DEVELOPMENT AND EVALUATION OF WEBSITE TO CHECK INSTRUCTIONAL DESIGN BASED ON THE ARCS MOTIVATION MODEL

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ABSTRACT

Website that contained motivational design strategies for various instructional setting, including face-to-face lectures and self-paced learning materials, were designed and developed to help lecturers/designers improve their instruction based on the result of user reaction questionnaire. The Website has capabilities of collecting questionnaire data, analyzing them, and suggesting weak areas, based on Keller's ARCS motivational design model. Strategies to improve instruction are then suggested by retrieving from motivational strategy database that are suitable for a given instructional setting (teaching mode, target audience, characteristics of learning objectives, etc.). Formative evaluation studies were conducted to revise the Website for usability and practical effects, where the lecturers/designers worked through the Website to come up with a set of their own motivational enhancement strategies by referring to the weak areas the system analyzed and the motivational strategies the system proposed.

KEY WORDS

Instructional Design, Evaluation and Assessment in WBE, ARCS Model, Formative Evaluation, Motivation

1. INTRODUCTION

1.1. What are ID models?

Instructional Design (ID) models are practical summing of psychological as well as other researches, for helping those who create educational and training materials. Sometimes ID represents the processes of instructional material development, such as Dick & Carey Model[1] and ADDIE model[2] (i.e., Analysis, Design, Development, Implementation, and Evaluation). ID, at other times, represents a framework for the final instructional product so as to improve the effectiveness and appeal of the learning resources.

The former is called ID process, or Instructional System Development (ISD) model, whereas the later is called ID model. Systems science forms the basis of the former (i.e., formative feedback, plan-do-see, clear statement of learning objectives, etc.), whereas psychology related to human learning forms the basis of the later (i.e., information processing model of human learning, motivation theories, usability design, etc.).

Reigeluth[3] was among the first ID researchers who made clear the distinction between systematic process models for ID and design models. He prefers to call the former Instructional Development Model, to distinguish from the ID (Design) Model. Although the word ID is still used to mean both ID process and design models, this paper follows the Reigeluth's footstep.

Reigeluth's book in 1983, which is often called "The Green Book", was a major milestone in the history of ID related research, by making available and easy to compare the 8 dominant ID (design, not development) models at that time. The most well known ID model, Gagne's model of Nine Events of Instruction[4] [5], was included in the Green Book, as the model that has the strongest psychological underpinnings supporting the model. Gagne, who turned himself from an established psychologist to one of the founders of ID field, well represents the close relationship between psychology and ID. Among the 8 models in the Green Book, was John M. Keller's ARCS Motivational Design Model[6].

1.2. ARCS Motivational Design Model

ARCS Model, proposed by John M. Keller, was one of the pioneering works in the area of motivational design, whose goal is to make instruction more appealing to the learner. Motivation is often regarded as an input variable of ID that each of the learners brings into, and therefore, that should be taken care as a possible distracting factor of instruction. Motivation is also regarded as a variable in the instructional process, and therefore, should be taken

care to keep, or not to loose, during the instructional activities.

ARCS model deals learner motivation as not only an input and process variable, but also as an output variable. The goal of motivational design is such that the learner feels to keep continuing the study as the result of learning experience with well-designed instructional material. It is the appeal of instruction that would make learner's continuing motivation[7] high at the end. It is important to regard motivation as the goal of instruction, especially it has always reported that Japanese students do well in math and science in international surveys, but they are at the same time score the lowest when asked if they like math and science.

The ARCS represents four factors affecting learner's motivation, namely, Attention, Relevance, Confidence, and Satisfaction (i.e., ARCS model). The ARCS model has been created by surveying related psychological and other research and theories, so as to depict all important factors for instructional designers, but in a simplistic (easy to apply) manner. It has been well received by and widely used in the ID community, but not as well recognized by the professional community of educational psychology with few exceptions[8] [9].

The research bases of the ARCS model are wide and thorough to cover all major motivation theories and concepts. Curiosity arousal, inquiry arousal, variability are included in Attention. Familiarity, goal orientation, achievement, affiliation, and power motives are in Relevance. Goal setting, goal seeking behavior, success experience, efficacy, learned helplessness, and attribution theory are reflected in Confidence. Reinforcement, Peer praise, Equity, Consistency, and Cognitive Feedback are included in Satisfaction, just to name a few. However, practitioners don't have time to refer to all of the psychological concepts and theories, when designing instruction.

