A Computer-Assisted Approach for Conducting Information Technology Applied Instructions

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ABSTRACT

The growing popularity of computer and network technologies has attracted researchers to investigate the strategies and the effects of information technology applied instructions. Previous research has not only demonstrated the benefits of applying information technologies to the learning process, but has also revealed the difficulty of applying them effectively. One of the major difficulties is due to the lack of an easy-to-follow procedure for inexperienced teachers to design course content with proper use of suitable information technologies. In this paper, a model for conducting information technology applied instructions is proposed. The novel approach can assist teachers in designing information technology applied course content based on the features of subject materials and the learning status of the students. An experiment on a Chemistry course in a junior high school was conducted to evaluate the performance of our novel approach.

Keywords: analytic hierarchy process; computer-assisted learning; computer-assisted tutoring; distance education; information technology applied instruction

INTRODUCTION

With the popularity of computers and information technologies, systems and learning theories have been developed for web-based learning in higher education, while the effectiveness of these implementations has been empirically evaluated as well (Barrett & Lally, 1999). New technologies are presented each day in more activities and, of course, in education. This great innovation is changing the concept of information technology applied instruction, not only in terms of the teaching process itself, but also with respect to the methodologies applied. The new information age has changed the educational system, with the result being the birth of information technology applied instruction and computer-assisted learning.

Researchers have suggested that teachers examine the instructional strategies supported by various environments so as to determine the relative effectiveness of these environments. One of the major difficulties of information technology applied instructions is the lack of an easy-to-follow procedure for inexperienced teachers to design subject content such that suitable information technologies can be properly applied to the tutoring process. Chou (2003) indicated that teachers are the key to the successful use of the Internet for both teaching and learning. However, without any assistance, teacher's anxiety can often reduce the success of such technological and pedagogical innovations.

To cope with this problem, a systematic instructional design model is proposed to assist teachers in employing proper information technologies in the development of tutoring strategies and learning activities. The model provides a systematic procedure that guides inexperienced teachers to select proper information technologies or tools for the courses they teach by taking the features of the course content and the learning status of the students into consideration. With the help of this innovative approach, teachers can easily learn how to design a quality learning activity that employs proper information technologies to improve the learning performance of the students. An experiment on a Chemistry course in a junior high school was conducted to evaluate the performance of this novel approach. The results of this experiment show that the developed instructional design can significantly improve the learning performance of students, and hence we conclude that the present approach is desirable.

RELEVANT RESEARCH

The rapid progress in information technology can help instructors to teach more efficiently and effectively by employing new tutoring strategies with appropriate software tools and environments. Several studies have demonstrated the benefits of applying information technologies to instructions, such as Computer Scaffolding (Guzdial et al., 1996), CSCL (Computer-Supported Collaborative Learning) (Harasim, 1999), CSILE (Computer-Supported Intentional Learning Environments) (Scardamalia et al., 1989) and CiC (Computer-Integrated Classroom) (Eshet, Klemes, & Henderson, 2000).

The benefits of using Adaptive CAI (Computer-Assisted Instruction) systems make them desirable educational tools. A CAI system can be thought of as a tutorial system, which is a guided system to provide well-constructed information. Students can use this system to learn how to use a technical system or how to operate an instrument. For example, Oakley (1996) presented computer-based tutorials and a virtual classroom to teach circuit analysis. Meanwhile, Zhou, Wang, and Ng (1996) proposed a tutorial system using artificial intelligence technology. Later, Davidovic, Warren, and Trichina (2003) argued that greater efficiency can be achieved by basing the system development on the theoretical background of cognitive knowledge acquisition. In addition, some researchers have utilized auxiliary software to enhance their tutorial systems (Harger, 1996, Williams & Kline, 1994; Marcy & Hagler, 1996), while others have provided interactive tutorials for manuals with a graphical user interface (Wood, 1996) or with rich multimedia formats (Sears & Watkins, 1996; Lee & Sullivan, 1996).

Furthermore, owing to the rapid growth of network technologies, considerable work has been done on the use of the Internet as a distance-learning tool (Huang & Lu, 2003), especially the discussions and surveys concerning web-based educational systems and their applications (Shor, 2000) and the use of web-based simulation tools for education (Sreenivasan et al., 2000). Moreover, some practical usages of web-based educational systems in the control area have been reported (Poindexter & Heck, 1999). In addition to their obvious uses in a distance-learning scenario, computer and network technologies can also be used to enrich classroom experience through the use of a data projector (Ringwood & Galvin, 2002). For example, Exel et al. (2000) demonstrated a web-based remote laboratory for System Control courses. Meanwhile, Junge and Schmid (2000) showed how remote experiments could be conducted via the Internet. Several well-known software environments have been developed to support remote experiments, such as LabVIEW (Ramakrishnan et al., 2000) and MATLAB/Simulink (Apkarian & Dawes, 2000).

Although information technologies have provided a more interactive and flexible learning environment, educational researchers have indicated that teacher's anxiety can often reduce the success of such technological and pedagogical innovations (Gressard & Loyd, 1985; Heinssen, Glass, & Knight, 1987; Chou, 2003; Todman & Day, 2006). This anxiety is owing to the lack of sufficient knowledge to apply the computer systems to their classes, which has become a barrier to conducting information technology-applied instructions (Marcoulides, 1988). Consequently, instructional design with information technologies has become an important and challenging issue. To cope with this problem, in the following sections, a systematic model is proposed.

MODEL FOR CONDUCTING INFORMATION TECHNOLOGY APPLIED INSTRUCTIONS

Esquembre (2002) classified information technologies that can be applied to the tutoring process into five categories:

1. **Tools for the acquisition and manipulation of data**, including examples ranging from the use of simple spreadsheets to the more advanced microcomputer-based laboratories (MBL) and video analysis.
2. **Multimedia software**, which is based on the concept of hypermedia, and presents information in a structured, usually graphical way.
3. **Microworlds and simulations**, which consist of very complex computer programs, constructed by experts, to implement a simulation of a wide range of physical processes and laws.
4. **Modeling tools**, which are software environments that allow students to build their own computer simulations.
5. **Telematics and Internet tools**, which exploit the capability of computer intercommunication, making use of all of the previous types of software.

