vista as subject, this research combined the paradigm of innovation-decision process and technology acceptance model (TAM) to analyze the factors influencing the adoption attitude and adoption intention of teachers toward Vista in order to understand the nature of the chasm. In addition, management implications for integrating information technology into teaching and for overcoming the chasm are delineated.

Literature Review.

Integrating information technology into teaching. Literature frequently cites technological integration (Dias, 1999) and integration of computers into teaching (Hadley and Sheingoid, 1993) to highlight the importance of information technology in teaching and to show how information technology can be used in courses and classrooms. In this paper, information technology is defined as technology where words, pictures, audio, animation and visual message representations are used to transmit information through media platforms such as multimedia computer or the Worldwide Web so that information can be conveniently collected, analyzed, integrated, utilized and transmitted.

Jonassen (2000) clearly defined 3 stages in the learning of information technology, namely "learning from computer," "learning about computer" and "learning with computer." From historical, research and practical perspectives, Leggett and Persichitte (1998) analyzed the technology implementation problems faced by teachers over the last 50 years, and like the obstacles faced by today's teachers who had attempted to implement and integrate technology into teaching, the key factors persistently revolve around time, expertise, access, resources and support (acronym TEARS). These factors must be fully attended to and resolved if teachers are to successfully implement and maintain the use of technology in their teaching.

Technology Acceptance Model (TAM). Modifying Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA), Davis (1989) proposed the technology acceptance model (TAM) which explains consumer adoption intention of information technology from the perspective of internal cognition of consumers. This model targets the influence of cognitive and emotional factors on the use of technology. The purpose of this model is to simplify the theory of reasoned action, examine the pattern of information acceptance and usage by individuals, and subsequently understand the external variables influencing the acceptance of technology, the relationship between the perception and attitude of users; through such, the study can effectively explain and predict their adoption of technology. Nevertheless, the TAM has left attitudes of subjective norms and normative belief and motivation that antecede behavior. Therefore, the proposition that attitude toward the use of technology is influence of "perceived usefulness" and "perceived ease of use" was forwarded, and that subsequently, the adoption intention of users and their actual use are affected, respectively.

Diffusion of Innovation. Diffusion of innovation refers to the process where a new product is gradually understood and adopted by members of a specific population through specific distribution channels. Since this concept was forwarded by Bass (1969), many related modified paradigms have been developed based on the theories of diffusion and use of innovation. Subsequent to Bass, Rogers (1995) proposed the paradigm of innovation-decision process which explained that even when individuals have learned about a new product and understood the many strengths of its innovation, acceptance is still difficult. Separating perception and actual behavior is a huge chasm. Before accepting an innovation, individuals often need a very long period of time for evaluation. The factors resulting or changing the attitude of individuals or other decision-making units toward adopting an innovation are 5 primary "innovation characteristics," described as follows:

(1) Relative advantage. Refers to the advantage that the innovation has over the original object that it substituted. The more individuals perceived the innovation as advantageous, the more likely they will adopt it.

(2) Compatibility. Refers to the degree of compatibility between an innovation and the existing values, experience and needs of potential users. The more individuals perceive the innovation as compatible, the more likely they will adopt it.

(3) Complexity. Refers to perceived difficulty associated with understanding, learning and operation of the innovation. The more individuals perceive the innovation as difficult, the less likely they will adopt it.

(4) Trialability. Refers to test — using the innovation under certain conditions to evaluate its effectiveness. The more individuals can reduce potential risks, the more likely they are to adopt the innovation.

(5) Observability. Refers to the degree of observation and discussion after the innovation was adopted. Higher visibility of innovation results indicates that innovation results can be observed and potential users can communicate and discuss the innovation, and subsequently the more likely they will adopt the innovation.

Conceptual Framework and Hypotheses

Research Framework. The connection between diffusion of innovation and technology acceptance model has already been examined through the literature review. Therein, the concept of relative advantage is similar to perceived usefulness; and complexity similar to perceived ease of use (Tornatzky and Klein, 1982; Moore and Benbasat, 1991). Therefore, this study extended the paradigm of innovation-decision process by Rogers (1995) and integrated it with the technology acceptance model by Davis (1989) to construct the decision-making path of teachers toward using VISTA, as shown in Figure 1. In other words, the factors delineated in the paradigm of innovation-decision process, namely relative advantage, compatibility and observability were integrated with perceived usefulness in Davis' (1989) technology acceptance model. In addition, complexity and trialability in the paradigm of innovation-decision process were integrated with the perceived ease of use in the technology acceptance model.

