EVALUATION OF A WEB-BASED ASSEMBLY TRAINING OF FLUID POWER PRODUCT SYSTEM

Learning Effectiveness and Attitudes

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Abstract: This study explored the learning effectiveness and the attitudes of fluid power firms laborers toward web-based product assembly learning system. Firstly, this study tested the effectiveness of the product assembly education to prevent mistakes by different learning modes used to assess operation behavior and learning effectiveness during the training period. According to the average pass rate, course satisfaction, and total number of wrong behaviors in product assembly process, the web-based learning mode improves learning effectiveness. In addition, the study also investigated the relationship between laborers' attitudes and several independent variables. The findings revealed that the web-based learning mode is positively associated with learning effectiveness of product assembly training. Meanwhile, the results also point to the importance of laborers' vision of skills itself, their experience with it, and the learning conditions that surround its introduction into firms in shaping their attitudes toward skills and their subsequent diffusion in their real operation.

1 INTRODUCTION

The global adoption of information and communication technologies (ICT) into education has often been premised on the potential of the new technological tools to revolutionize an outmoded educational system, better prepare students for the information age, and/or accelerate national development efforts (Pelgrum, 2001). Developed countries, including USA, EU, Japan, and Taiwan have recently begun promoting e-learning. To reduce the costs of educational training, firms have also started to aggressively introduce education via Internet (Levy, 2007). Some studies have showed that web-based technology will promote learning efficiency effectively when meaningful pedagogical models are implemented. Thus, in the last decades, many relevant research streams have been proposed (Ligorio and Veermans, 2005).

This study investigates the effectiveness of web-based learning mode and traditional learning method in delivering product assembly training. The objective of the study was to test the efficacy of digitizing product assembly training programs in fluid power industry firms. The attitudes and effectiveness evaluation were investigated via the current conditions of web-based learning system and questionnaires. Meanwhile, references researched to construct the research architectures and problems. The specific goals of the study were as follows: (i) analyze the current conditions of product assembly training in fluid power industry, and to identify factors that may affect the effectiveness of web-based learning; (ii) investigate the impact of learning content design and system function on the effectiveness of web-based learning system; (iii) analyze and verify learning effectiveness via questionnaires for reference when generating web-based learning course in fluid power product assembly training; (iv) explore the relationship between laborers' attitudes and computer factors of web-based learning system.

2 RESEARCH METHODS

This study employed test, questionnaire, interview, observation and document analysis to investigate learning effectiveness. A two-phase data analysis was performed in the learning effectiveness. At the first phase, different learning results generated from

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different training mode of Group_I, Group_II, Group_III were explored. According to the analysis results of the first phase, a questionnaire survey was performed the second phase. The product assembly training of web-based learning mode was tested for web-based effectiveness through questionnaire for two product assembly groups with similar attributes.

The purpose of this study was also to explore the relationship between laborers' attitude and factors that are though to be influencing them, including perceived computer attributes, perceived computer capability, and social perceptions. Laborers' personal characteristics were also involved in order to ensure maximum possible control of extraneous variables by building them into the design of the study.

3 MAIN FINDINGS

3.1 Assessment of Preceding Data

At the first phase, the objects included three groups (Group_I, Group_II and Group_III) in product assemble operation. The participants were a cohort of novices employed in the three different firms in fluid power industry. The participants all worked in department of product assembly. Ninety members attending the course elected to participate in the study. Because of the lack of randomization of and control on the participating group of laborers, this study was strictly observational in its design. The content analysis method was adopted, and the product assembly training to prevent operation mistakes. Table 1 depicts the different learning modes used to assess operation behavior and learning effectiveness during the training periods. Six items of Table 1 were measured to decide the overall merit of product assembly training. Mistake occurrence, property damage rate, and human injury rate during work are the typical measures of the effectiveness of product assembly training. Hence, the acceptance of achievement was separated into three portions (learning by portions in accordance with the course content).