Most of such software and tools are popular in schools. Table 1 shows seven candidate information technologies that have been frequently applied in the instruction of Chemistry courses (Tsai, Hwang, & Tseng, 2004). In conducting the arrangement of information technology applied instruction, the possible number of difficulty levels for a subject unit, as well as that of the learning levels for a student, is 3, 5 or 7 levels, as widely used in psychoanalysis (Hwang et al., 2006). For example, in Table 2, three difficulty levels (namely "Easy", "Middle" and "Difficult") and three learning levels (namely "Naïve", "Average" and "Good") are used to describe the status of subject units and students. Assuming that the difficulty level is "Easy" and the learning level is "Naive", the weight of IT_1 (Search Engine) is greater than that of IT_3 (E-mail), which implies that IT_1 (Search Engine) is more appropriate for the subject unit than IT_3 (E-mail). For another situation, difficulty level "Easy" and learning level "Naive", the order of proper information technologies for the course is IT_1(Search Engine)>IT_3(E-mail)>IT_4(Word Processor)>IT_2(BBS)>IT_6(CAI) = IT_7(Spreadsheets)>IT_5 (Presentations). Similarly, if the difficulty level is "Difficult" and the learning level is "Average", the arrangement of information technology applied instruction is IT_4(Word Processor)>IT_5(Presentations) >IT_6(CAI)> IT_3(E-mail)> IT_1(Search Engine)>IT_2(BBS) = IT_7(Spreadsheets).

In addition to the difficulty levels of subject units and the learning levels of the students, there are several other factors which need to be taken into consideration when applying information

Table 1. Illustrative examples of information technologies

Information Technology	Definition	Application
Search Engine (IT_1)	Web-based programs for searching data on the Internet	Searching for supplementary subject materials
BBS (IT_2)	Software systems to provide information exchange in public	Performing group-discussion on line Enabling use of an announcement board for each class
E-mail (IT_3)	Software systems to provide person-to-person information exchange with or without attached files.	Performing group-discussion on line Allowing the teacher to be a personal-consultant for each student Allowing students to discuss homework and to share information
Word Processor (IT_4)	Document editing software, such as Microsoft Word.	Enabling students to write reports
Presentations (IT_5)	Presentation software, such as Microsoft PowerPoint	Assisting the teacher to make presentations to the students Enabling students to present homework to the teacher and classmates
CAI (IT_6)	Computer-assisted instruction software.	Stimulating real-world phenomena Offering drill and practice functions for some specific courses Offering testing and evaluation functions for some specific courses
Spreadsheets (IT_7)	Computer software that offers analysis and statistical functions on the data represented in tabular form, such as Microsoft Excel.	Assisting teachers and students to present analysis and statistical results, such as Pie charts or bar charts.

Table 2. Illustrative example of the systematic model for conducting information technology applied instructions

Difficulty Level	Learning Level	Degrees of Fitness
Easy	Naive	$IT_1(a_1)>IT_3(a_3)>IT_4(a_4)>IT_2(a_2)>IT_6(a_6)=IT_7(a_7)>IT_5(a_5)$
	Average	$IT_2(a_2)>IT_1(a_1)=IT_6(a_6)>IT_3(a_3)=IT_4(a_4)>IT_5(a_5)>IT_7(a_7)$
	Good	$IT_6(a_6)>IT_4(a_4)>IT_1(a_1)>IT_3(a_3)>IT_7(a_7)>IT_2(a_2)>IT_5(a_5)$
Middle	Naive	$IT_2(a_2)>IT_3(a_3)>IT_4(a_4)>IT_7(a_7)>IT_6(a_6)>IT_1(a_1)=IT_5(a_5)$
	Average	$IT_1(a_1)>IT_6(a_6)>IT_7(a_7)=IT_2(a_2)>IT_3(a_3)=IT_5(a_5)>IT_4(a_4)$
	Good	$IT_3(a_3)>IT_7(a_7)>IT_4(a_4)>IT_2(a_2)>IT_1(a_1)>IT_5(a_5)>IT_6(a_6)$
Difficult	Naive	$IT_1(a_4)>IT_2(a_2)>IT_1(a_1)>IT_7(a_7)=IT_6(a_6)>IT_5(a_5)>IT_3(a_3)$
	Average	$IT_4(a_4)>IT_5(a_5)>IT_6(a_6)>IT_3(a_3)>IT_1(a_1)>IT_2(a_2)=IT_7(a_7)$
	Good	$IT_5(a_5)>IT_7(a_7)>IT_3(a_3)>IT_2(a_2)>IT_6(a_6)>IT_1(a_1)>IT_4(a_4)$

technologies to the tutoring process. It is difficult for experienced teachers to arrange learning activities and tutoring strategies for information technology applied instruction without any aid.

To cope with this problem, in this article, a systematic model for conducting information technology applied instructions is proposed based on the Analytic Hierarchy Process (AHP) method (Saaty, 1977, 1980), which is a systems analysis technique for solving decision-making problems. AHP provides a hierarchical framework within which multi-attribute decision problems can be structured. Its use of ratio scale along with paired relative comparison enables AHP to compare intangible attributes. AHP has the flexibility to combine quantitative and qualitative factors, to handle different groups of actors, and to combine the opinions expressed by many experts. It can also help in stakeholder analysis (Ramanathan, 2001).