3.2 Research Hypothesis.

Basing on the literature review, we develop the hypotheses as follows:

H1: Perceived ease of use has positive influence on perceived usefulness.

H2: Perceived ease of use has positive influence on adoption attitude.

H3: Perceived usefulness has positive influence on adoption attitude.

H4: Perceived usefulness has positive influence on adoption intention.

H5: Adoption attitude has positive influence on adoption intention.

H6: Adoption intention has positive influence on actual use.

3.3 Research Method.

This research used the structural equation modeling (SEM) to verify the path relationship of each adoption decision-making hypothesis of teachers toward VISTA. Related structural models are as follows:

$$\eta_1=\beta_{61}\eta_6+\zeta_1 \quad (1)$$

$$\eta_2=\beta_{62}\eta_6+\zeta_2 \quad (2)$$

$$\eta_3=\beta_{63}\eta_6+\zeta_3 \quad (3)$$

$$\eta_4=\gamma_{14}\xi_1+\zeta_4 \quad (4)$$

$$\eta_5=\gamma_{15}\xi_1+\zeta_5 \quad (5)$$

$$\eta_6=\gamma_{16}\xi_1+\zeta_6 \quad (6)$$

$$\eta_7=\gamma_{17}\xi_1+\beta_{67}\eta_6+\zeta_7 \quad (7)$$

$$\eta_8=\beta_{68}\eta_6+\beta_{78}\eta_7+\zeta_8 \quad (8)$$

$$\eta_9=\beta_{89}\eta_8+\zeta_9 \quad (9)$$

where:

η_1~η_9 — relative advantage, compatibility, observability, complexity, trialability, perceived usefulness, adoption attitude, adoption intention and actual use, respectively;

ξ_1 — perceived ease of use;

γ ` β — the path weights of links between the factors;

ζ — error term.

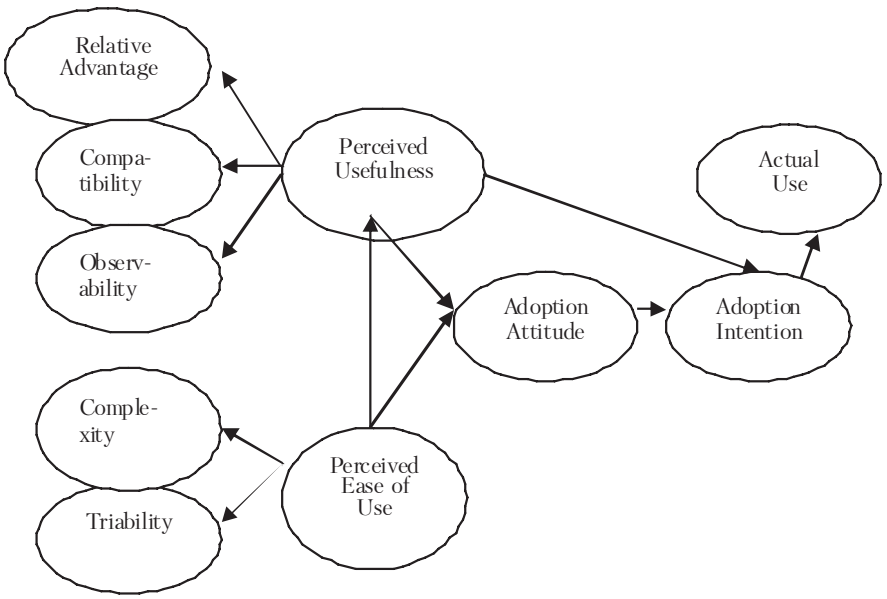

Figure 1. **The theoretical framework**

Sampling Design. The study subjects comprised Taiwan grade and junior high school teachers who have integrated information technology into their teaching, specifically those who have used VISTA operating system. Samples were primarily taken from grade and junior high schools in northern, central, southern and eastern regions of Taiwan. In the northern region, 167 questionnaires were distributed; central — 135 questionnaires; southern — 146 questionnaires; and eastern — 52 questionnaires, totaling in 500 questionnaires. Eliminating 86 invalid responses, the return rate was 82%, with 414 questionnaires.