It is therefore advisable to refer to the ARCS model that covers many findings of psychological research efforts. One can save time by using the ARCS model, as compared to study all of the basic psychological concepts and theories, and to be able to judge when to apply which.

The ARCS model not only suggests four categories to divide motivational problems, but also suggests various motivational strategies in each of the four categories from different application areas. The ARCS model has been applied to such areas as courseware design[10], teacher training[11], multimedia production[12], science education[13], instructional message design[14], etc., so as to provide a set of sample motivational strategies for the designers working in those areas. However, it is still perceived that applying ID models, such as the ARCS model, may require a lot of effort.

One of the burdens that seems to prevent from using such models has been the implementation cost associated with the application of rather abstract concepts to a particular set of practical situations. There has been a gap between the potential usefulness of ID models and the actual or perceived difficulty for applying the models. There is a need for a computer-based tool to bridge this gap.

1.3. Purpose of the study

The purpose of this study was to bridge such a gap so as to make it easier to apply ID models in practical settings. It was to be done by providing a semi-automated strategy selection mechanism based on one of ID models for motivational enhancement of instruction, i.e., Keller's ARCS motivational design model. It was aimed to provide a Web-based tool to collect evaluation data, analyze them, suggest motivational enhancement strategies that fit the given instructional setting, so that the users could come up with a set of ideals to improve their instruction.

2. OVERVIEW OF THE WEBSITE

The Website "Check-and-Revise Your Motivational Design" was designed to have the following features:

1) Reaction Questionnaire Collection
2) Data Analysis
3) Motivational Strategy Database
4) Strategy Suggestion
5) Strategy Selection and Idea Plotting

2.1. Reaction Questionnaire Collection

Based on Keller's ARCS categories and subcategories (3 for each of the ARCS), Kogo and Suzuki[15] developed a Japanese version of reaction questionnaire to ask motivational characteristics of instruction using 12 items of 9-point Likert scale. Items use Semantic Differential scheme by asking how much the respondent felt about the instruction, by placing a mark in between two adjectives opposite to each other, such as (the instruction was) boring vs. interesting, useless vs. useful, etc. Web version of this questionnaire was placed as a part of this system as shown in Figure 1. As the instructor or developer of the instructional material sets up an account for each of the course titles, the system will create a file to store the data collected on the 12 items, together with open-ended comments and suggestions.

