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A Case Study of Design and Usability Evaluation of the Collaborative Problem Solving Instructional Platform System

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This study used Focus Group to analyze user requirements for user interface so as to understand what capabilities of the Collaborative Problem Solving (CPS) Instructional Platform were expected by users. After 12 focus group interviews, the following four functions had been identified as essential to the CPS Instructional Platform: CPS instructional models, instructional resources database, evaluation system, and instructional plan sharing. The user interface for the CPS Instructional Platform were designed accordingly. After programmers of the integrated project had completed system development based on the design, the study was proceeded usability evaluation of user interface of the CPS Instructional Platform. As for the satisfaction survey, 33 users were chosen based on purposive sampling. In the Likert Scale of five levels, the average score of this system was 4.1 by the testers. And, it indicated that most users were satisfied with the system user interface design and functions.

Keywords: collaborative problem solving, instructional platform system, usability evaluation, user interface design

INTRODUCTION

The study is one of the integrated project researches entitled "A study of the development and establishment of CPS spatial concept courses and assessment instructional platform for indigenous students" of the Ministry of Science and Technology in Taiwan. Findings show that indigenous students can be improved of team work and problem-solving capacity from the 9-step instructional strategies of Collaborative Problem Solving (CPS) (Chao, J.Y, 2013). Hence the study establishes a platform for teachers to use CPS instructional requirement through user interface development process and usability assessment in addition to evaluating the effectiveness through satisfaction questionnaires.

In view of the aforementioned reasons, the problems of the study consist of the follows: (1) What are the development and performance established for CPS instructional platform? (2) What is the satisfaction for users of CPS instructional platform?

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LITERATURE

CPS instructional strategies

Collaborative Problem Solving (CPS) instructional strategy was first proposed by Nelson (1999), a problem-solving oriented collaborative learning method that emphasizes on the need for teachers to divide the students into teams while each team discusses, coordinates and solves the problems of the unit questions assigned to the team to complete the learning tasks.

CPS instructional strategy integrates two instructional methods including collaborative learning and problem-oriented learning with emphasis on learn orientation to encourage learners to learn from doing and convert to autonomous learners in order to develop abilities in diverse critical thinking, problem solving, interaction, and teamwork (Roblyer & Kuhs, 2003).

Nelson (1999) proposed the following nine steps for the specific implementation of CPS instructional strategies:

A) Step 1: Prepare- Instructors and learners pre pare to carry out work in teams.

B) Step 2: Learners form small and heterogeneous working teams.

C) Step 3: Teams first discuss and understand the problems to be carried out in addition to defining the problems.

D) Step 4: Teams define the roles required for each project with distribution.

E) Step 5: Discuss repeatedly as the process of collaborative interaction and problem solving.

F) Step 6: Teams start to present and conclude the answers.

G) Step 7: Instructors help learners to recall the activity process and reflect the learning experience.

H) Step 8: Instructors and learners assess the learning outcome and process.

I) Step 9: Instructors and learners terminate the learning activities.

The research team also discovered the aboriginal children could understand mutual collaboration, team discussion, expressing personal opinions as well as team work and problem-solving abilities through the nine steps of CPS instructional strategy teaching activity (Chao, J.Y., 2013).

Hence the study established a 9-step CPS instructional sample system to assist teachers with online teaching plan design for students to participate in more diverse learning activities.

State of the literature

- Collaborative Problem Solving (CPS) instructional strategy was first proposed by Nelson.
- The nine steps of CPS are: (1) Instructors and learners prepare to carry out work in teams; (2) Learners form small and heterogeneous working teams; (3) Teams discuss, understand and define the problems ; (4) Teams define the roles required for each project with distribution; (5) Discuss repeatedly as the process of collaborative interaction and problem solving; (6) Teams start to present and conclude the answers; (7) Instructors help learners to recall the activity process and reflect the learning experience; (8) Instructors and learners assess the learning outcome and process; (9) Instructors and learners terminate the learning activities.
- Nielsen stated that the function design of user interface must meet user requirement to increase user convenience in using system functions. Nielsen proposed five assessment indicators in major user interface, namely: memorability, efficiency, learnability, errors and satisfaction.

