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Promoting in-depth reading experience and acceptance: design and assessment of Tablet reading interfaces

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This study employs an interface design on a Tablet to facilitate in-depth reading for learners and allow them to apply better strategies and skills when reading; thereby cultivating their positive attitude towards reading and improving their willingness to use Tablets. Using human-centred design, we first investigated the Tablet functions within learner wants and needs based on their reading experiences, analysed each function and its correlation to reading satisfaction, and obtained a basis for evaluation. We next employed the 10 functions demonstrating the highest importance to complete a prototyping design. Finally, based on the technology acceptance model, we employed experimental methods to verify the prototype using the post-test-only control group design. The results of the study indicate that for perceived usefulness, perceived ease of use, reading and using attitudes, and behaviour intentions, the average scores for the improved Tablet were significantly higher ($p < 0.05$) than those for the original version.

Keywords: human–computer interaction; usability; user-centred design; Kano model; in-depth reading; Tablet

1. Introduction

Among digital reading applications, Apple's iPad was released on the market in recent years and promoted the iBooks reading platform for reading application. The innovative and compelling application architecture of iBooks has not only created instructional application value for Tablets, but has also created new business opportunities for well-known booksellers worldwide. Previous studies have highlighted that printed books are more useful than digital reading (Chao and Chen 2009). Although an increasing number of people read documents on-screen, most people prefer printed copies for in-depth reading such as educational articles that are over three or four pages (Nicholas *et al.* 2008, Hillesund 2010, Liesaputra and Witten 2012, Pearson *et al.* In Press). Additionally, some researchers believe this result occurs because readers maintain that reading printed books is natural and intuitive (Liesaputra *et al.* 2009), do not want to change their existing printed-book reading experiences (Marek 1999), and possess negative opinions of digital reading (Appleton 2004). These negative influences have limited the acceptance level of using digital devices for in-depth reading. Irrespective of its disadvantages regarding usability, digital reading demonstrates multiple advantages, including multimedia functions, hypertext functions, and interactivity (Shepperd *et al.* 2008, Woody *et al.* 2010). To enhance the usability of Tablet reading and its acceptance, a user-centred design (UCD) concept should be employed to contemplate user experienced, in addition to capitalising on existing advantages (Lee and Koubek 2011). This is because emotions and perceptions directly influence attitude and willingness to use Tablet reading functions (Llinares and Page 2011).

We believe that although Tablet reading systems have reinterpreted and revolutionised digital reading, whether flaws and difficulties experienced in the past regarding in-depth reading can be eliminated is a question warranting close attention. In addition, from perspectives of users and designers in the context of human–computer interaction (HCI), users desire interactive experience with the function to meet their wants and needs (W&N), whereas designers hope to effectively understand users' W&N and pursue maximum satisfaction within limited resources. Therefore, considering usability and users' emotions, this study improves users' experiences with Tablets regarding in-depth reading, enhancing usability and use attitude, and thereby increasing user willingness. Based on this goal, we proposed the following questions: (1) When the current tablet reading system is employed to do in-depth reading, are there any W&N functions connected with reading strategies or skills that have not been satisfied? (2) How can we effectively evaluate each W&N function to maximise satisfaction? (3) What are the differences between the users' preferences on

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interactive interface and improved interactive interface in in-depth reading?

In this article, we focused on the needs and experiences during the process of in-depth reading. Additionally, because the reading software of Apple iPad and iBooks play a leading role in the Tablet reading system, this research applied the reading software as the typical research subject.

2. Theoretical background

2.1. Reading and reading strategies

Goodman *et al.* (2003) argued that reading was a process of understanding articles and that the purpose of reading was to obtain information and understand written works (Adler 1949). Graesser *et al.* (1994) discovered that, during the reading process, readers can simultaneously establish goals, read, and construct meaning; readers can apply reading strategies and skills to increase article comprehension and incorporate new and existing knowledge to achieve learning goals. Reading strategies and skills, including underlining, note-taking, text cueing, drawing pictures, signalling, and defining article structures (Cook and Mayer 1983, 1988, Brown 2005, Chao and Chen 2009, Pearson *et al.* In press), assist readers in determining key words and sentences, organising structures, and further establishing external connections, thereby promoting reasoning extending beyond articles (Cook and Mayer 1983). Therefore, appropriate reading strategies for in-depth reading assist in the comprehension of reading material. Fulfilling reading strategies are key factors that influence the usability of digital reading devices when using an interactive interface.

2.2. Exploring user experience on human-centred design

If usability is regarded as an HCI prerequisite, UCD is an approach for achieving goals (Hasan *et al.* 2012). ISO 13407 (1999) believed that understanding users, analysing requirements designing, and evaluation composed four major activities for UCD (Figure 1). The process consists of (1) specifying the context of use; (2) specifying requirements; (3) creating design solutions; and (4) evaluating designs. Through this process, not only will new product or service concepts become more clearly defined (Rhee *et al.* 2010), usability will also be guaranteed (Jokela 2004). Additionally, by analysing user experience qualitatively, we can understand emotional explanations and requirements for satisfaction and dissatisfaction for HCI (Kincl and Štrach 2012, Partala and Kallinen 2012).