The data, number of participants, post test, satisfaction, and course time were collected during the experiment. Course satisfaction was represented on a 5-point Likert-type scale. There are 10 questions included by the questionnaire and the full score is fifty points. The result indicates web-based learning mode was most effective in Group_III. The second most effective was blended learning mode (Group_II).

Table 1: The list of group information.

Item	Group_I	Group_II	Group_III
Training mode	Traditional training	Traditional training + Web-based learning	Web-based learning
Learning type	Lecturer teaching	Lecturer teaching + Digital materials	Digital materials
Course arrangement	3 hrs per week, total of 3 portions	3 hrs per week, total of 3 portions	3 hrs per week, total of 3 portions
Evaluation method	Paper-and-pencil test	On-line test	On-line test
Work duration	10 weeks	10 weeks	10 weeks
Observation time	5 weeks	5 weeks	5 weeks

Three groups were audited by three-portion training. The gradual induction and review of staged course can increase the right behavior of actual operation greatly, and reduce the mistake rate and property damage rate. Therefore, after summarizing the preceding data assessment content of first phase, the following results can be obtained under different training modes: (i) Efficient training can minimize mistake rate and property damage rate; (ii) The web-based learning mode improves learning effectiveness in accordance with the results; (iii) Repeated product assembly training can significantly reduce the injury of laborer operation.

3.2 Assessment of Web-based Learning Effectiveness

As the above mentioned conclusion, the web-based learning with the highest satisfaction is used to investigate the learning effectiveness. This study defines the research hypotheses: content design (H_1) and system function (H_2) have positive effect on learning effectiveness. To test the validity of the sample size, Group_A and Group_B were used as different working projects in the questionnaire. The product assembly was the primary training program. The participants were forty laborers in Group_A and forty-eight workers in Group_B, respectively. All participants finished the web-based learning program and questionnaire survey.

The content of questionnaire was built in accordance with the preceding data, the laborers' interview and lecturers. In the item analysis, the independent T-test was adopted to test each question. All questions were reserved to build the validity of questionnaire. In the reliability of questionnaire, to

confirm the construction validity of questionnaire first and applying the exploratory factor analysis to extract the common factors. Based on the viewpoint proposed by several researches (Li, Gu & Wang, 2010), larger Kaiser-Meyer-Olkin (KMO) value is more suitable for the factor analysis, which shows there are more common factors among variables. The KMO = 0.877, the accumulated variation amount = 72.165, and $p < 0.001$, which was significant, so the measurement of questionnaire is suitable for factor analysis. Meanwhile, the Cronbach's α factor was used to show the same characteristics of item. The result shows that the content of questionnaire has the consistent level.

At the second phase, the study discussed the influence of content design and system function on learning effectiveness. There are four influence factors included in content design: multimedia design, simulation test, case studying, and content fitness. With respect to three assessment parameters of learning effectiveness, their relations can be described as follows: (i) Correlation coefficient, ρ = 0.79, represents that there is positive relation between two variables, and it supports H_1 research hypothesis; (ii) multimedia design has the biggest influence on the learning satisfaction of learning effectiveness in the analysis of correlation coefficient; (iii) Among the factors of content design, the 'multimedia design' has the biggest contribution to independent variable (χ_1). Among three factors of learning effectiveness, the 'learning satisfaction' has the biggest contribution to dependent variable (η_1). As for the system function, there are four influence factors included: system operation, user interface, self-learning mode, and network quality. With respect to three assessment parameters of learning effectiveness, their relations can be described as follows: (i) Correlation coefficient, ρ = 0.75, represents that there is positive relation between two variables, and it supports H_2 research hypothesis; (ii) system operation has the biggest influence to the learning effectiveness in the analysis of correlation coefficient; (iii) Among the factors of system function, the 'system operation' has the biggest contribution to χ_1. Among three factors of learning effectiveness, the 'operation validity' has the biggest contribution to η_1. The above data indicate that content design and system function positively affect learning effectiveness.