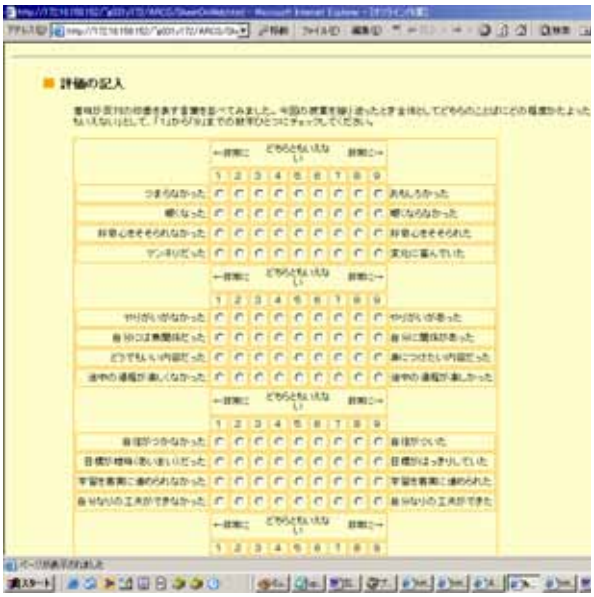

Figure 1. ARCS Reaction Questionnaire

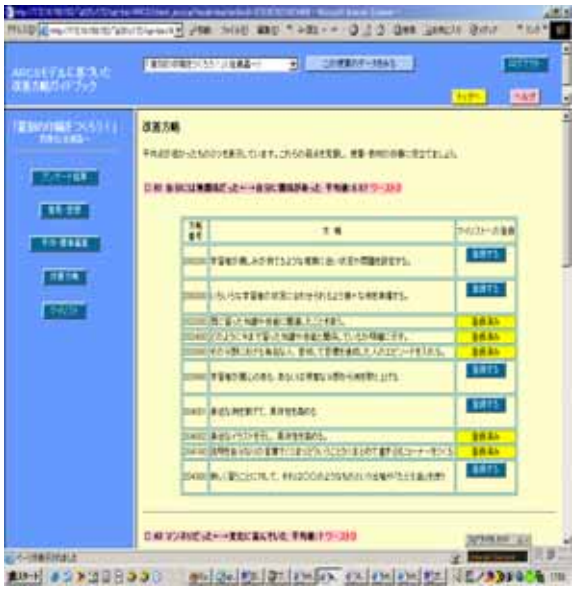

Figure 2. Strategy Suggestion

2.2. Data Analysis

Means and Standard Deviations are calculated for each item on the Reaction Questionnaire. The system then will show the results in descending order of means, so as to highlight the weak aspects of instruction. Three items with the lowest mean scores are determined as the areas that need focus in revision, so that the effort in revising instruction will be concentrated in the area that are expected the largest improvement, as suggested in the ARCS motivational design procedure.

2.3. Motivational Strategy Database

One hundred and fourteen motivational strategies, written in Japanese, were included in the prototype of the Website's database. They were taken from various resources that explain the ARCS model and its strategies by paraphrasing them to relatively easy to understand wording. Each strategy is identified as to which of the ARCS subcategories that it should be used, together with its applicability in terms of instructional settings (lecture, self-regulated learning, etc.), target group's ages, and instructional objectives (knowledge, skills, attitudes, etc.). All the strategies can be examined by the Website users, by calling the "all strategy at glance" function.

2.4. Strategy Suggestion

By linking Data Analysis section of the Website with Motivational Strategy Database, the system has a function of displaying only the suitable strategies by the ARCS subcategories. When the user select to see the best strategies for a certain instruction, the lowest three items are examined through the database to show only those strategies fit the ARCS categories as well as instructional setting. This function is to help the user concentrate on the weak areas depicted by the questionnaire analysis, although the user can select to further see the suggested strategies in other relatively problem-less areas. Figure 2 shows a result screen showing a set of strategies selected by the system based on the questionnaire results.

Figure 2 indicate, in Japanese, that the worst item in the questionnaire result was "The instruction is not related to me," which was included as the first item of Relevance. Ten motivational strategies are suggested from the strategy database. The suggested strategies include, from the top of the box, "200200: Set problems in a realistic situation, which students feel familiar," "200300: Prepare various examples to try to fit various background of the students," and "202300: Deal with things related to knowledge and skills covered in previous lessons."

2.5. Strategy Selection and Idea Plotting

The system has a function of assisting the users to collect from the suggested strategies the ones they would like to incorporate in their idea generating session for the improvement of instruction. The shopping cart model was adopted to collect only the ones they liked.

In Figure 2, out of ten motivational strategies suggested by the system for the first problem, it is shown that 5 strategies have been selected by the user. "202300: Deal with things related to knowledge and skills covered in previous lessons," which is displayed as the third in the suggested list, is one of the strategies selected for the inclusion of user's shopping cart. The right-most column indicates if each of the strategies has been selected. The remaining 5 strategies have not been selected, which can be added to the user's shopping cart at any time.

The users are then prompted to come up with their idea of revision by referring the strategies they selected. The final draft that contains selected strategies and their ideas for revision can be saved in the text format, or printed out for their references.

3. FORMATIVE EVALUATION STUDIES

The Website has undergone the following formative evaluation studies[1].

3.1. Usability Testing (One-to-One Evaluation)

Two young college faculty members were participated in an experiment to check and improve usability of the Website. Cognitive walkthrough method were adopted in one-to-one evaluation sessions in which a user was asked perform all the functions the Website provided: to see general description of the system, the ARCS model, the reaction questionnaire sheet, to log in, to see the questionnaire results, to check the enhancement strategies the system proposed, to select from the proposed strategies into "my list," to download and print revision ideas that the user summed up. Previously collected data from students who took an undergraduate lecture, that both of the participants were familiar with, were used in this experiment.