Based on these descriptions, the emphasis of this concept is that a design must consider the behavioural pattern and needs of a user, as well as potential problems that a user may encounter, and to incorporate user experience as a part of design (Kincl and Štrach 2012, Kotamraju and van der Geest 2012). To gain user acceptance, products must be designed to fulfil the needs of users (ISO 1999) instead of requiring users to accommodate to the design of products (Katzeff *et al.* 2012).

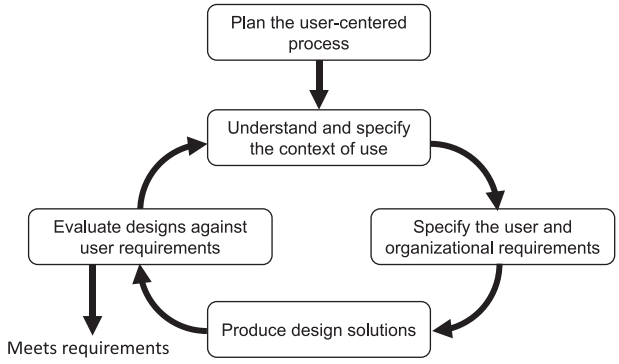

Figure 1. Standard for user-centred design processes for interactive systems. Adapted from ISO (1999).

2.3. The Kano model that considers both the psychological and physical levels

In past assessments of W&N functions, it was typically hypothesised that a linear relationship exists between the indicator of the performance of products and services and satisfaction (Sireli *et al.* 2007). However, this relationship does not apply to all indicators, because different levels of indicators have different impacts on satisfaction (Llinares and Page 2011, Kincl and Štrach 2012). For this reason, Kano *et al.* (1984) proposed the Kano model because it places 'functional availability' on the horizontal axis and 'psychological satisfaction' on the vertical axis based on the two-dimensional concept. In relation to functional availability, depending on the relationship corresponding to varying levels of psychological satisfaction expression, the users' needs can be classified into 'attractive', 'one dimensional', 'must be', 'indifferent', and 'reverse' (Kano *et al.* 1984); the corresponding relationship is illustrated in Figure 2. The effects of each quality on user satisfaction are explained as follows:

The 'must-be' quality: Users perceive this quality to be indispensable. When this quality is present, users' satisfaction increases moderately; however, when this quality is absent, dissatisfaction results instantly.

The 'one-dimensional' quality: The more sufficiently this quality is provided, the higher the user's satisfaction will be, and vice versa. Therefore, the provision of this quality is always desirable, and absence should be avoided.

The 'attractive' quality: When this quality is present, users are extremely satisfied; however, users are not dissatisfied when this quality is unavailable. Surprises are desirable, especially when they are unanticipated.

The 'indifferent' quality: The presence or absence of this quality does not affect users' satisfaction.

The 'reverse' quality: The presence of this quality causes user dissatisfaction, whereas the absence of this

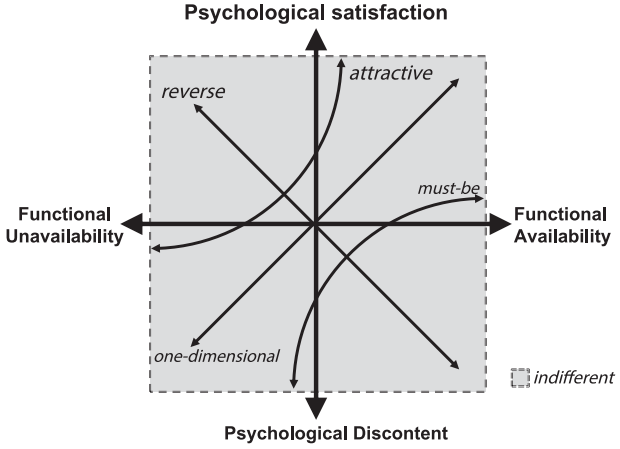

Figure 2. The relationship between functional availability and psychological satisfaction in the Kano model. Adapted from Berger *et al.* (1993).

quality leads to greater satisfaction. Scholars have further developed the application techniques of this concept. For example, when classifying need items, the results of the 'Kano model bidirectional questionnaire' (Matzler and Hinterhuber 1998) can be used as a basis, and the 'decision-making matrix' (Table 1) can be employed for definition, thereby obtaining the attribute categories of each W&N function (Bilgili *et al.* 2011). Regarding design decision-making, the quantified established importance obtained from the questionnaire results and the calculation formula can be used as a basis for assessment (Sireli *et al.* 2007).

By adopting the concept of the Kano model while considering psychological and physical levels to evaluate HCI designs, more detailed evaluations based on the properties of W&N were allowed.

2.4. Technology acceptance model

Usability is the key factor determining whether a product can succeed (Skov and Stage 2012). Many studies investigating user acceptance of information technology products have employed the technology acceptance model (TAM) proposed by Davis (1989) as the theoretical framework to predict and interpret behaviours in adopting new technologies (Pan and Jordan-Marsh 2010, Yeh and Teng 2012). The reason for adopting TAM is that TAM is a mature model and it effectively and accurately interprets the usability of technology products and users' attitude (ATUT) and behaviour intention (BI) towards technology products (Kim and Maher 2008, Pan and Jordan-Marsh 2010). Additionally, TAM is helpful in understanding the usage behaviour of users towards a system. Furthermore, TAM is more appropriate for measuring the overall user experience than usability is (Yang *et al.* 2011).