To confirm the positive relation for the influence of learning effectiveness, this study performed multiple regression analysis to check the consistency of analysis. The content design and the learning effectiveness are used as independent and dependent variables respectively in multiple regression analysis, the significant level of the 'operation validity' (F = 6.12, $p < 0.001$), 'time' (F = 7.78, $p < 0.001$) and 'satisfaction' (F = 13.84, $p < 0.001$). Furthermore, the explanation ability of satisfaction is up to 16% (R^2 = 0.16). Besides, the following several are found based on the standard regression coefficient and significance: (i) content fitness is not significantly related to any of the three factors of learning effectiveness; (ii) the method of case studying significantly affects operation validity and satisfaction, which indicates that choosing real cases of product assembly can help the laborer to realize the important knowledge and raise the operation validity and satisfaction; (iii) simulation test and multimedia obviously affect satisfaction and time, which presents that diversity of content design increase satisfaction and reduce the learning time. At the same time, the system function is assigned as independent and the learning effectiveness is assigned as dependent variable to conduct multiple regression analysis. The effect of 'operation validity', 'time', and 'satisfaction' are statistically significant, and 'satisfaction' has the highest explanatory power. In addition, the revealed issues are listed: (i) system operation and user interface has obviously influence on the satisfaction of learning effectiveness; (ii) self-learning mode has significant influence on the operation validity and satisfaction of learning effectiveness. It shows the mode could enforce the right operation and satisfaction; (iii) network quality has obviously influence of the learning time and satisfaction. It means that good network quality can promote learning effectiveness.

3.3 Evaluation in Laborers' Attitudes

3.3.1 Laborers' Attitudes toward ICT in Training

Participants were asked to respond to fifteen, Likert-type statements dealing with their attitudes toward ICT in training. The items were made to measure the emotional field of computer attitude, cognitive field, and behavioral field. Computer attitudes of laborers was represented by a means score on a five-point scale. Participants' overall attitudes toward ICT were positive with an overall mean score of 4.10 (SD=0.35). The participants' positive attitudes were obvious within the emotional (M=4.05; SD=0.45), cognitive (M=4.00; SD=0.5) and behavioral (M=4.15; SD=0.45) fields. The participants had positive (62.1%) or highly positive (23.3%) emotion toward computers. These respondents reported that

they considered using computers enjoyable, felt comfortable about computers, and liked to talk with others about computers and to use them in working, Inside the cognitive field, most of the participants agreed (86.6%) that computer save time and increase effort, enhance their learning, are fast and efficient means of getting information, are needed in the their work, and generally do more good than harm. In the behavioral field, the majority of the participants expressed positive (88.6%) behavioral intentions in terms of learning about them, spending more time in learning through them, and using them in the near future.

3.3.2 Laborers' Perceptions in Terms of Factors Related to Attitudes of Web-based Learning System

(1) Computer Attributes. According to the results, participants' perceptions of computers' attributes were somewhat positive with a mean score of 3.78 (SD=0.36). Participants positive perceptions varied across the four computer attributes examined in this study. Laborers' responses were most positive about the relative benefits of computer as a learning tool (M=4.07; SD=0.43). Laborers' perceptions of the simplicity of computers were also midway between fine and positive (M=3.49; SD=0.6). Most of the laborers' responses were split between positive and fine about whether it is easy to know the basic functions of computers, operate them, and use them in learning. Furthermore, participants' responses on the observability subscale indicate somewhat positive perceptions (M=3.69; SD=0.65). Most of the respondents reported that they had seen computers at work and as learning tool in general. Finally, participants' responses on the concordance subscale indicate somewhat positive perceptions (M=3.52; SD=0.52). The majority of participants indicated that computer use suit their learning preference and level of computer knowledge and is appropriate for product assembly learning activities.

