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Usability evaluation of the operational interface of the NARERO learning system

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Abstract

Aim: This research aimed to examine the functionality and usability of NARERO's administrative interface. As a means of analyzing user obstacles and providing recommendations, we looked at the blind spots in the NARERO learning system's usage.
Methodology: This research summarizes and organizes the issues with the NARERO learning system by collecting and analyzing data about people, events, and objects through observation, literature collection, and user evaluation. In addition, an objective experimental test was used to evaluate user satisfaction, and a Likert scale was employed to measure and analyze user evaluations and learning performance. Five professionals and forty high school students each gave their opinion on the system's user interface in an objective experiment. In conclusion, system operations were carried out to aid in assessing academic performance.
Findings: When looking at the expert evaluation results, most of the testers were pleased with how the NARERO learning system's functions were designed. Furthermore, the system's aesthetic design and usability could have been enhanced.
Novelty/Implications: By learning and training the entire system, students can use the digital instruction system to select the course that best suits their interests and abilities.

Key Words: NARERO, Usability Evaluation, Interface Design, Experiment Design

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INTRODUCTION

Research Background and Motivation

The majority of students, the teacher's abilities, and the teacher's learning habits form the basis for the traditional environment's instructional content, methods, and progress arrangements. However, the educational benefits of such an environment would be severely limited because of the inability to cater to each student's unique needs. Ashaari (2017), Basoglu (2017), and Rosenberg (2001) all point out the many ways in which digital instruction excels over more conventional methods of teaching and learning. These include lowered tuition costs, improved responsiveness, standardized or individualized lesson plans based on student needs, constant content updates, mobile access to course materials, and community-wide knowledge building. The internet has enabled the development of rich learning content, diverse learning resources, individualized learning needs, and an open learning context due to the rapid development of computer, communications, and audiovisual technology, the World Wide Web, multimedia, and hypermedia, humanized interfaces, simplified operations, diversified functionality, and integrated usage. These have broken down geographical and temporal barriers, creating a digital learning environment that combines synchronous and asynchronous teaching strategies.

In May 2001, the Ministry of Education in Taiwan formulated the "Master" Plan for Information Education in Junior and Senior High and Elementary Schools in response to the growing importance of digital learning around

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the world and the need to maintain Taiwan's international competitiveness. To facilitate the review, registration, exchange, and sharing of mechanisms for the design of instructional activities and learning resources and encourage the online posting of school curricula, the project creates an open education platform for the collaborative creation and sharing of network resources. Therefore, it is evident that educational authorities in Taiwan also view instructional resources as crucial to the growing acceptance of digital education. The Master Plan for Information Education is meant to strengthen the growing trend of online education.

Both the public and private sectors, in the United States and abroad, have an advanced state of art in digital learning environment. As a result, the following pedagogical challenges may arise in the classroom, even though most only focus on the establishment of system functionality (Chadyiwa and Mgutshini 2015; Lee 2001; Sales 1988; Schwier and Misanchuk 1993; Tarmuchi, Mohamed, and Ismail 2015; Yang 2002):

Firstly, students should know that while online learning offers many benefits, including learning at their own pace, not all students are naturally disciplined enough to benefit from this method. There are a variety of internal and external factors that can get in the way of a student's ability to learn, including but not limited to: having a full-time job or caring for a family, the online instructional materials being too challenging, the pacing of the course is too fast, the learning environment is too noisy, personal financial reasons, or poor test results in the past. In addition, people may be reluctant to participate in online instruction because of the challenges associated with developing self-confidence and positive relationships in a learning environment that needs face-to-face communication.

Some educators are hesitant to implement online learning because they feel unprepared to deal with students' technologically advanced questions. This makes them less interested in contributing to the design and implementation of novel approaches to online education. Due to their lack of expertise, they are not likely to take an active interest or contribute to creating educational resources. There are several challenges that educators may encounter when implementing or adjusting to online instruction, including but not limited to the following: students who only take and don't give back; students' involvement in the private affairs of the school; problems with network transmission; students' inactivity; teachers' struggles to establish and maintain study communities; students' failure to share a common vision; teachers' struggles to locate and recruit qualified administrators for online discussion forums; and experts' struggles to diagnose technical issues in online settings.