Contribution of this paper to the literature

- The CPS instructional platform established by the research team underwent several expert focus group meetings and was developed in accordance with the user interface process. It is better able to meet the users' needs.
- The analysis of the user satisfaction questionnaire results revealed that the overall questionnaire satisfaction mean was 4.1 points, indicating considerably excellent user satisfaction toward this platform. Again, the user-centered interface design approach is better able to achieve user satisfaction.
- The CPS instructional platform provides teachers nine steps to quickly create lesson plans of collaborative problem solving strategy.

Instructional platform

The advent of digital era allows learners to choose learning content needed

through autonomous choice online without being constrained by time and space. Such learning model also unknowingly changes the way people learn (Chen, M. P., Chuang, L. P. and Lin, Y. S., 2002; Liu, H. W., 2012).

On contrary, Chao S. J. (2014) suggests the purse of establishing instructional platform primarily aims to administer digital materials systematically to assist instructors and learners to conduct teaching or learning activities through effective platform management.

Hence, the study established an instructional platform integrated with CPS instructional strategies to assist users to user platform related resources and successfully conduct teaching or learning activities.

User interface satisfaction assessment

Norman (1988) suggested that the design of user interface for web pages, websites and intelligent devices should be oriented towards user requirement and discuss the difference between product design and users' mentality model through cognitive psychology, followed by conducting physical operational test to reduce negligence in interface design.

Nielsen (1993) also expressed that the function design of user interface must meet user requirement to increase user convenience in using system functions. Nielsen thereby proposed five assessment indicators in major user interface, namely:

A) Memorability: The design of user interfacemust take consideration of users to reduce the operational methods that require additional memorization of new system.

B) Efficiency: Systematic interface design needs to reduce complex operational steps and possibly simplify to allow users complete operational tasks quickly.

C) Learnability: Users do not need to read excessive descriptive text to quickly understand system operation.

D) Errors: Avoid design that will produce errors, crash or confusion in addition to provide system error corrective mechanism.

F) Satisfaction: Users can meet the function requirement through system operation.

The study referred to the studies conducted by Wu, T. D. (2005), Chen, Y. Y (2008), Lin, P. Y. (2009), Lin, Y. H. (2013) and others and the satisfaction questionnaire based on Likert's Five-Point Scale developed according to the five indicators of Nielson as the grounds for assessing user satisfaction.

Apart from satisfaction questionnaire survey, focus group, user test, and heuristic evaluation (Holcomb and Tharp, 1991) are one of the methods for assessing user interface design. Nielsen (1993) made it clear that evaluation of interface usability using in many ways, questionnaire of which at least 30 people to find satisfaction for users.

Hence based on the domestic and foreign literature and the prior study results, the study has established the CPS instructional platform system according to the user interface development process, adopting questionnaire to understand user satisfaction for the system and using CPS instructional platform with complete functions to provide course teaching and self-learning for teachers and students.

EXPERIMENTAL

Research progress design

The study is a user satisfaction assessment for establishing an online instructional platform in 3 research stages, as described briefly below:

A) Design stage

This stage mainly focuses on the analysis of requirement and functions for CPS instructional platform with investigation on the domestic and foreign literatures and various focus group meetings. The researchers collected comments from the interview with 14 team members to complete four major platform functions, including CPS instructional sample, instructional database, assessment system, and project sharing.

B) Assessment stage

This stage focuses on the CPS instructional platform already completed with development and the satisfaction questionnaires of 33 users were collected based on purposive sampling.

C) Completion stage

This stage emphasizes on conducting statistical analysis and consolidation from valid satisfaction questionnaire recovered to understand user satisfaction towards CPS instructional platform.

Research Tools

The research tools used for this study include focus group, satisfaction questionnaire and other qualitative and quantitative data. The following is the description on various research tools:

Focus group meeting

Among the 14 participants of the meeting, four of them were aboriginal science education project coordinators of the team, eight were staff and two were elementary school teachers of aborigines.

Qualitative data taken from focus interview were denoted as "F" while the participants were denoted as "R1, R2 and R3."The number of meetings was denoted in numbers. For example, "F R1-3" implies the comment of R1 personnel during the third focus group meeting.

Satisfaction questionnaire survey for CPS platform

The satisfaction questionnaire survey of the study referred to the domestic and foreign academic literature, which underwent the test of two scholars and experts and the pre-test of 15 users to form questionnaire with good validity of α=0.8.