In practice, users' acceptance is subjectively evaluated by surveying participants' attitude towards electronic products or prototypes (to test if a design concept would be useful and easy to use in the future), using questionnaires (Yang *et al.* 2011).

The TAM theory holds that users' perceived usefulness (PU) and perceived ease of use (PEOU) jointly affect users' ATUT, and that ATUT and PU are decisive factors for BI (Davis *et al.* 1989). Wherein, PU refers to an individual's opinion on the extent of performance improvement of which using a system can bring. PU has a positive influence on ATUT and BI; it is also positively influenced by PEOU. PEOU refers to an individual's perception on the ease of use of a system; it is positively influenced by PU and ATUT. ATUT refers to an individual's attitude towards a system; it is positively influenced by PU and PEOU. BI refers to the degree of willingness of an individual in using a system; it is positively influenced by PU and ATUT (Jan and Contreras 2011).

Although Davis *et al.* (1989) discussed past studies of external variables, these variables were not actually included in their research model. After conducting considerable research of the TAM, academics have proposed an increasing number of external variables for the model, with each variable possessing differing explanatory power for their contexts. To extend the TAM, Venkatesh *et al.* (2003) integrated the results of these studies and proposed a new framework named 'the unified theory of acceptance and use of technology' (UTAUT), which differs significantly from the TAM by including external variables for exploration.

3. Method

This study employed qualitative and quantitative research methods to achieve research goals. The research framework

Table 1. The decision-making matrix of function attributes.

	Dysfunctional form of the question				
Functional from of the question	I like it that way	It must be that way	I am neutral	I can live with it that way	I dislike it that way
I like it that way	Questionable	Attractive	Attractive	Attractive	One dimensional
It must be that way	Reverse	Indifferent	Indifferent	Indifferent	Must be
I am neutral	Reverse	Indifferent	Indifferent	Indifferent	Must be
I can live with it that way	Reverse	Indifferent	Indifferent	Indifferent	Must be
I dislike it that way	Reverse	Reverse	Reverse	Reverse	Questionable

Note: From Matzler and Hinterhuber (1998).

can be divided into three parts (Figure 3). We first held focus group interviews and used affinity diagrams to identify W&N in users and then established an evaluation foundation for W&N function items, using the Kano model and questionnaires. We next completed a prototyping design using the 10 W&N function items possessing the highest importance. Finally, based on TAM, experimental methods were used to investigate PU, PEOU, ATUT, and BI for using and reading.

3.1. Identifying needs

3.1.1. Gather W&N data

To collect reader perceptions and ideas on their W&N and their experiences with interactive interfaces for in-depth reading, this study employed a focus group interview (Kuniavsky 2003), and the results were used as the material for the subsequent W&N analysis. To ensure that participants have appropriate commonality to trigger recognitions in the discussion, while maintaining appropriate differences and experiences among participants (Barbour 2007), the focus group interview was planned as follows:

Target participants: Considering that students before the junior high school do not have maturely developed independent reading and learning capabilities (Gunning 1996), we chose students currently enrolled in junior high school or above as our study participants.

Pre-requisites for participation: (a) Being an iPad owner capable of operating the iBooks reading software; (b) not having been previously involved in focus groups (Kuniavsky 2003).

Recruitment: The participants were recruited during the summer vacation using the judgement sampling technique, in the hope to investigate the variety of the research population, instead of the representativeness (Barbour 2007). Therefore, to 'obtain a wider variety of viewpoints', forming six to eight focus groups was more appropriate (Krueger and Casey 2000).

Grouping: The data collected from focus groups were conversations among group members and the characteristics of group members were observed to influence the content of discussion; therefore, members of each group should have similar characteristics in principle. Participants of this study were divided into groups based on their age. Each group consisted of five to seven members (Courage and Baxter 2005, Stewart *et al.* 2007), and the members in the same group were not acquainted with one another (Kuniavsky 2003).

Qualification: Sufficient experience with in-depth reading should be ensured for all participants, so that they can obtain relevant contextual experience. Two copies of pre-compiled reading materials (in .epub format) with different contents were given to the participants two days before the interview, with the expectation that they would read with the iBooks software on the iPad. All participants were notified that a test would be held on the interview date, and only those who scored above 80 out of 100 points would be accepted into the focus group interview.

Reading material and test design: The pre-compiled reading materials were expository writings extracted from books or textbooks requiring in-depth reading. Six books were compiled, including: *Introduction to economics*, *English essays*, *Management psychology*, the *Digital SLR camera user manual*, *Understanding the copyright law*, and *Logic*. Among them, *Management psychology* is written in English while the others are written in Chinese. Each reading material was about 7000–10,000 words in length; the original diagrams were kept during the compilation; and the typographical layouts of the original texts were kept in the .epub format to the extent possible. The participants were asked to pick up two books of their choice with the condition that the contents of the books should be unfamiliar to them. The design of the test paper was based on the two levels proposed by Gagné *et al.* (1993), namely literal and inferential comprehensions. The type of questions in the test paper included multiple-choice questions (60%) and question and answer (40%). The purpose of this design was to ensure that each participant had a certain amount of reading experience that they could share during interviews.