As online education has grown in popularity, the importance of integrating digital instruction systems has grown, and so has the variety of subjects taught. In light of these shifts, the ability to design a systematic and singularly integrated learning environment is becoming increasingly important, as it will determine whether or not students can use the digital instruction system to choose a course that is appropriate for them and help them achieve the goal of education through learning and training of the entire system.

Research Purposes

The purposes of this study are: (1) To analyze and explore the organizational structure and functionality of the NARERO digital learning system, (2) To evaluate the usability of the NARERO digital learning system, and (3) To discover the usage problems and difficulties in the NARERO learning system through tests on subjects and to provide improvement plans.

LITERATURE REVIEW

The Definition of Usability

In order to explore user conditions in operating the NARERO learning system interface, the study has learned about the definitions of usability in order to evaluate usability. Usability is focused on the testing and assessment of products from an ergonomic perspective. ISO 9241 defined usability as the extent to which a user can achieve specific goals in using a product; these specific goals include efficiency and satisfaction (Kongmanus 2016; Price 1991; Stanton 1998). Stanton (1998) recommended that in the product design stage, eight categories relating to usability should be evaluated, which are: 1) Learnability), 2) Effectiveness, 3) Attitude, 4) Flexibility, 5) Perceived usefulness, 6) Task match, 7) Task characteristics, and 8) User characteristics. Domestic scholars Wang (2007) proposed that usability can be examined through learnability, memorability, efficiency, error rate, and satisfaction.

Usability Engineering

Based on the aforementioned definitions of usability, the study will explore usability assessment to serve as the basis for evaluation in subsequent research.

According to Landel and Nielsen (1993), usability engineering was not a singular criterion, but five evaluation criteria, which are: (1) Learnability, (2) Efficiency, (3) Memorability, (4) Error rate, and (5) Satisfaction. These five criteria allow a product to be objectively assessed, and, in turn, improved according to these five criteria. In the book Usability Engineering, Landel and Nielsen (1993) proposed nine methods for assessment and research, as shown in Table 1.

Table 1: Assessment and research methods (Landel and Nielsen 1993)

Method	Subjects	Applicable Stages	Key Advantages	Key Disadvantages
Heuristic evaluation	6-10 experts	At the beginning of design, repeated design	Can discover individual usability problems, and record problems discovered by expert users	Does not include the real users, does not discover surprising problems
Performance measures	At least 10 subjects	Competitiveness analysis, final testing	Quantified data with easily comparable results	Cannot discover individual usability problems
Thinking aloud	3-5 subjects	Structural evaluation of repeated design of prototypes	1. Can accurately point out user misunderstandings 2. Cheaper testing	Unnatural for users, difficulty in linguistic expression for experienced users
Observation	More than 3	Research after system completion	Ecological efficacy, demonstrating real work for users, can establish functionality and features	Difficult to fix the interval, lack of control by experienced users
Questionnaires	At least 30 subjects	Work analysis, research after system completion	Can discover topics preferred by users	Requires guidance (to prevent misunderstanding)
Interviews	5 subjects	Work analysis	Flexible, can engage in in-depth exploration of views and experiences	More time-consuming and is difficult to analyze and compare
Focus groups	6-9 subjects per group	User participation stage	Spontaneous response and active group discussion	Difficult to analyze, lower effectiveness

Table 1: Conti....

Method	Subjects	Applicable Stages	Key Advantages	Key Disadvantages
Logging actual use	At least 20 subjects	Final testing, research after system completion	Can discover higher-level usage features, can be continuously conducted	Analysis requires a great deal of data, which would infringe on the privacy of users
User feedback	Several hundred subjects	Research after system completion	Can track changes in user needs and perspectives	Needs special organization to manage user responses

METHODOLOGY

Research Framework

This study seeks to explore and assess the usability of interface design of the NARERO learning system. The study uses observation survey and data collection methods to observe the conditions and rates of usage. The observation method, literature collection method, and user evaluation method are used to collect and analyze the people, events, and objects for exploration, in order to generally construct the behavioral actions and usage difficulties of users.