(2) Computer Capability. The computer capability was represented by a mean score on a four-point. Most of the participants had no (41.8%) or little (40.6%) computer capability in handling the computer functions needed by tutors. Few participants had moderate (17.4%) or much (0.2%) computer capability. Overall, the participants reported that they had 'Little capability' (M=1.80; SD=0.58) in computer uses for web-based learning, including telecommunication resources, computer accessories usage, basic troubleshooting, learning resources evaluation, and access of files.

(3) Social Perceptions. Participants' responses to the ten items on the social perceptions scale were somehow midway between fine and positive (M=3.42; SD=0.41). The majority of the participants had positive (63.5%) or highly positive (22.0%) perceptions about the relevance of computers to Taiwan society. Specially, most of the participants indicated that they need to know how to use computers for their current jobs. Meanwhile, most of them expressed that computers will contribute to improving their standard of living and that knowing about computers earns one the respect of others. However, the fact that participants saw computers as socially appropriate for Taiwan society did not prevent them to indicate that there are other social issues that need to be addressed before implementing computers in education.

3.3.3 Proportion of Variance in Laborers' Attitudes Explained by the Independent Variables

A multiple regression analysis was also applied for determining the proportion of the variance in the attitudes of laborers toward web-based learning in product assembly training that could be explained by the selected independent variables. Simple correlations were first performed to identify independent variables that individually correlate with the dependent variable. The independent variables that individually correlated with the dependent variable were: computer attributes (r=0.78, p<0.05), computer capability (r=0.32, p<0.05), social perceptions (r=0.64, p<0.05), and computer training (r=0.14, p<0.05). Spearman rank correlations yielded no significant relationships between laborers' attitudes and any of the demographic variables (with the exception of computer training background). The results showed that 62% of the variance in laborers' attitude was explained by the independent variables included in this study. The results of multiple regression analysis indicate that three variables affect the laborer attitudes toward web-based learning at the 0.05 level of significance (as shown in Table 2).

Table 2: Multiple regression on dependent variable.

Variable	Standardized b	*t*	*p*
Computer attributes	0.54	11.21	0.000***
Computer capability	0.10	2.26	0.02*
Social perceptions	0.30	4.98	0.000***
Training	0.06	1.48	0.36

Note: * $p \le .05$, ** $p \le .01$, *** $p \le .001$

4 DISCUSSION

4.1 Learning Effectiveness

This study performed canonical correlation analysis and multiple regression analysis to verify the mutual relationships among content design, system function and learning effectiveness. The results supported H_1 and H_2 as follows: (1) Test of H_1 and H_2 hypotheses: (i) The H_1 hypothesis is that content design positively affects learning effectiveness. According to the analytical results, the learning satisfaction is an essential index of learning effectiveness. Good content design has to involve multimedia contents, actual case studying, content fitness, and simulation test, which will influence the satisfaction of learning effectiveness and improve the operation validity directly. Hence, H_1 hypothesis is verified in canonical correlation analysis. However, the content fitness of content design is not significantly related to any index in multiple regression analysis. Therefore, H_1 hypothesis was partially supported; (ii) The H_2 hypothesis is that system function positively influences learning effectiveness. According to the analytical results, the learning satisfaction is an essential index of learning effectiveness. Analysis of the four factors found that easy to operate system function, good to network communication, conformity of use interface, and assessment of self-learning are the impressions of the learners. The operation validity first produces directly influences and then raises the Learning satisfaction. Thus, H_2 hypothesis was fully supported. (2) Relation between the right behavior of product assembly operation and web-based learning effectiveness: A good training mode can reduce wrong behavior and increase the overall validity of product assembly operations. Among them, the web-based learning mode is a subject worthy to be discussed studied. The analysis revealed that the key issues of learning effectiveness are satisfaction, operation validity, and learning time. Regarding the laborers at product assembly worksite, raises right operations and product quality, and avoid vocational injuries. In addition, because the laborers' working time is always settled tightly, time is needed for independent learning, so the learning time is an important factor influencing the learning satisfaction. Under this situation, the web-based learning mode is positively associated with the learning effectiveness of product assembly training. High learning effectiveness increases right behavior during product assembly operations. (3) Relation between the web-based product assembly learning and its learning effectiveness: Because web-based learning system possesses the functions instead of traditional learning mode, when the web-based learning mode is used in the product assembly training, the laborer can applies the learning material more autonomously. Meanwhile, the laborer can also employ the system functions, such as multimedia learning materials, case studying, and simulation test, to decrease the mistake rate of operation, property damage and human injury.