The methodology of AHP is basically to decompose a complex decision problem into elemental issues to create a hierarchical model. Without loss of generality, we shall use the design of a Chemistry course as an illustrative example to demonstrate our novel approach, consisting of four steps:

1. **Structuring of the decision problem into a hierarchical model**

In this step, the decision-making problem is decomposed into several elements according to their common characteristics, based on which a hierarchical model with different levels is constructed. For example, Figure 1 shows a hierarchical model of a Chemistry course with five levels. The top three levels are "Course Design", "Difficulty level" and "Learning level". The fourth levels are factors affecting "Learning level", such as "Computer Skill", "Learning Achievement" and "Attitude of Learning". The lowest level contains some candidate alternatives of applied information technology, such as "Search Engine", "BBS", "E-mail", "Word", "PowerPoint", "GSP" and "Excel".

2. **Making pair-wise comparisons and obtaining the judgmental matrix**

In this step, the elements of a particular level are compared pair-wise, with respect to a specific element in the immediate upper level. For example, the pair-wise comparison matrix of the fourth level of the hierarchical model in Figure 1 is given in Table 3. The meaning of each value used in the matrix is described in Table 4 (Vargas, 1990), where each A_{ij} value follows the rules: $A_{ij}>0$, $A_{ij}=1/A_{ji}$, $A_{ii}=1$ and $X_j = \Sigma A_{ij}$. For example, in Table 3, $A_{11}=1$, $A_{22}=1$, $A_{33}=1$, $A_{12}=1/7$, $A_{21}=7$, $A_{13}=1/3$, $A_{31}=3$, $X_1 = (1+7+3)=11$ and $X_2 = (1/7+1+1/3)=1.476$.

3. **Determining local priorities and consistency of comparisons**

Figure1. Illustrative example of an AHP hierarchical model for a Chemistry course

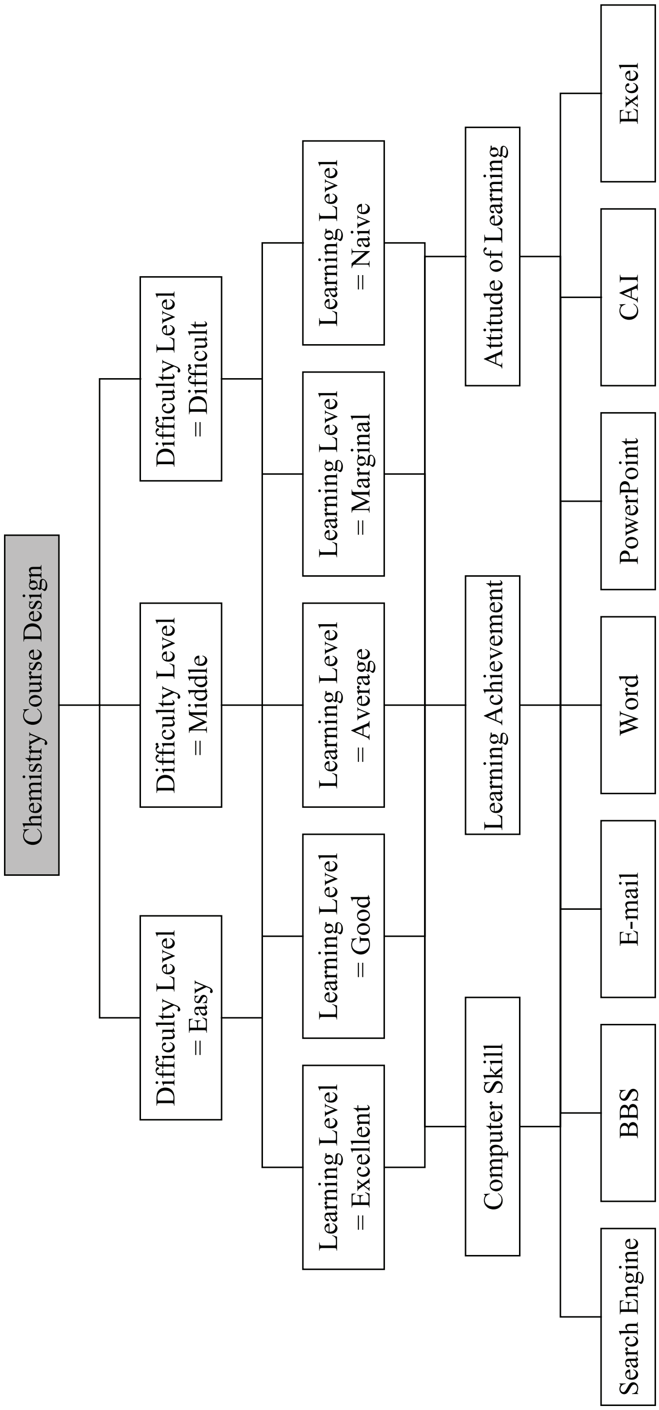


Table 3. The pair-wise comparison matrix of the fourth level

A_{ij}	Computer Skill	Learning Achievement	Attitude of Learning
Computer Skill	1	1/7	1/3
Learning Achievement	7	1	3
Attitude of Learning	3	1/3	1
Xj = ΣAij	11	1.476	4.333

Table 4. The AHP comparison scales (Vargas, 1990)

Intensity of importance	Definition	Description
1	Equal importance	Elements A_i and A_j are equally important
3	Weak importance of A_i over A_j	Experience and judgment slightly favor A_i over A_j
5	Essential or strong importance	Experience and judgment strongly favor A_i over A_j
7	Demonstrated importance	A_i is very strongly favored over A_j
9	Absolute importance	The evidence favoring A_i over A_j is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate	When compromise is needed, values between two adjacent judgments are used
Reciprocals of the above judgments	If A_i has one of the above judgments assigned to it when compared with A_j, then A_j has the reciprocal value when compared with A_i	

Before calculating the local priorities, $B_{ij} = A_{ij}/X_j$ and $Y_i = \Sigma B_{ij}/n$ need to be computed first. For example, in Table 5, $B_{11} = 1/11 = 0.091$ and $B_{12} = (1/7)/1.476 = 0.097$, $Y_1 = (0.091+0.097+0.077)/3 = 0.088$ and $Y_2 = (0.636+0.678+0.692)/3 = 0.669$.