Subjects

The subjects in this study were all first-time users of the NARERO learning system. In the experimental process, each user was recorded for subsequent user evaluation. The observation method was used to conduct the experiment on four subjects, and usability engineering evaluation was used for analysis. The subjects were two male and two female users. Next, the study conducted user system evaluation on 40 students from the Department of Metallic Art at Chung Cheng Industrial High School. In order to ensure precision of the experiment, all experiments were carried out at the computer classroom of Kaohsiung Municipal Chung Cheng Industrial High School.

Observation Survey

Observation surveys were used to observe the users in order to form the foundation for further testing.

Observation survey refers to a study under natural or controlled conductions based on research objectives, using one's own sensory and assistive tools to directly observe the study subjects to gain materials and in turn making objective explanations regarding an individual's actions or phenomena. Scientific observations may be characterized as: (1) Purposeful, (2) Planned, (3) Systematic, and (4) Repeatable. Common observation surveys may be divided into: (1) Checklist method, (2) Ranked scale method, and (3) Narrative descriptions. According to the state of the observed contexts, the observational research methods may be divided into the following, as in Table 2: (1) Natural observational research and (2) Practical observational research. According to the structured nature of observation, methods may be divided into: (1) Unstructured observation, (2) Structured observation. According to the relationship between the observer and the observed, methods may be divided into: (1) Participant observation and (2) Non-participant observation. According to continuity, methods may be divided into: (1) Continuous observation and (2) Non-continuous observation. In investigative research and scientific experimentation, observation surveys are effective in three dimensions, which are: (1) To expand people's sensory cognition, (2) To inspire people's thinking, and (3) To lead to new discoveries. Investigation of something specific through observation methods may be divided into four categories based on cost and data quality, as shown in Table 3.

Table 2: The extent of structure in the observation contexts (Bailey 1987)

	Natural Contexts	Artificial Environmental Contexts
Structure	Structured field investigation	Completely structured experimental observation
Unstructured	Completely unstructured field investigation	Unstructured field investigation experiment and analysis

Table 3: Types of observation survey

Survey	Results
Natural observation	Natural observation refers to the observer's observation of the actions of the observed subject in a natural environment.
Designed observation	Designed observation refers to the observer's design and simulation of a context, in which the observer observes the actions and conditions of the observed subject in the set scenario and in natural environments. The more the created scenario approximates a natural setting, the more the observed subject approaches the true state.
Concealed observation	In concealed observation, the observed subject is unknowingly under monitoring.
Machine observation	Under certain conditions, using machines in place of human observation may be cheaper, more accurate, and more efficient in completion of work.

Evaluation of Usability Engineering

The study conducted preliminary usability engineering evaluation based on the aforementioned observational basis in order to understand the problems and conditions in usage, which served as the basis for improvements.

A product must be tested and evaluated by possible users to assess its usability. According to Landel and Nielsen (1993), only five subjects need to be tested to discover approximately 75-80% of usability problems; in order to ascertain more definitive usability problems, it is necessary to increase the number of subjects. The evaluation methods depend on the characteristics of the tested products, and generally do not only use a single evaluation criterion, but rather several criteria to create a general analysis. Evaluation is conducted using the eight methods related to usability: 1) Learnability: When a user learns how to use a product on their own, the shorter the amount of time spent on learning before the subject reaches the preset target, the greater the learnability. 2) Effectiveness: Whether this product can effectively allow a user to reach a goal and specific tasks. 3) Labor load: When a user uses the product, the greater the resulting discomfort or fatigue, the greater the labor load, the worse the product's usability. 4) Mental load: When using the product, if excessive thinking is required to make it work, and it causes discomfort or fatigue, then the greater the mental load, the worse the product's usability. 5) Operational performance evaluation: When using the product to complete certain tasks, there are specific performance indicators based on tasks, and the correct completion of work during specific times would lead to greater performance evaluation. By measuring performance, it is also possible to determine which of the design options is best. Shen, Kang, and Wu (2003) used the performance evaluation method to assess tables suitable for use by students with cerebral palsy. The design plans include tables that were horizontal or tilted 20 degrees, rectangular table surfaces and concave table surfaces. After 32 disabled students were tested, it was found that the concave table surfaces produced more significant writing performance, while tables tilted 20 degrees produced better visual effects than did horizontal tables, with less neck curvature. 6) Subjective satisfaction and comfort evaluation: Satisfaction levels are generally represented by number 1, 2, 3, 4, and 5 on the Likert five-point scale, before the quantified evaluation scores are collected. 7) Flexibility: Flexibility is measured when the product to be evaluated is applied in different work tasks or usage scenarios to consider whether tasks can be completed smoothly. If they can be applied in more tasks or scenarios, then flexibility is high. 8) Perceived usefulness: Whether the user considers the product is valuable in usage.