Results and Findings.

Reliability and Validity Analysis. Table 2 shows the results of the confirmatory factor analysis (CFA) for the decision-making pattern model of teachers adopting VISTA. Construct reliability for all the latent variables was above 0.70, indicating excellent internal consistency where latent variables were explainable by the observable variables. The construct model was then tested for convergent validity and discriminant validity. Convergent validity calculates the factor loading of the measured variables on the latent variables, and the statistical significance of each factor loading. Table 2 shows that the factor loading for all individual items was >0.7, and therefore statistically significant. In addition, the average variance extracted (AVE) for all the dimensions were >0.5, indicating that the decision-making model for teachers adopting VISTA had discriminant validity.

Table 2. **CFA outcomes for the measurement model**

	Factor Loading	Construct Reliability (CR)	Average Variance Extracted (AVE)
Relative Advantage			
I think VISTA has less security loopholes than XP.	0.732	0.784	0.548
I think VISTA consumes less system resource than XP.	0.778		
I think VISTA helps me work more effectively.	0.709		
Compatibility			
I think VISTA can support the computer's existing brands of drivers.	0.857	0.892	0.733
I think VISTA can support the computer's existing accessories.	0.821		
I think there is no conflict between VISTA and XP user software.	0.890		
Observability			
I can easily find information on other users' experience with the VISTA.	0.732	0.793	0.562
I can easily appreciate the advantages if I were to adopt VISTA.	0.794		
It is not difficult for me to describe my experience with VISTA to others.	0.721		
Complexity			
I think VISTA operating screen is too complex and difficult to accustom to.	0.786	0.812	0.590
I think installing VISTA is a complicated process.	0.736		
I think the instructions on the use of each VISTA function is difficult to understand.	0.781		
Trialability			
Installing the official trial version of VISTA is sufficient for me to understand how this product is different.	0.740	0.766	0.522
There is sufficient information introducing VISTA on the Microsoft website.	0.715		
Retailers provide consumers with free trials on VISTA.	0.713		
Adoption Attitude			
I think adopting VISTA as an operating system is a wise decision.	0.809	0.867	0.687
I think installing VISTA is a way to improve inadequacies in the existing system.	0.738		
I think having a VISTA computer operating system is a very worthwhile enjoyment.	0.928		

The End of *Table 2*

	Factor Loading	Construct Reliability (CR)	Average Variance Extracted (AVE)
Adoption Intention			
I will try hard to search for related information on VISTA.	0.833	0.877	0.704
VISTA will be my first choice when installing a new operation system.	0.867		
I will recommend VISTA as the top choice in computer operating systems to my family and friends.	0.817		
Actual Use			
I am already using VISTA as the operating system for my personal computer.	0.709	0.858	0.671
I find only VISTA computer operating system convenient and efficient.	0.829		
I only select new accessories that can support VISTA.	0.907		

The Goodness of Fit Test for the Structure Model.

This study employs AMOS 17.0 for structuring equation modeling (SEM) by maximum likelihood method (MLE) to estimate the paths in the model. Shown in Table 3 are the results of goodness fitting indexes for the structure model. All the values are close to the preferable ones, indicating a fairly good fit.

Table 3. **The goodness of fit for structure model**

Model goodness fit	Preferred value	Value
CMIN/DF	< 3	2.384
GFI	> 0.9	0.911
AGFI	> 0.8	0.842
RMSEA	< 0.1	0.025
NFI	[0,1] and approaches 1	0.915
RFI	[0,1] and approaches 1	0.922
IFI	[0,1] and approaches 1	0.931
CFI	[0,1] and approaches 1	0.959

Analysis of Factors Affecting Perception toward VISTA. Table 4 shows the results of the second-order confirmatory factor analysis (CFA) for verifying the decision-making pattern of teachers adopting VISTA. Deciding factors influencing whether teachers perceived VISTA as useful are compatibility (0.732) and relative advantage (0.601). In other words, low compatibility between VISTA and existing software, and hardware and support programs, and high system resource consumption and the deep influence of XP on teachers resulted in their being unable to appreciate VISTA's contribution to improved effectiveness. Next, the deciding factor influencing whether teachers perceived VISTA as easy to use is complexity (-0.651). In other words, the more complicated the system installation and operation is perceived as difficult by teachers, the more they think it is difficult to use.