The matrix W_i is then calculated by summarizing the product of each column of matrix A, say Ai, and the corresponding Y_i as $W = \Sigma Y_i \times A_i$. For example,

$$W_i = 0.088 \times \begin{bmatrix} 1 \\ 7 \\ 3 \end{bmatrix} + 0.669 \times \begin{bmatrix} 1/7 \\ 1 \\ 1/3 \end{bmatrix} + 0.243 \times \begin{bmatrix} 1/3 \\ 3 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.265 \\ 2.014 \\ 0.73 \end{bmatrix}$$

The Consistency Ratio (CR) can then be calculated by

CR = Consistency Index (CI)/ Random Index (RI),

Table 5. Illustrative example of B_{ij}'s and Y_i's

B_{ij}	Computer Skill	Learning Achievement	Attitude of Learning	$Yi = \Sigma B_{ij}/n$
Computer Skill	0.091	0.097	0.077	0.088
Learning Achievement	0.636	0.678	0.692	0.669
Attitude of Learning	0.273	0.226	0.231	0.243

where CI = $(\lambda_{max} - m)/(m-1)$ for $\lambda_{max}=[\Sigma(W_i/Y_i)]/m$, and the RI values for matrix size ranging from 1 to 8 can be found in Table 6 (Ramanathan, 2001).

Therefore, $\lambda_{max} = [(0.265/0.088)+(2.014/0.669)+(0.73/0.243)] / 3 = 3.008$, and CI = (3.008 - 3)/(3-1) = 0.004. In the above example, matrix size is 3, and hence RI=0.58, and CR = 0.004 / 0.58 = 0.007. Since CR = 0.007<0.1, consistency of comparisons is acceptable.

4. **Aggregation of local priorities**

After calculating W_i for each level of pair-wise comparison matrices, the final priority can be derived. Let W(P|Q) denote the priority weight of P under the circumstance that Q is true. In the example given above, by assuming that difficulty level = "Easy" and learning level = "Excellent", the priority weight of IT_i is:

W[Easy, Excellent, IT_i] = W(difficulty level is "Easy") × W(learning level is "Excellent"| difficulty level is "Easy") × W("Computer skill"| learning level is "Excellent") × W("IT_i"| "Computer skill")+W(difficulty level is "Easy") × W(learning level is "Excellent"| difficulty level is "Easy") × W("Learning achievement"| learning level is "Excellent") × W("IT_i"| "Learning achievement")+W(difficulty level is "Easy") × W(learning level is "Excellent"| difficulty level is "Easy") × W("Attitude of learning"| learning level is "Excellent") × W("IT_i"| "Attitude of learning")

After deriving the weight of each IT_i, the priorities of applying different information technologies under some specified considerations can be obtained.

Based on the constructed AHP hierarchical model, a standard interacting and computation procedure is then invoked to decide the priority of each candidate alternative to the top-level

Table 6. Average consistencies of random matrices

Size	1	2	3	4	5	6	7	8
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41

goal (Saaty, 1980). After deriving the weight of each IT_i, the priorities of applying different information technologies under some specified considerations can be obtained.

IMPLEMENTATION AND OPERATIONS OF I-DESIGNER

Based on the proposed model, the I-Designer, a web-based computer-assisted system for conducting information technology applied instructions has been implemented. The I-Designer aims to assist inexperienced teachers to plan learning activities and course content for applying information technologies to improve student learning performance. For most of the teachers who seldom or never use information technologies in their classes, this step-by-step guidance could be very helpful to them in preparing their classes.

The flowchart of the AHP-based model for conducting information technology applied instructions is given in Figure 2, which includes the following steps:

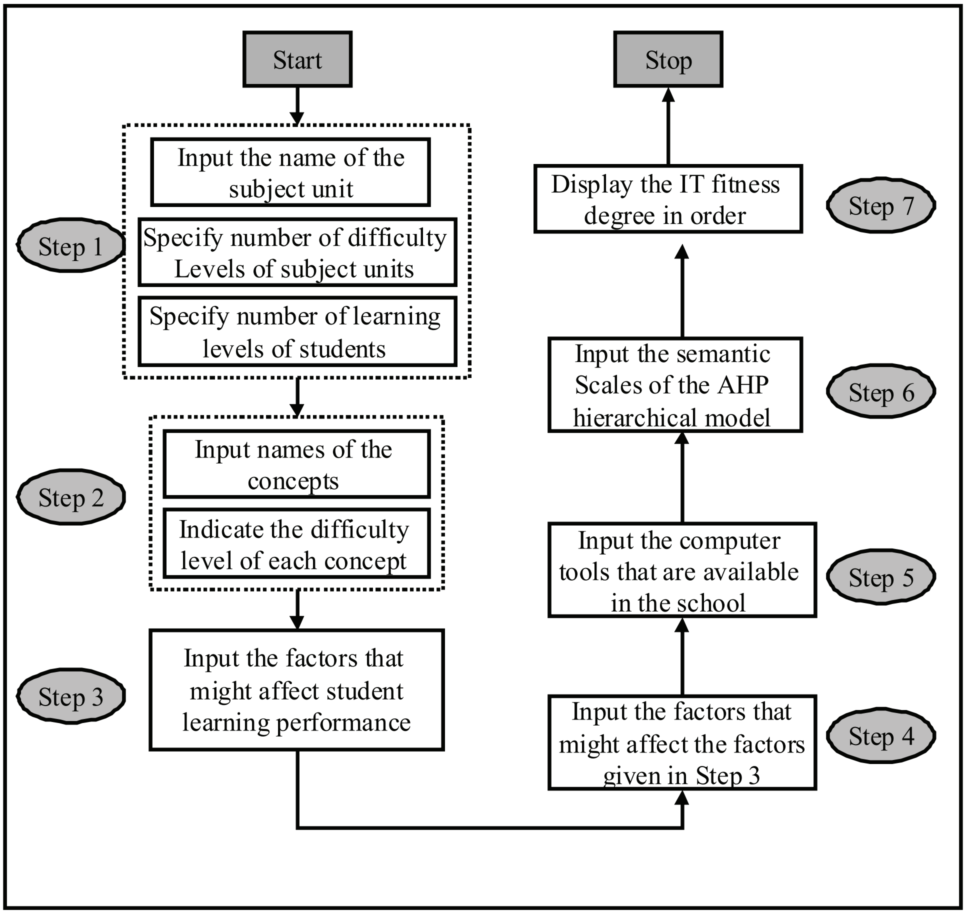
Step 1: Input the name of the subject unit. Furthermore, specify the number of difficulty levels to classify the concepts in the subject unit (3, 5 or 7 levels) and the number of learning levels to identify the learning status of the students (3, 5 or 7 levels). For the example given in Figure 3, the teacher has entered "Chemical reaction" as the name of the subject unit, and chosen "3" as the number of difficulty levels, and "5" as the number of learning levels. That is, the candidate difficulty levels are "Easy", "Average" and "Difficult" and the candidate learning levels are "Excellent", "Good", "Average", "Marginal" and "Naive".