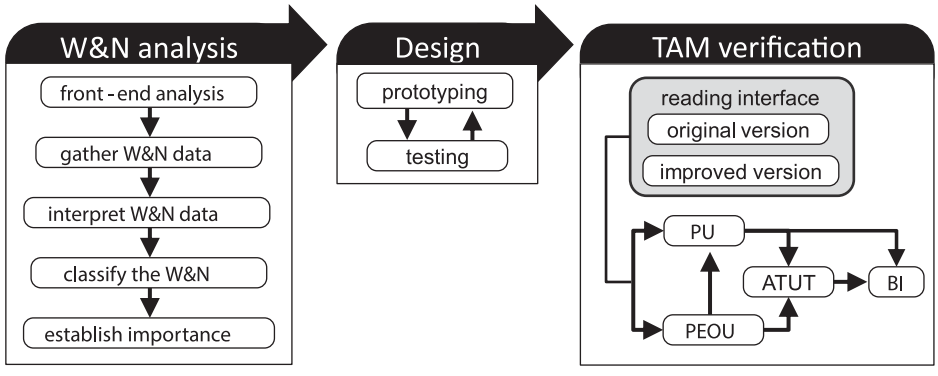

Figure 3. Research procedures and framework.
Notes: PU, perceived usefulness; PEOU, perceived ease of use; ATUT, attitude; BI, behavioural intention.

The formal focus group interview: The proceedings of the interview were elaborated in Table 2. The process was recorded in writing and supplemented by video footage.

3.1.2. *Interpret W&N data*

The W&N data collected during each interview were recorded in written form along with the situational information observed during the interview, which was then be summed up to formulate a common demand in its context. After the interview, researchers employed the affinity diagram to organise and categorise diffusive and qualitative raw data and identify the common points among the categorised groups (Beyer and Holtzblatt 1998, Courage and Baxter 2005, Sharp *et al.*, 2007). Researchers first wrote opinions, ideas, situational observations, and quotes that contained valuable information on individual note cards. The note cards were coded to form affinity points. A bottom-up approach was then employed to use the analysis of affinity points to categorise correlations and label each group with a title. A hierarchical affinity diagram was created after the groups were compiled. Finally, researchers interpreted the needs, intentions, and behaviour of readers according to the affinity diagram to identify common W&N items for readers (Beyer and Holtzblatt 1998).

3.1.3. *Classify the W&N*

To clarify the relationship between the W&N functions and reading satisfaction, a group of 'relative' questions were used (Matzler and Hinterhuber 1998) to classify individual W&N functions. To help the participants further understand the individual functions, written explanations supplemented by appropriate illustrations were used, as shown in Figure 4. The participants were asked to check the options on both sides of the questions according to their emotional responses when asked whether a specific function was 'available' or 'unavailable'.

Next, based on the opinions reflected towards specific functions, the participants' responses to each W&N function were classified according to the 'decision-making matrix of function attributes'. In the end, the classification results of all participants were accumulated by the frequency of occurrence, with their values after a 'mode' operation representing the 'category of the W&N function attributes' (Matzler and Hinterhuber 1998).

Table 2. The process and content of the focus group interview.

Item	Content	Duration
Warm-up and introduction	(1) The host introduced the agenda, rules, confidentiality agreement, and discussion topics with a PowerPoint presentation (2) Group members introduced themselves to one another during ice-breaking activities	15 min
Interview guide	(3) During the reading of the books selected, which reading strategies and interactive interfaces were used? Were there any questions or requirements that could make the reading and learning smoother? (4) Were there any frustrations encountered during previous in-depth readings with the reading system of Tablets? How did they happen? Was there any W&N for the interactive interface? Discussions derived from these experiences (5) What reading strategies and skills were used before while reading textbooks?	50 min
Summary	(6) What functions should be included in future versions of e-books/e-textbooks? How can these functions be applied during reading?	25 min

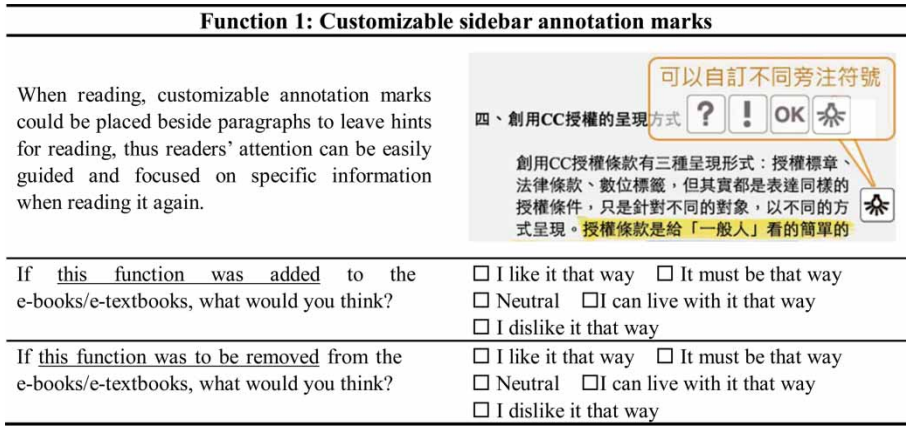

Figure 4. Kano model bi-directional questionnaire.