RESULTS AND DISCUSSION

This study used observational methods, literature collection, and usability engineering evaluation to further analyze usability of the computer learning system. The methods of on-site observation and the evaluation of learnability, effectiveness, and performance were applied for initial operational testing of the NARERO learning system and to summarize its problems, which are:

(1) When using the NARERO learning system, first-time users had to rely on instructions, otherwise system steps were difficult to complete.

(2) A person who was both a user and an administrator cannot log-in using one account and must switch between the two, which could be troublesome for users.

Interface Usability Evaluation

The study used one design expert evaluation form and one user evaluation form in order to assess satisfaction with and evaluation of the system by different users. The expert evaluation was mainly divided into system function assessment and general opinions. Other than these two categories, the user evaluation also included assessment of the extent to which the system functions aided in learning.

Evaluation of system function was primarily based on the operational interface, layout planning, and the effectiveness achieved by each function, to evaluate whether the functions in the system were appropriate, and to understand the efficacy of each function. The main purpose of assessing the degree to which system functions aided learning was to understand whether the functions of the system could aptly help users in their learning.

Results and Analysis of Expert Evaluations

Five experts in industrial education, instructional assessment, and information networks were selected to carry out evaluations. System instructions and evaluation forms were sent to experts, who were requested to download and install the NARERO learning system to test all functions, and then fill out the evaluation form to complete the task of expert evaluation. The expert evaluation forms converted each question by a five-point scale scoring method, with five points for “highly agree”, four points for “agree”, three points for “neutral opinion”, two points for “disagree”, and one point for “highly disagree”. These scores were used to compute the means and standard deviations for each question, in order to better reflect the outcomes of expert evaluation. The general opinions were summarized and organized to serve as references for system improvement.

Results of expert evaluations are shown in Table 4. According to expert opinions of the NARERO learning system, we learned that experts were generally satisfied with the design of various functions of the NARERO learning system. However, they expressed that there was still room for improvement in terms of the aesthetic design and accessibility of the system. Of course, they approved of the system’s promotability and prospect.

Opinions provided by experts in “general opinions” were summarized as follows:

1. If the NARERO learning system can be enhanced with more interactive digital learning systems and be successfully applied to assist learning outside traditional classroom instruction, it would have better prospect and potential.
2. The elements relating to the various planned functionalities, instruction, and evaluation in the system had achieved the initial scale; however, the layout design was somewhat insufficient at motivating students. In the future, this area may be strengthened by lively and eye-catching aesthetic design.
3. The calculation of time may be used as one indicator in the assessment of students being tested.
4. It might be more feasible to implement fuzzy treatment when quantifying the difficulty levels in test questions.
5. In online testing, students may be permitted to know their grades, or the means and standard deviations of the whole class.