Step 2: Input the names of the concepts in the "Chemical reaction" unit, and indicate the difficulty level of each concept. As shown in Figure 4, the teacher has identified "Atoms" as an "Easy" concept, "Chemical compounds" as an "average" concept, and "Chemical formulas" as a "Difficult" concept.

Step 3: Input the factors that might affect student learning performance. I-Designer has provided a manual containing several possible factors that might affect student learning performance. The teacher can either select feasible candidates from or enter new factors to I-Designer. The example given in Figure 5 shows that "attitude of learning", "computer skills" and "learning achievement" have been selected as the most critical factors affecting student learning performance in applying information technologies to the Chemistry course.

Step 4: Input the computer tools that are available in the school. Those computer tools are the candidate information technologies that might be applied to the tutoring process of the course. A list of the most frequently used information

Figure 2. Flowchart of the systematic model



technologies is displayed on the right side of the screen as a reference for inexperienced teachers to select possible candidate information technologies. In the example given in Figure 6, the teacher has entered “Search engine”, “BBS”, “E-mail”, “Microsoft Word”, “Microsoft PowerPoint”, “CAI” and “Microsoft Excel” as the candidate information technologies.

Step 5: Input the semantic scales of the AHP hierarchical model. I-Design will make pair-wise comparisons and present the analysis results according to the input semantic scale. Figure 7 demonstrates the user interface for inputting the semantic scale of the AHP hierarchical model. While comparing the importance of factors Ai and Aj, the input value “1” indicates that the two factors are of equal importance;