Figure 5. The presentation system for the improved version of the interactive interface.

3.1.4. Establish importance

First, the impact of whether a function was available on the level of satisfaction or dissatisfaction was calculated; that is, the resulting reading satisfaction (S_i) when a function was available, and the resulting reading dissatisfaction (D_i) when a function was unavailable (Berger *et al.* 1993). This computation is based on the frequency of the classification results and performed with the formula (Matzler and Hinterhuber 1998) as follows:

$$S_i = A_i + \frac{O_i}{A_i} + O_i + M_i + I_i, \tag{1}$$

$$D_i = M_i + \frac{O_i}{A_i} + O_i + M_i + I_i, \tag{2}$$

where the closer the value is to 1, the greater its impact; and the closer the value is to 0, the smaller its impact.

Next, to enable the sorting of individual W&N functions in order of importance, using the Kano model to gain a more insightful understanding into all W&N functions that affect reading satisfaction, we focused on pursuing higher reading satisfaction when making decisions for the interactive interface design of the reading software (Matzler and Hinterhuber 1998). This paper employed the assessment method suggested by Sireli *et al.* (2007), which takes the bigger value of S_i and D_i as the value for absolute importance (w_i). At the same time, the value of relative importance (W_i) was computed using the following formula:

$$W_i = \text{Max}\left(\frac{S_i}{\sum_{i=1}^{m} S_i}, \frac{D_i}{\sum_{i=1}^{m} D_i}\right). \tag{3}$$

3.2. Design

First, of all individual W&N functions, the 10 items with the highest W_i were selected for the design of the improved version. Adobe Photoshop, Flash, and Captivate software were used as the tools for design, following the interface logic and visual style of the iBooks 1.3. Next, target users were invited four to six persons at a time (Nielsen 1994) to test the operations and perceptions of the interactive interface prototyping by means of thinking aloud (Rubin and Chisnell 2008), then seeking possible ideas for improvement from the results of the tests (Wilson 2009). In the end, revisions were reiterated with feedback from the participants, until the improved version of the interactive interface was completed, as shown in Figure 5 (see online supplemental archives).

3.3. Verification

3.3.1. Measurements

According to the scope and aims of this study, the examined constructs and operational definitions are shown in Table 3. Adopting a seven-point Likert scale and the measurement were revised to reflect the actual situation of the research setting. After the adequacy of the items in the scale was verified by experts, the content validity was established.

3.3.2. Experimental design and validity

In the experimental manipulation, the demonstration description system of the interactive interface of the improved version in 2.2 Design is the experimental group (EG); the iBook 1.3 reading software (the original version) is the control group (CG). The recruitment conditions of the research participants are listed as follows: (a) familiar with the operation of iPad and iBooks and having three month or more of use experience, (b) aged between 14 and 50 years old, (c) do not have significant visual or auditory impairment after correction; and (d) had never read the terms set forth by the 'Creative Commons'.

Because the objective of this study was to identify the differences between the current interactive interface and the interface enhanced by the design solutions, only the TAM framework was verified, and the external variables associated with the UTAUT were considered control variables in this study. Thus, this paper synthesised related research and identified three external variables that influence the field in

Table 3. Operational definitions and measures of variables.

Construct	Operational definition	Source of measure
PU	The extent to which the demands for in-depth reading can be satisfied using this interactive interface	Davis (1989)
PEOU	The extent of ease of adopting this interactive interface	
ATUT	The attitude towards adopting this interactive interface	Venkatesh *et al.* (2003)
BI	Subjective willingness to adopt this interactive interface in the future	Davis (1989) and Venkatesh *et al.* (2003)

Note: PU, perceived usefulness; PEOU, perceived ease of use; ATUT, attitude; BI, behavioural intention.

question: computer self-efficacy, characteristics of information technology, and subjective norms. Among them, computer self-efficacy is considered to have a significant influence over the users' PEOU (Venkatesh and Davis 1996). The characteristic of information technology is considered to have a potential direct and indirect influence over the PU and PEOU (Davis *et al.* 1989, Hong *et al.* 2002) and to have indirect influence over the BI (Davis and Venkatesh 1996). The subjective norms in this paper refer to the intention to use the tablet reading system by individuals and their friends. They had an indirect influence over the ATUT and BI (Jan and Contreras 2011, Jonas and Norman 2011).

To avoid the influence of external variables and to improve the validity, this paper took several measures. A post-test-only CG design was employed to verify the experimental design, such that selection biases and interaction deviations were reduced. The criteria for participants to be screened were set as those who were familiar with the operations of iPad and iBooks, with more than three months of experience. For the information technology dimension, the original version was used as a blueprint for the design of the improved version to homogenise the non-manipulative parts of the two versions used by the EG and CG, so that consistency would be maintained in the operational logic and visual style of the interactive interface. For the subjective norms section, the randomisation assignment sampling technique was used for both the EG and CG. The laboratory experiment was conducted to minimise the variances of errors derived from other exogenous variables.