Table 4: Expert evaluation results

Item	Evaluated Content	Highly Agree	Agree	Neutral	Disagree	Highly Disagree	*Mean*	*Standard Deviation*
Online Learning Area	The operational interface is easy to use	1	4	0	0	0	4.20	0.44
	The layout plan is appropriate	3	1	1	0	0	4.40	1.30
	It has interactive feedback functions	2	1	2	0	0	4.00	1.00
	It can record the difficulty of questions	2	1	2	0	0	4.00	1.00
Online Testing Area	The operational interface is easy to use	2	2	1	0	0	4.20	0.83
	The layout plan is appropriate	1	3	1	0	0	4.00	0.70
	Results can be immediately received	4	1	0	0	0	4.80	0.44
Online instruction area	The operational interface is easy to use	1	3	1	0	0	4.00	0.70
	The layout plan is appropriate	2	3	0	0	0	4.40	0.83
	The course browsing process is appropriate and smooth	0	5	0	0	0	4.00	0.00
	The content of the online instructional materials is clear and easy to understand	1	4	0	0	0	4.20	0.44
Personal records area	The operational interface is easy to use	2	2	1	0	0	4.20	0.83
	The layout plan is appropriate	2	3	0	0	0	4.40	0.54
	Students can easily search for and modify personal data	2	2	1	0	0	4.20	0.83
Student data management area	The operational interface is easy to use	2	3	0	0	0	4.40	0.54
	The layout plan is appropriate	1	4	0	0	0	4.20	0.44
	Operational explanations are clear and easy	3	2	0	0	0	4.60	0.54
	Personal data can be easily modified	3	2	0	0	0	4.60	0.54
Question bank editing area	The operational interface is easy to use	1	3	1	0	0	4.00	0.70
	The layout plan is appropriate	1	4	0	0	0	4.20	0.44
	Operational explanations are clear and easy	3	2	0	0	0	4.60	0.54
	Test questions can be easily added or deleted	4	1	0	0	0	4.80	0.44
	Test questions and feedback can be easily modified	3	1	1	0	0	4.40	0.89
	Difficulty of questions in the question bank can be easily checked	0	4	1	0	0	3.80	0.44
Test question editing and analysis	The operational interface is easy to use	1	3	1	0	0	4.00	0.70
	The layout plan is appropriate	2	3	0	0	0	4.20	0.83
	Test questions can be easily added or deleted	3	2	0	0	0	4.60	0.54
	Test difficulty can be easily checked	3	2	0	0	0	4.60	0.54
	Test discrimination can be easily checked	3	2	0	0	0	4.60	0.54
Learning records area	The operational interface is easy to use	1	3	1	0	0	4.00	0.70
	The layout plan is appropriate	1	3	1	0	0	4.00	0.70
	Students can easily search for their grades	4	1	0	0	0	4.60	0.89
System log-in and log-out	The operational interface is easy to use	1	2	2	0	0	3.80	0.83
	Smooth log-in process	3	2	0	0	0	4.60	0.54
	Smooth log-out process	0	4	1	0	0	3.80	0.44

Results and Analysis of User Evaluations

The study focused on 40 students in the second year of the Department of Metallic Art at Chung Cheng Industrial High School. The students used part of their time in computer classes to conduct online learning, and filled out the evaluation forms; 40 valid evaluation forms were collected. The accounting of user evaluations was the same as for expert evaluations; the means and standard deviations of each question were computed to clearly understand the results of user evaluations. The results of student evaluations are shown in Table 5, with most students expressing views of “neutral”, “agree”, or “highly agree” with regards to the evaluated content. There

were more "agree", and "highly agree" responses, with average scores over 4.0. This meant that most students felt satisfied regarding the functions of this system.

Table 5: Results of user evaluation

Item	Evaluated Content	Highly Agree	Agree	Neutral	Disagree	Highly Disagree	*Mean*	*Standard Deviation*
Online learning area	The operational interface is easy to use	8	28	4	0	0	4.10	0.55
	The layout plan is appropriate	5	30	5	0	0	4.00	0.51
	It has interactive feedback functions	7	27	11	1	0	3.85	0.74
Online testing area	The operational interface is easy to use	11	26	2	1	0	4.18	0.64
	The layout plan is appropriate	6	29	5	0	0	4.03	0.53
	Results can be immediately received	14	17	7	2	0	4.08	0.86
Online instruction area	The operational interface is easy to use	11	25	4	0	0	4.18	0.59
	The layout plan is appropriate	7	31	2	0	0	4.13	0.46
	The course browsing process is appropriate and smooth	6	25	9	0	0	3.93	0.62
	The content of the online instructional materials is clear and easy to understand	7	20	13	0	0	3.85	0.70
Personal records area	The operational interface is easy to use	15	19	6	0	0	4.22	0.70
	The layout plan is appropriate	7	27	6	0	0	4.03	0.58
	Students can easily search for and modify personal data	17	14	7	2	0	4.15	0.89

On the other hand, in order to understand the extent to which each system function assisted learning, we also asked students to fill out an evaluation form in this regard. The evaluations are shown in Table 6. To make this form clearly reflect how students feel about the extent to which the system functions helped their learning, there were only four response items, and the "neutral" opinion was not included.