Figure 3. Illustrative example of operations in Step 1

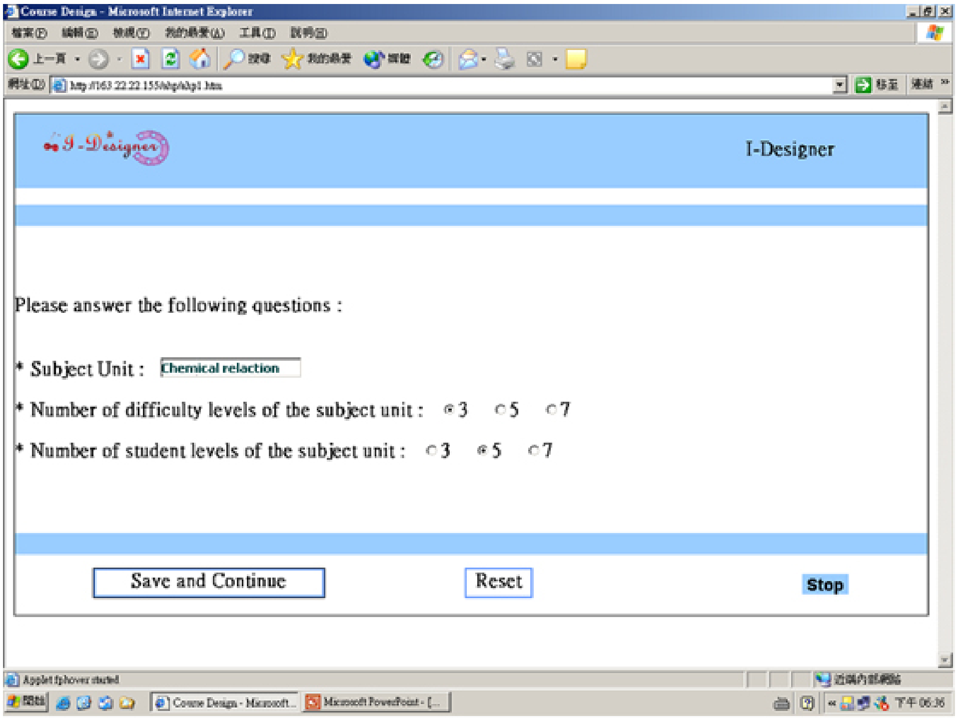


Figure 4. Illustrative example of operations in Step 2

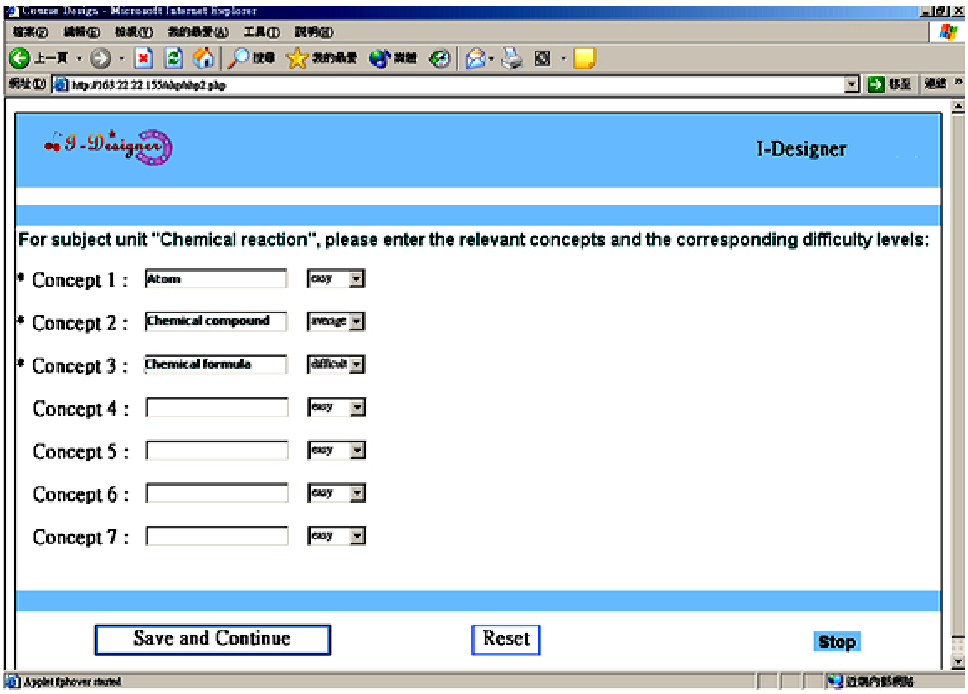


Figure 5. Illustrative example of operations in Step 3

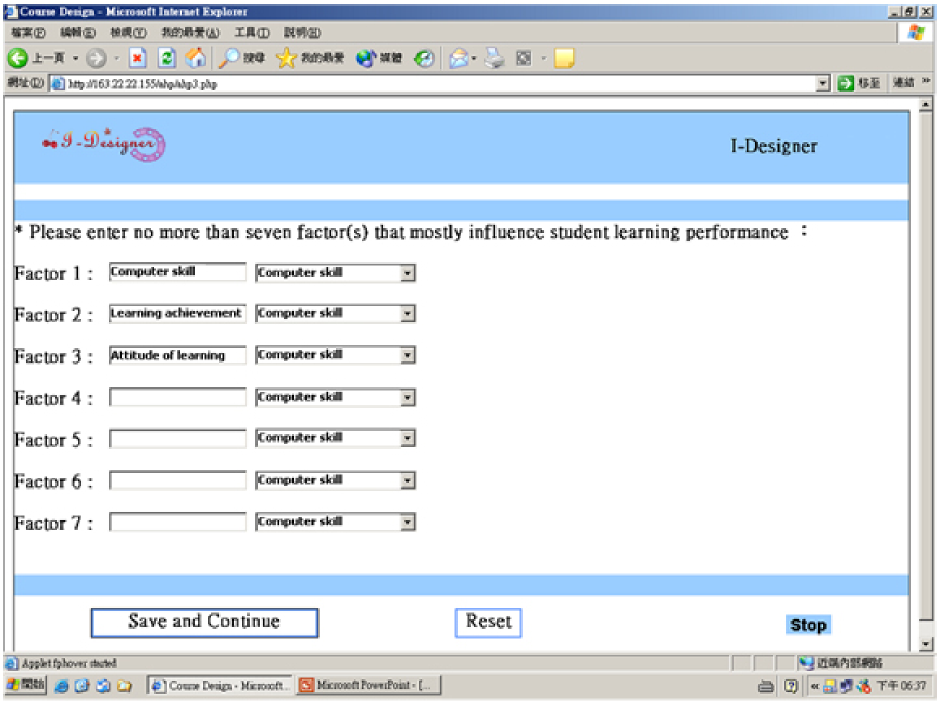


Figure 6. Illustrative example of operations in Step 4

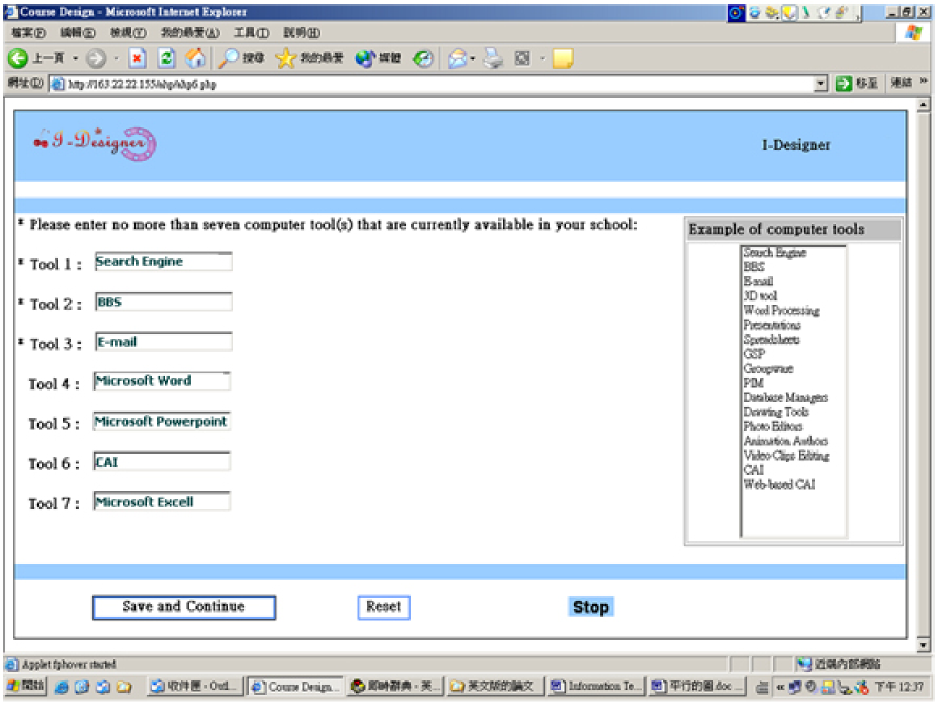
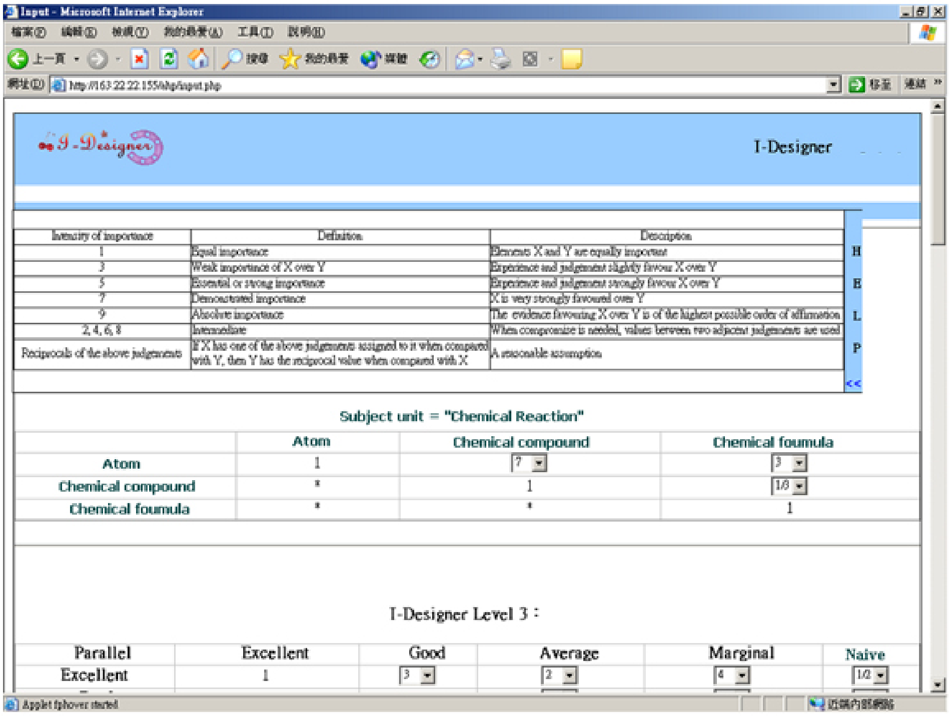


Figure 7. Illustrative example of operations in Step 5



"3" represents that experience and judgment slightly favor Ai over Aj; "5" implies that experience and judgment strongly favor Ai over Aj; "7" indicates that Ai is very strongly favored over Aj; "9" represents that the evidence favoring Ai over Aj is of the highest possible order of affirmation. In addition, when compromise is needed, values between two adjacent judgments (i.e. "2", "4", "6" and "8") are used.

Note that the computations for determining the applicability of each information technology to each concept with different difficulty levels, the suitability of each information technology to the student with different learning levels, and the relationships among the factors that might affect student learning performance and student learning levels are obtained by