Hypotheses Test. Table 5 shows the results of the hypothesis test for the constructs in this research. The results verified all the hypotheses. Interpretation of the weight coefficient of the two factors influencing intention of use showed that the perception of usefulness (0.579) had greater influence than adoption attitude (0.341). According to the above analysis, compatibility and relative advantage of VISTA have been the

persistent complaints of teachers, contributing to their inability to acknowledge the better utility of VISTA and their eventual adoption intention towards VISTA.

Table 4. **The results of the hypotheses test**

Path between constructs	Estimate weight	p-value
Perceived usefulness > Relative advantage	0.601	***
Perceived usefulness > Compatibility	0.732	***
Perceived usefulness > Observability	0.428	0.021
Perceived ease of use > Complexity	-0.651	***
Perceived ease of use > Trialability	0.317	0.034

*** refers to p value smaller than 0.001

Table 5. **The results of the hypotheses test**

Path between constructs	Estimate weight	p-value	Test result
Perceived ease of use > Perceived usefulness	0.125	0.032	support H1
Perceived ease of use > Adoption attitude	0.187	***	support H2
Perceived usefulness > Adoption attitude	0.233	***	support H3
Perceived usefulness > Adoption intention	0.579	***	support H4
Adoption attitude > Adoption intention	0.431	0.041	support H5
Adoption intention > Actual use	0.635	***	support H6

*** refers to p value smaller than 0.001

Analysis of Direct and Indirect Effects. Indirect effect is a type of moderating effect which can better establish the level of influence of moderating variables on a model than direct effect. In this research construct, adoption attitude and adoption intention both showed indirect effect, as shown in Table 6.

Analysis of Impact of Adoption Attitude towards VISTA. The empirical results show that adoption attitude towards VISTA had both direct positive effect (0.187) and indirect positive effect (0.029). The total effect (0.216) of adoption attitude towards VISTA is equivalent to the sum of direct effect and indirect effects. The direct effect of the teachers' adoption attitude towards VISTA was greater than its indirect effect, indicating that the teachers were already perceiving VISTA as difficult to use. If compounded with the perceived lack of usefulness, the adoption attitude towards VISTA was further undermined.

Analysis of Impact of Adoption Intention towards VISTA. The adoption intention of teachers towards VISTA showed both direct (0.579) and indirect effect (0.100), and the total effect of 0.679. The direct effect of the adoption intention of teachers towards VISTA was greater than its indirect effect, indicating that the teachers perceived VISTA as difficult to use, which was the major factor decreasing adoption intention.

Table 6. **The direct and indirect effects**

Path between constructs	Direct Effect	Indirect Effect	Total Effect
Perceived ease of use > Adoption attitude	0.187	0.029	0.216
Perceived ease of use > Perceived usefulness	0.125		
Perceived usefulness > Adoption attitude	0.233		
Perceived usefulness > Adoption intention	0.579	0.100	0.679
Perceived usefulness > Adoption attitude	0.233		
Adoption attitude > Adoption intention	0.431		

Discussion. This study extended the paradigm of innovation-decision process forwarded by Rogers (1995) and integrated the technology acceptance model by Davis (1989) to construct the consumer decision-making path of teachers towards VISTA. The purpose was to understand why given the more power functions of VISTA operating system, the response of teachers was not as expected. In other words, this study sought to understand the crux of why in the integration of information technology into teaching, VISTA was unable to cross the chasm and failed to become widely adopted. The research results showed that teachers' perception of the low compatibility of VISTA and their inability to appreciate its relative advantage over existing XP operating system underscored their doubt about the usefulness of VISTA functions. In addition, the highly complicated VISTA installation and operation resulted in teachers perceiving it as difficult to use. The aforementioned were the main reasons why VISTA was unable to cross the chasm to become widely adopted.

The conclusions in this study are worth noting and considering when introducing information technology into teaching. In other words, when teachers select an innovative information technology for their teaching, the issue of whether the innovation could be easily diffused should be considered.

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