The questionnaire content is divided two-dimensional scales of 13 questions consisting of "CPS Instructional Platform Single Function Satisfaction" and 20 questions consisting of "CPS Instructional Platform Interface Satisfaction."

There were 33 participants of the investigation with a total of: (1) 19 elementary school teachers of aborigines having participated in the teacher seminar activities organized by the project. (2) 10 IT personnel who have not involved with the project. (3) 4 IT engineers who have not produced this platform.

RESULTS

Development of system function for CPS instructional platform

The four primary function design page for CPS teaching sample, instructional database, assessment system, and project sharing were concluded and designed after conducting 12 expert focus group meetings (as shown in Figure 1).

The description of the development for this instructional platform system functions is provided below:

CPS instructional sample function

The function of CPS instructional sample can be divided into four fields of courses with content in "spatial concept,""basic mechanics," energy application," and "Five senses of mathematics" (Figure 2 & 3).

However, the design process of the instructional sample is the same.

Figure 1. CPS instructional platform diagram

Figure 2. Landing page for CPS instructional sample

Figure 3. .CPS instruction sample design page

Functions of instructional database

The instructional database is divided into "interactive teaching materials," "document based teaching materials,""learning sheets," and "user manual."The users can find applicable teaching materials (as shown in Figure 4) from the different categories of the four types of teaching materials.

> I would like to increase teaching materials for the instructional database such as the in-class projector, learning sheets and animation. (F R4-7)
>
> I think the instructional database is a little confusing and not easy to find the documents. Is it possible to categorize it such as the categories for documents, teaching materials and learning sheets? (F R2-12)

Assessment system function

The implementation of traditional teaching often consumes money, paper and labor to print assessment in paper forms. Hence the instructional platform designed an online assessment system in attempt to conduct question tests through online system while the system can also provide questions analysis to reduce the costs of assessment tests (as shown in Figure 5).

> It will be better if we could directly take the test online. We spent over NT1,000 on printing the testes and the printing cost is too expensive. If we could adopt online test, we will not need print the paper and save excess costs of tests. (F R1-10)
>
> We expect to directly produce online test records from the platform for teachers to make query on the students' test performance. (F R1-10)

Figure 4. Teach database page

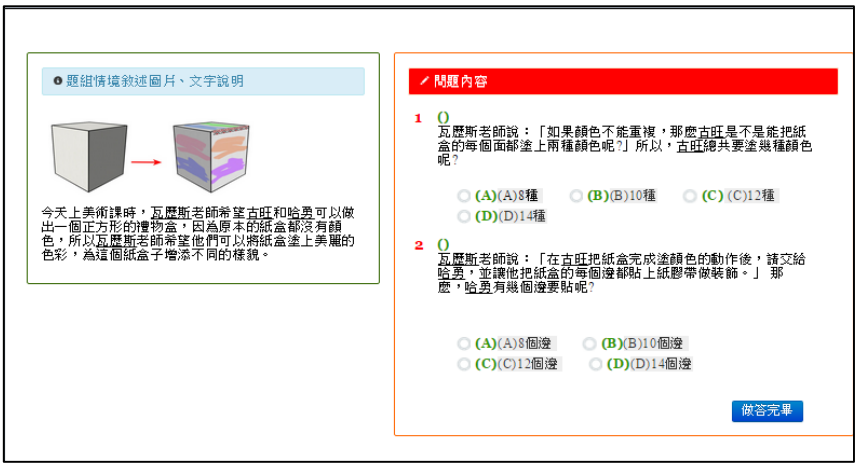

Figure 5. Online assessment system page

Project sharing function

Project sharing function stores the content of records such as the "seed teaching training, "volunteer training," "project outcome exhibition," and "event sidelights" in addition to establishing backend mechanism for project related staff to conduct backend editing (as shown in Figure 6).

User satisfaction for CPS instructional platform

The questionnaire consists of 33 questions in the category of "Instructional Platform Single Function Satisfaction" and "Instructional Platform Interface Satisfaction." The overall satisfaction mean of the questionnaire was about 4.10 suggesting most participants show considerably good satisfaction for CPS instructional platform, as shown in Table 1.