invoking AHP with some background knowledge given by experienced teachers. Therefore, inexperienced teachers only need to enter basic data, that is, the difficulty levels of the concepts in the subject unit, student learning levels and the interested learning factors.

Step 6: Display the analysis results. Assume that the following results are obtained after performing the AHP analysis:

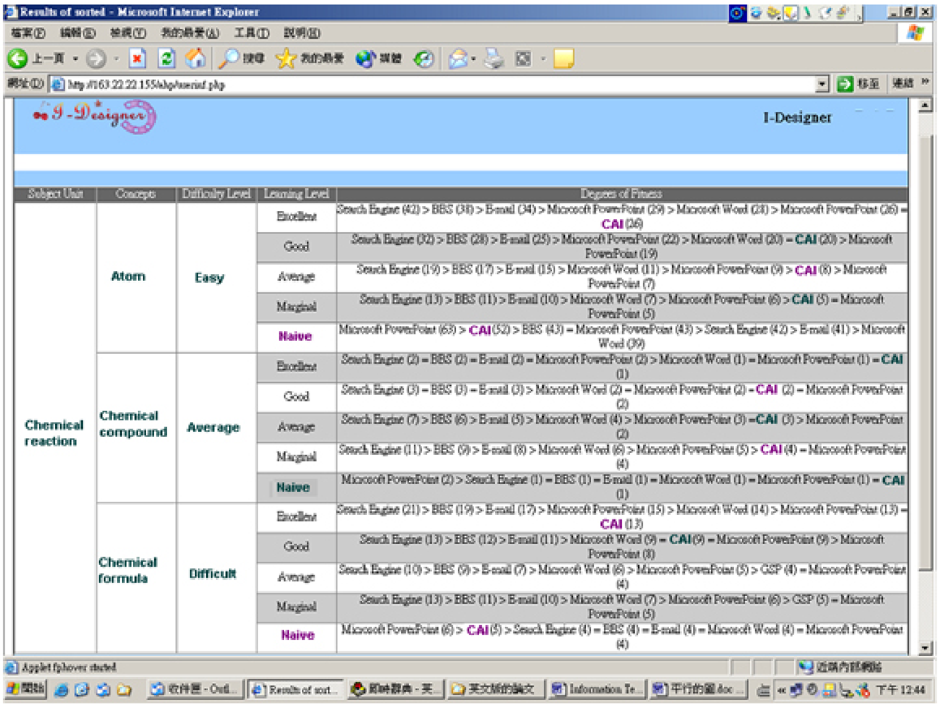
IF Subject unit "Chemical reaction" and
Concept "Chemical formula" and
Difficulty level is "Difficult" and
Learning level is "Excellent"
THEN Search Engine(21) > BBS(19) > E-mail(17) > Microsoft Excel(15) > Microsoft Word(14) > Microsoft PowerPoint(13) = CAI(13)

This rule shows that the priority weights of Search Engine, BBS, E-mail, Microsoft Excel, Microsoft Word, Microsoft PowerPoint and CAI are 21, 19, 17, 15, 14, 13 and 13, respectively. Consequently, the Search Engine is a more suitable tool for learning "Chemical formula" than BBS, and BBS is more suitable than E-mail… etc. As shown in Figure 8, I-Designer depicts the analysis results by showing a list of candidate information technologies ordered by the corresponding priority weights for each combination of subject unit, relevant concepts, difficulty levels, and learning levels.