3.3.3. Instruments and materials

Instruments included (a) a laptop to show the presentation slides of the laboratory instructions and to display the interactive interface presentation system; (b) an iPad 2 (iOS 4.3); (c) introductory readings for the 'Creative Commons' (in .ePub format, with about 9000 words); and (d) the introduction and presentation system for the interactive interface.

3.3.4. Procedure

The experiment consisted of seven steps, as shown in Table 4.

4. Result

4.1. Focus group interview

Based on the focus group planning results, a total of 46 participants were recruited. The participants were divided into three groups based on their age: K7 to K12 (16 students), undergraduate and graduate students (16 students), and non-students (12 participants). Members of these three groups were subdivided into eight focus groups with five

Table 4. Detailed instructions and experimental steps.

Procedure	EG	CG
Instructions for the experiments (5 min)	Experimental activities and agenda explained with PPT	
Reading the text (30 min)	Introduction to the 'Creative Commons' read with iBooks 1.3	
Test (15 min)	The 'Literal Comprehension' section was made up of multiple-choice questions, accounting for 60%; the 'Inferential Comprehension' section was made up of questions and answers, taking up the remaining 40%	
Random grouping	The participants were assigned to the EG or the CG randomly	
Experimental manipulations (15 min)	System presents the improved version of the interactive interface	N/A
Surveying (10 min)	Aimed at the improved version	Aimed at the original version (iBooks 1.3)
Grading	Participants who failed the test (score < 80) were regarded as an invalid sample	

to seven members in each focus group (three focus groups the K7–K12 and the undergraduate/graduate students, and two focus groups for the non-student group).

4.2. The results of W&N analysis

4.2.1. The identification of W&N function items

The researchers analysed the user experiences using the affinity diagram and identified the common W&N function items for readers. The results are presented in Table 5.

4.2.2. Classifying needs and establishing importance

When classifying each W&N function, a total of 38 participants completed the Kano model two-directional questionnaires. The obtained results of calculations and categorisations based on these questionnaires are presented in Table 6. Results representing responses from all participants can be found in the 'accumulated counts' section; the categorisation results of the Kano model for each W&N function can be found in the 'Kano category' section. In the 'importance' section, the numerical values of S_i and D_i indicate that when a function was 'available' or 'unavailable', readers were 'satisfied' or 'dissatisfied' (the effect on 'satisfaction' or 'dissatisfaction' was greater when the value was close to 1). Based on the value of W_i, we can infer the contribution of each W&N item made to learner satisfaction. Using this method, researchers constructed an importance ranking for every W&N item.

4.3. Verifying the TAM assessment

4.3.1. Demographics

In the design evaluation stage, the survey had a valid sample size of 66 participants. Among the 34 samples for the EG, 14 were women and 20 were men. The ages of participants were between 13 and 48 years ($M = 25.12$, SD $= 10.05$). Overall, 18 participants were students and 16 were not. Among the 32 samples for the CG, 15 were women and 17 were men. The ages of participants were between 14 and 43 years ($M = 24.41$, SD $= 8.03$). Overall, 19 participants were students and 13 were not.

4.3.2. Reliability and validity tests

The Cronbach's α reliability coefficient was used to measure the internal consistency of various dimensions of the survey. The analytical result indicates that Cronbah's α for all constructs surpassed 0.82. Moreover, with respect to whether the constructs were truly able to reflect actual conditions, exploratory factory analysis was conducted for verification; the analytical results show that the factor loading values for all question items exceeded 0.78, suggesting that the survey scale used in this study had good reliability and validity.

4.3.3. Verifying the PU, PEOU, ATUT, and BI assessments

The average scores of the four constructs in the EG and CG groups were significantly different ($p < 0.001$), and the scores of the independent samples tests for the four perceived variables, PU, PEOU, ATUT, and BI, in the EG were significantly greater than those in the CG (Table 7). Based on the values of η^2, the effect size of all four constructs were greater than or equal to 0.37, suggesting a strong relationship (Cohen 1988). Furthermore, the statistical powers $(1 - \beta)$ were all 1, suggesting a very good rate of correct statistical judgement. The improved version is superior to the original version in terms of PU, PEOU, ATUT, and BI, and there are strong relations among the four constructs.

5. Discussion

5.1. Results based on the obtained W&N functions

This study investigated which W&N for reading strategies and skills had to be satisfied when readers used Tablet reading systems to conduct in-depth reading. Therefore, we identified 21 W&N function items (Table 5). In addition, empirical results for the original Tablet reading system showed that the mean value for PU was not ideal, indicating that certain functions of the original Tablet reading system were not satisfied when readers participated in in-depth reading. When analysing the 21 W&N functions, researchers discovered that the items in the 'annotation' and 'comparison' sections were similar to reading strategies and skills mentioned in previous studies. This phenomenon occurred because the same reading process behaviours were adopted in this and previous research. People may have inherited previous habits of reading printed books in their digital reading strategies; that is, during the digital reading process, people attempt to satisfy needs and behaviours satisfied during printed-book reading experiences. In comparison to the reading system for printed books, Tablets emphasise multimedia, personalisation, and social networking applications. In comparison to traditional modes of digital reading, the 21 W&N functions for the Tablet reading system presented more intuitive and multiple-use contexts. Consequently, Tablets concretely alter interactive relationship between readers and interactive interfaces from a book-oriented reading system to a learner-oriented reading system, which allows autonomous learners to gain increased levels of support.