Statistical analysis for CPS instructional platform single function satisfaction scale

The single function satisfaction survey scale for CPS instructional platform consists of 13 questions with means of 4 points (as shown in Table 1), suggesting excellent user satisfaction.

The result of question means (as shown in Table 2) suggests better user satisfaction for platform design items such as "homepage item illustration, "preference for typesetting totem color," "add sample illustration," and "quantity choice" writing style;" all with 4.06 points or higher.

Platform design items such as the "font size of assessment system," "CPS Step

Figure 6. Project sharing page

Table 1. Satisfaction questionnaire descriptive statistics

	No. of Questions	M
Instructional Platform Single Function Satisfaction	13	4
Instructional Platform Interface Satisfaction	20	4.18
Total Scale	33	4.10

Table 2. CPS ınstructional platform single function satisfaction

No.	Questions	M	No.	Questions	M
1	Homepage Item Illustration	4.15	8	"Quantity Choice " Writing Style	4.06
2	Add Sample Illustration	4.06	9	Convenience of Instructional Database	3.94
3	CPS9 Step Bottom Illustration	3.91	10	Font Size of Assessment System	3.61
4	CPS9 Step Description Illustration	4	11	Size of Teaching Material Button	4.03
5	Course Selection Position	4.03	12	Select ability of Answers for Assessment System	3.94
6	Unit Selection Position	3.97	13	Preference for Typesetting Totem Colors	4.09
7	"Text Block Writing" Style	4.03			

button Illustration," "Convenience of Instructional database," "and "select ability of answers of assessment system" scored relatively lower on satisfaction with means of 3.61, 3.94 and 3.94 respectively, which will undergo continual improvement.

Statistical analysis for CPS instructional platform interface satisfaction scale

The interface user satisfaction survey scale of CPS instructional platform consists of 20 questions with total means of 4.18 points (as shown in Table 1), suggesting the users perceive successful operation, stably system performance and good satisfaction in the use of instructional platform.

The results of question mean (as shown in table 3) suggest better user satisfaction for platform interface design items such as "high text legibility," "users can complete work according to scheduled operational order," "add sample illustration," and "the error of system single function will not cause break down of the entire system" with score of 4.09 points or higher.

The satisfaction for platform interface design items such as "easy memorization of system operation methods," "text size readability" and "fast system reaction" with means of 3.61 and 3.91, which will continue to improve.

Table 3. Instructional platform ınterface satisfaction

No.	Questions	M	No.	Questions	M
1	High text legibility	4.15	11	Consistency in interface illustration position	4.03
2	Text font readability	4	12	Moderate size of system typesetting	3.94
3	Text font size readability	3.91	13	Easy memorization of system operation method	3.61
4	Text color readability	4	14	The use of this system will have the same operational model for different items	4.03
5	Button comprehension	4.03	15	Easy comprehension of system terminology	3.94
6	Button position meeting user requirement	3.97	16	System offers error message	4.09
7	Consistency in button position	4.03	17	The error of system single function will not cause breakdown of the entire system	4.09
8	Interface illustration comprehension	4.06	18	Users can complete work according to scheduled operational order	4.15
9	Interface illustration offers help test	3.94	19	Fast system reaction	3.91
10	Interface illustration position meeting user requirement	3.94	20	High system stability	3.97

CONCLUSION

Conclusion

The CPS instructional platform established by the research team underwent several expert focus group meetings and was developed in accordance with the user interface process with primary functions such as the CPS instructional samples, instructional database, assessment system and project sharing.

The analysis of the user satisfaction questionnaire results revealed that the scale means of "instructional platform single function satisfaction" was 4 points, the "instructional platform interface satisfaction" scale mean was 4.18 points while the overall questionnaire satisfaction mean was 4.10 points. The means of the scale or the overall satisfaction questionnaire scored above 4 points, indicating considerably excellent user satisfaction toward this platform.

Suggestions

The study established CPS instructional platform and assessed user satisfaction for such user interface. Nonetheless there are many methods for user interface assessment other than the satisfaction questionnaire survey, hence it is suggested for follow-up researchers to adopt heuristic evaluation and user testing to assess the

different usability as well as to increase the number of testing users and thereby strengthen the platform usability.

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