4.2 Attitudes

Laborers' attitudes toward ICT have been universally recognized as an important element for the success of technology integration in education (Wang, 2008). Findings from this study propose that participants had positive attitudes toward ICT in training. The respondents' positive attitudes were obvious in the emotional, cognitive and behavioral fields. The participants seemed to have accepted the rationale for introducing ICT into worksites and were able to base their judgments on understandable reasons. Therefore, the most of participants considered computers as a learning tool that has the potential to bring about different improvements to their tasks and workplaces.

This symbiotic relationship between attitudes toward ICT and its use for learning has been widely reported in the literature (Haywood and Lidz, 2007). The findings of the study revealed a very evident positive correlation between laborers' attitudes toward ICT in learning and their perceptions of computer attributes. The results are consistent with Rogers' research (2003). An investigation of individual computer attributes exhibits that participants were most positive about the relative benefit of computers as a learning tool. However, laborers' perceptions of the concordance of computer with their current working practices were not as positive. The majority of them were uncertain about whether computers fit well in their task goals. The discrepancy between the existing tasks and technological demands has often been a major obstacle for technology integration (Pelgrum, 2001). Participants' concern about the incompatibility of computers with the existing work indicate that tasks' change cannot simply be attained by placing computers in workplaces (Wilfong, 2006). For a change to occur, many renovations need to be generated at the structural layer and the pedagogic layer. Otherwise, a mismatch will be occurred. This mismatch is referred as a "Technological contradiction" resulting from 'the consistent

tendency of the learning system to preserve itself and its practices by the assimilation of new technologies into existing instructional practices (Salamon, 2002). Thus, it is required that the equivalent renovations in pedagogical, structural, and course approaches when the ICT innovations is introduced into learning domain.

Social perceptions were the second most important predictor of computer attitudes in this study. The most of participants considered computers as relevant to Taiwan society and available methods for improving education and standards of living in general. Besides, many of the respondents regarded that computers will widen my knowledge on professional fields. Hence, almost all of the respondents agreed that the increased proliferation of computers will make their lives easier. The similar results had also been emphasized in the literature (Wilfong, 2006). Meanwhile, previous research has indicated to laborers lack of computer capability as a main obstacle to their acceptance and adoption of ICT. The results of the current study support and extend the findings from previous researches. The majority of participants revealed having little or no capability in handling many of the computer functions needed by tutors. This finding did not support the assumption that participants with low level of computer capability usually have negative attitudes toward computers (Shih et al., 2006). On the other hand, the fact that computer capability was significantly related to laborers' attitudes supports the theoretical and empirical arguments made for the importance of computer capability in determining laborers' attitudes toward ICT (Hasan and Ali, 2004).

5 CONCLUSIONS

The findings of this study may be specific to laborers in Taiwan vocational training, but their implications are significant to other learners in relative industries as well. Laborers' positive attitudes in the current study have a special significance given the limitations characterizing the current status of web-based learning in Taiwan power fluid industry firms: laborers' lack of computer capability. It is therefore essential to sustain and promote laborers' attitudes as a prerequisite for deriving the benefits of costly technology initiatives. Since positive attitudes toward computer factors of web-based learning system usually foretell future computer application, the managers of companies can take advantage of laborers' positive attitudes toward ICT to better prepare them for incorporating professional technology in their working practices.

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