5.2. The application of classify the needs & establish importance

This study also investigated how to effectively evaluate each W&N function to maximise satisfaction. The methods adopted in this study can be used to conduct three indicator evaluations for each function item: (1) the mental attributes of learners regarding the function item, (2) the effect of the

Table 5. The functions and details of common W&N items for readers identified using the affinity diagram.

Function	Details
Annotation	
Customisable sidebar annotation mark	When reading, customisable annotation marks can be placed as necessary beside paragraphs to leave clues for reading, thus readers' attention can be easily guided and focused on specific information when reading it again
Bookmark notes	A bookmark flags a whole page. Bookmark notes further explain why the bookmark was created, or provide some additional information
Classification of annotations	The content of the highlighted sections and notes can be sorted and classified according to the sidebar annotation marks, which can then be used to help the readers categorise the concepts for review and memorisation
Freehand line	Freehand lines can be drawn on the page without the restrictions of formatted texts, thus helping to substantialise thoughts and establish inherent connections within the text
Hiding annotations	Temporarily shut off highlights/freehand line/notes/sidebar annotation marks without deleting the annotations, so that the readers can concentrate on the text
Customisable supplementary material	External supplementary materials can be inserted with hyperlinks. The material can be a URL, document, or multimedia file
Audio and video notes	In addition to text notes, photograph, video, or audio notes can also be created via embedded components of the iPad
Audio	
Audio reading	A range of selections can be based on words, sentences, paragraphs, and full texts, and the selected text can be read with Text to Speech to promote visual, auditory, and oral multi-sensory learning
Audio repeating	The auditory contents of the highlights and notes can be played back and exported into files. This can be used for audio-based learning on occasions in which the hands and eyes are inconvenient (such as when driving, commuting, or jogging)
Audio dictionaries	Dictionaries with built-in audio pronunciation functions
Comparison	
Language comparison	Switching to a bilingual mode when reading books in a foreign language, with the foreign and native languages, respectively, displayed and compared on the left and right sides of the page. When a sentence is selected, it is highlighted on both the left and right page simultaneously; and when scrolling through the page, both the left and right pages will be scrolled synchronously
Cross-referencing	To display cross-referenced contents on the left and right pages simultaneously, so that the contents can be compared and analysed easily
Navigation	
Record of reading progress	Provides 10 entries of the latest records of the reading process to avoid getting lost in the path of nonlinear reading, and effectively reduce the cognitive workload
Scopes of search	Readers can choose any of the three scopes for search, including: current chapter, chapters already read, and the entire book
Sharing	
Annotation sharing	Annotations can be shared with peer readers of the same e-book by export and import
Discussion board for learning	Online discussion boards can be created for various chapters in the book, where readers may share and discuss issues of concern and interest
Reading critiques and rating	Includes book critiques and star ratings of the reader himself and other readers, and additional information about books
Personalisation	
File of personalised reading process	Records the personalised reading status of each book and presents them in clear diagrams and texts
Reading plan	Pace of learning is customisable, and the implementation of the plan can be managed and traced
Electronic test	Provides the functionality of a timed test, and test grading and answering
Other	
Reading pen	Unique capacitive stylus with well-sized pen tip, suitable for swift and precision selection and clicking operations for all occasions. There is a button at the holding spot on the pen, which can be used to adjust the line thickness and brush shapes, draw freehand lines in freehand mode, or control audio and video functions in the audio mode

availability or non-availability of function items, and (3) the contribution of each W&N item to reading satisfaction. In practical applications, we can consider the status and characteristics of a reading system to identify optimal and effective function items that can improve reading satisfaction. Particularly, trade-offs can provide effective guidance and maximise effectiveness. However, Kano categories may change over time; for example, an 'attractive' function item

Table 6. The computation results of the Kano category and importance of individual W&N functions.

Function	Accumulated counts				Kano category[a]	Importance			
	A	O	M	I		S_i	D_i	w_i	W_i (%)
Annotation									
Customisable sidebar annotation mark	18	11	8	1	A	0.76	0.5	0.76	**6.23**
Bookmark notes	23	3	2	10	A	0.68	0.13	0.68	5.58
Classification of annotations	12	6	2	18	I	0.47	0.21	0.47	3.86
Freehand line	21	10	2	5	A	0.82	0.32	0.81	**6.73**
Hiding annotation	9	9	3	17	I	0.47	0.29	0.47	3.86
Customisable supplementary material	5	13	3	17	I	0.47	0.42	0.47	4.43
Audio and video notes	18	14	5	2	A	0.84	0.5	0.84	**6.89**
Audio									
Audio reading	13	17	6	1	O	0.79	0.61	0.79	**6.48**
Audio repetition	23	10	4	1	A	0.87	0.37	0.87	**7.14**
Audio dictionaries	4	5	27	2	M	0.23	0.84	0.84	**8.86**
Comparison									
Language comparison	13	17	5	3	O	0.79	0.58	0.79	**6.48**
Cross-referencing	9	21	7	1	O	0.79	0.74	0.79	**7.81**
Navigation									
Records of reading progress	2	5	29	2	M	0.18	0.9	0.90	**9.49**
Scopes of search	5	4	7	22	I	0.24	0.29	0.29	3.06
Sharing									
Annotation sharing	11	16	6	5	O	0.71	0.58	0.71	6.12
Discussion board for learning	11	15	6	6	O	0.68	0.55	0.68	5.80
Reading critiques and rating	15	5	6	12	A	0.45	0.29	0.53	3.69
Personalisation									
Files of personalised reading process	11	8	15	4	M	0.5	0.5	0.76	5.27
Reading plan	3	7	6	22	I	0.26	0.34	0.34	3.59
Electronic test	7	5	5	21	I	0.32	0.26	0.32	2.74
Other									
Reading pen	27	6	4	1	A	0.87	0.26	0.87	**7.14**
Total						12.19	9.48		100