EXPERIMENTS AND EVALUATION

To evaluate the efficacy for conducting information technology applied instructions, an experiment was conducted from March 2003 to June 2003

Figure 8. Analysis results with ordered priority weights



on a Chemistry course in a junior high school. One hundred and twenty-eight students participated in the experiment, and were separated into two groups, each consisting of sixty-four students.

The pre-test aimed to ensure that the students in the control group and experimental group had an equivalent basis for taking the course. The test sheet of the pre-test contained twenty multiple-choice questions. The t-test for the pre-test results of the control group and experimental group is shown in Table 7. The t-value is –0.891 and p-value is 0.374. Consequently, the pre-test results of the control group and experimental group are not significant at a confidence interval of 95%. That is, the students in the control group and the experimental group had equivalent ability when beginning the course.

After three months, a post-test was performed to compare the learning performance of the students in both groups. In this test, the students received twenty multiple-choice questions as in the pre-test. The t-test for the post-test results of the control group and experimental group is shown in Table 8. The t-value is 4.222 and p-value is 0.000. Consequently, the post-test results of the control group and experimental group are significant at a confidence interval of 95%. From the experimental results, it can be seen that the students in the experimental group achieved significantly higher performance than those in the control group, and hence we conclude that the new approach is helpful in enhancing student learning efficacy.

In addition, 33 teachers and 70 students who participated in several tutoring activities constructed by the I-Designer were asked to fill out questionnaires. Table 9 shows the analysis results of the questionnaires for the teachers. It can be seen that over 90% of the teachers indicated that the designed tutoring contents were able to promote learning motivation and help the students to understand the subject content. In addition, 77.8% of the teachers indicated that the novel approach was helpful to them in designing the learning activities.

Table 10 shows the analysis results of the student questionnaires. It can

Table 7. Statistical results of pre-test

	Control Group	Experimental Group
N	64	64
Mean	6.31	5.94
Std. Dev.	2.363	2.396
t = -0.891 sig. = 0.374		

Table 8. Statistical results of post-test

	Control Group	Experimental Group
N	64	64
Mean	9.56	12.73
Std. Dev.	4.059	4.434
t = 4.222 sig. = 0.000		

be seen that over 80% of the students agreed that the designed tutoring content could promote their learning motivation and help them understand the subject content. Moreover, 84% of the students would like to attend courses using a similar tutoring style in the future. Consequently, we conclude that I-Designer is helpful in enhancing student learning efficacy.

To further analyze the attitudes of the teachers toward using the I-Designer, we reviewed the teachers' basic data and compared this data with the answers to the questionnaire items. Of the 33 teachers who participated in the experiment, there were nine who had rich experience of applying information technologies in the courses they teach. We found that three of them (33.3%) chose "disagree" for this item while four of them (44.4%) chose "neither agree nor disagree". That is, 77.7% of the experienced teachers did not agree (by choosing "disagree" or "neither agree nor disagree") that the I-Designer was helpful to them in designing the learning activities. Nevertheless, 100% of the inexperienced teachers agreed that the I-Designer was useful to them. Therefore, it can be seen that this innovative approach is more suitable for assisting inexperienced teachers in designing

Table 9. The results of the teacher questionnaire

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The computer-assisted system (I-Designer) for conducting information technology applied instructions is easy to use.	0%	0%	3%	6.1%	90.9%
The planned tutoring contents are able to promote learning motivation.	0%	0%	6.1%	9.1%	84.8%
The planned tutoring strategy is helpful to the students to understand the subject content	0%	0%	9.1%	12.1%	78.8%
The computer-assisted system (I-Designer) is useful to me in designing the learning activities.	0%	9.1%	12.1%	12.1%	66.7%

Table 10. The results of the student questionnaire

Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The planned tutoring contents are able to promote learning motivation.	0%	8.6%	11.4%	32.9%	47.1%
The planned tutoring contents are helpful to the students to understand the subject content	0%	4.1%	14.3%	24.8%	56.8%
Would you like to receive courses with a similar tutoring style in the future?	0%	7.4%	8.6%	31.1%	52.9%

information technology-applied learning activities.

CONCLUSION

In this article, a systematic model for conducting information technology applied instructions is proposed. The novel approach can assist teachers to effectively employ information technologies in designing learning activities based on the features of the course content and the learning status of the students. Moreover, a web-based system has been developed based on the proposed model. To evaluate the performance of the novel approach, an experiment was conducted on a Chemistry course in a junior high school. The results of this experiment show that the novel approach is able to associate subject materials with proper information technologies and hence the students significantly appreciated the learning process.

For those elementary school teachers who seldom or never use information technologies in the courses they teach, the hints given by the I-Designer could be important and helpful; nevertheless, this does not imply that the approach is capable of solving all of the problems faced when applying information technologies in education. It should be clearly noted that the proposed approach can only be applied to assist teachers in designing the basic structure of the learning activities. The teachers still need to know the features of the courses they teach and make judgments based on their past teaching experience when designing the learning activities.

Currently, we are applying the I-Designer to the planning of other courses, including English and Physics courses in a junior high school, and Natural Science and Social Studies courses in an elementary school, to evaluate the applicability of our approach.

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