The accounting method converted each question by using a four-point scale scoring system: four points for "very helpful", three points for "helpful", two points for "not helpful", and one point for "very unhelpful". The results show that most students expressed that the evaluated items were "helpful" or "very helpful".

In particular, the "notification" function and "personal records area" were in the first and second places, which meant that the users were satisfied with functions provided by the system. The general opinions given by the students are as follows:

1. There could be hyperlinks on each page linked to each unit, without having to return to the homepage to select units.

2. More positive feedback functions can increase students' learning motivation.

3. The test questions could be mainly based on the ones that require flexible thinking, and avoid questions that emphasize rote memorization as much as possible.

Table 6: Evaluation on the extent that system functions helped learning

Items	Very Helpful		Helpful		Unhelpful		Very Unhelpful		*Mean*	*Standard Deviation*
	Students	(%)	Students	(%)	Students	(%)	Students	(%)		
Notification function	25	40.32	36	58.06	1	1.61	0	0.00	3.39	0.52
Upload homework function	7	11.29	48	77.42	7	11.29	0	0.00	3.00	0.48
Personal tool function	8	12.90	45	72.58	9	14.52	0	0.00	2.98	0.53
Online testing function	7	11.29	46	74.19	9	14.52	0	0.00	2.97	0.51
System usage recording function	12	19.35	36	58.06	14	22.58	0	0.00	2.97	0.65
Student information function	6	9.68	40	64.52	15	24.19	1	1.61	2.82	0.61
Grade inquiry function	2	3.23	45	72.58	13	20.97	2	3.23	2.76	0.56
				Average					2.96	0.62

CONCLUSION, RECOMMENDATIONS AND IMPLICATIONS

This study mainly explored the usability of interface design in the NARERO learning system. During the process, the experiment was set to be conducted in the same space, on the same machine, and with the same light source. Analysis was conducted based on records and questionnaire tests, summarizing and comparing the level of satisfaction with the interface in expert evaluations and user evaluations.

Research Conclusions

After analyzing and summarizing the experiment records and questionnaire tests, the perceptions and level of satisfaction when using the interface were analyzed and discussed.

(1) Analysis of the expert evaluation results showed general satisfaction toward the designs of the functions in the NARERO learning system, while there was still room for improvement in terms of the aesthetic design and accessibility of the system. Of course, the experts praised the promotability and prospect of the system.

(2) In terms of the user evaluation results, most students expressed views of "neutral", "agree", or "highly agree" with regards to the evaluated content. There were more "agree" and "highly agree" responses, with average scores over 4.0. This meant that most students felt satisfied regarding the functions of the NARERO learning system.

(3) In the evaluation on the extent to which the system functions helped learning, most students expressed that the items were "helpful" or "very helpful". In particular, the "notification function" and "personal records area" were in the first and second places, which meant that the users were satisfied with functions provided by the system.

Recommendations from the Research

According to the analysis above, regarding the NARERO learning system's interface design, expert evaluation results showed:

1. The expert recommendations were as follows:

(1) If the NARERO learning system can be enhanced with more interactive digital learning systems and be successfully applied to assist learning outside traditional classroom instruction, it would have better prospect and potential.

(2) The elements relating to the various planned functionalities, instruction, and evaluation in the system had achieved the initial scale; however, the layout design was somewhat insufficient at motivating students. In the future, this area may be strengthened by lively and eye-catching aesthetic design.

(3) The calculation of time may be used as one indicator in the assessment of students being tested.

(4) It might be more feasible to implement fuzzy treatment when quantifying the difficulty levels in test questions.

(5) In online testing, students may be permitted to know their grades, or the means and standard deviations of the whole class.

2. The user recommendations were as follows:

(1) There could be hyperlinks on each page linked to each unit, without having to return to the homepage to select units.

(2) More positive feedback functions can increase students learning motivation.

(3) The test questions could be mainly based on the ones that require flexible thinking, and avoid questions that emphasize rote memorization as much as possible.

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