Note: The bold texts are the 10 highest W_i items among the W&N functions.
[a]Q, questionable quality; A, attractive quality; M, must-be quality; O, one-dimensional quality; R, reverse quality; I, indifferent quality.

Table 7. Independent sample *t*-tests for PU, PEOU, ATUT, and BI for different reading systems.

Construct	*M* (SD)		*t*	95% CI		η^2	$1-\beta$
	EG ($n = 34$)	CG ($n = 32$)		LL	UL		
PU	5.59 (0.14)	2.90 (0.19)	64.03***	2.61	2.78	0.99	1
PEOU	5.83 (0.11)	5.61 (0.18)	6.01***	0.15	0.30	0.37	1
ATUT	5.77 (0.17)	4.21 (0.48)	17.44***	1.38	1.74	0.83	1
BI	5.85 (0.23)	3.77 (0.25)	34.88***	1.97	2.21	0.95	1

Notes: CI, confidence interval; LL, lower limit; UL, upper limit; η^2, measure of strength of relationship.
***$p < 0.001$.

may be classified as 'one dimensional' or 'must be' in the future.

5.3. The findings of the assessment

The study also evaluated whether improvements in the Tablet reading system could enhance usability and positive reading and using attitudes during the in-depth reading process, thereby increasing learner willingness to use Tablets. Empirical results (Table 7) show that the PU, PEOU, ATUT, and BI for the improved Tablet were higher than those for the original version. In addition, researchers discovered that with respect to the PU dimension, the PU of the original version ($M = 2.90$) presents a significant difference from that of the improved version ($M = 5.59$); while in the PEOU construct, the PEOU of the original version ($M = 5.61$) differs little from that of the improved version ($M = 5.83$). From the perspective of the TAM, PEOU has a positive

correlation on PU, and they both jointly and positively affect ATUT. Therefore, we may bring to light from Table 7 that the significant difference of ATUT between the original version ($M = 4.21$) and the improved version ($M = 5.77$) is mainly caused by the relatively low value of PU in the original version.

Moreover, the BI is positively affected by both PU and ATUT; as a result, significant differences are found in BI between the original version ($M = 3.77$) and the improved version ($M = 5.85$). This phenomenon shows that readers will first be driven by the usefulness of a product, followed by ease of use; if there is only ease of use but without usefulness, users tend to turn their backs on the product. In other words, PU plays a larger role in affecting users' willingness to adopt a product than PEOU does. This echoes the findings of other studies (Davis *et al.* 1989, Kwon *et al.* 2007, Jan and Contreras 2011, Yang *et al.* 2011).

5.4. Research implications

The purpose of this study was to investigate how the interactive interface design improved the experience of in-depth reading, thereby enhancing reading and using attitudes and willingness to use Tablets. The results of this study demonstrate that the application of in-depth reading strategies and skills regarding the reading system of Tablets has not been satisfied. The personnel who devotes to developing e-books/e-textbooks should focus on the problem and propose solutions. We suggest that in addition to the innovative potential of Tablets, the development personnel should also emphasise the existing reading experiences to create appealing reading experiences, thereby enhancing the willingness of learners to use Tablets. We believe that this can be beneficial to the long-term development of reading and learning and digital reading.

From the perspective of technical and learning applications, we discover that the level of information technology coupling with learning will be deepened in the future. The relationship between learners and texts will become learner oriented, and the presentation of books will become dynamic, which allows readers to control the learning content. Consequently, the content of reading and learning will be guided, organised, connected, and compiled, to satisfy the necessary reading strategies and skills during the process of reading.

When developing reading systems, we suggest that the development personnel reference the 21 W&N function items identified in this study or employed the research methods of this study to identify effective W&N. In addition, the research results indicate that learners are motivated by PU before considering PEOU, demonstrating that in addition to ease of use, the development of reading systems must satisfy learner reading needs regarding the applications of W&N. Otherwise, learners reject the systems.

6. Conclusions

Information technology has been an assistant in the application of education and learning. We hope that the application of technology can assist learner comprehension of articles and enhance autonomous learning in the process of in-depth reading, thereby forming positive reading and using attitudes and improving learner willingness to use Tablets.

We believe that printed books and digital reading systems are complementary and possess distinct advantages and disadvantages. This study is the first step in addressing this issue for the coming digital era. To promote digital reading and cultivate new reading strategies and skills for in-depth reading, readers must learn to adjust, which involves complicated and individualised mental processes and considerations of cultural background and environmental contexts. We suggest that further research should address these topics.

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