Both of the two participants could perform all the tasks with no problem in 51 and 31 minutes, respectively. Overall impressions of the system were favorably stated in the post experiment questionnaires. An interview session was then conducted for about one hour each, by going through the tasks that they performed. Comments and suggestions were noted in the interview sessions, which were categorized based on the urgency and expected magnitude of improvement.

Revisions were made and some functions were added before going on to the small group formative evaluation: Explanation of numbers 1-9 in reaction questionnaire result was added. Minor differences in wording in different parts of the system were made uniformed. Procedures that were not necessary were eliminated. Colors were added to clarify the groupings of strategies and of weakness of areas. The format for saving ideas for improvement was shifted from CSV to text.

3.2. Small Group Formative Evaluation

Ten undergraduate and graduate students were participated in the small group formative evaluation to check and improve the effectiveness of the Website. Participants examined six self-study print-based one-hour –long learning materials, which had been developed by six of the participants. Content of the material varied, including such topics as "How to assemble your own PCs," "Introduction to Knitting," "Let's study Piano Codes," and "How to calculate points in Mah-jongg." Expect for the one that each participant him/herself developed, they evaluated the attractiveness of each material by filling out Reaction Questionnaire Section of the Website, resulting in 9 sets of reaction data for each of the material evaluated.

Six of the participants who authored the material then reviewed the reaction data, and tried to come up with a set of revision ideas using the Website's Analysis, Suggestions, and Idea Plotting functions. As the results, all of the six participants were able to reach at least one revision idea, with an average of 3.67 ideas or a total of 22 ideas. Of 22 ideas, two were based on the comments and suggestions in the open-ended section of reaction data, whereas 20 were based on enhancement strategies suggested by the system. Of 20 ideas based on suggested strategies, 11 ideas were based only on strategies in the

Table 1: Number of strategies selected for "My Lists" by Ranks of Weakness

Rank	A		B		C		D		E		F		total
1	C3	1 *	R1	1	R3	1 *	C3	1 *	S1	1 *	R1	5 *	10
2	R3	1 *	A3	2 *	C3	1 *	A1	3 *	R1	2 *	A3	3	12
3	A3	1 *	C3	0	A3	2 *	S2	1 *	R2	2 *	C1	6 *	12
4	A1	2 *			C2	2 *	A3	2 *	S2	1 *	R2	4	11
5			S2	1							C3	5	6
6							C2	2 *	A3	1 *	S1	3	6
7											C2	3	3
8									C2	1 *			1
9									A2	1 *			1
10									C1	2 *			2
11			A2	1					R3	1 *			2
12									A1	3 *	A2	1	4
total	5		5		6		9		15		30		70

Note: * represent strategy that became basis for enhancement ideas
A3, C2, etc. refer area in the Reaction Questionnaire, cf. Table 2.

three weakest areas that the system called attention to the users, 4 used strategies in the three weakest areas in conjunction with the ones from other areas, whereas only 5 ideas were based solely on strategies in less weaker areas. It was seen in this experiment that the Website successfully facilitated to generate revision ideas, especially in the area that needed improvement.

In terms of strategies selected to form the "My Lists," which were kept and used in idea plotting for revisions, the six participants selected a total of seventy strategies (Table 1). The average number of strategies selected into "My Lists" was 11.67. Of 70 strategies selected, 34 were in the three weakest areas of each of the participants, whereas other 36 were in other 9 areas. That is to say, an average of 1.89 strategies were taken from the three weakest areas, whereas an average of 0.67 strategies were taken from other 9 areas. This shows that the Website facilitated to concentrate the revision effort to the weak areas depicted by the questionnaire data.

Except one participant who selected from two of the three weakest areas (i.e., Participant B in Table 1 selected no strategies for category C3), all other participants selected at least one strategy from all of their three weakest areas. Each participant selected strategies to "My Lists" from other 9 areas varied in number: from one (two participants, A and C in Table 1) to 7 areas (one participant, E in Table 1). Most (88%) of the strategies participants selected in the three weak areas were in fact used as bases of revision ideas, whereas only about a half (47%) of the selected strategies in other 9 areas was utilized in formulating revision ideas.

Ideas for further revisions were collected in the questionnaires and interviews from the 10 participants of this experiment. Several buttons and links were altered for better usability and a clearer structure of the Website.

3.3. Case Study of a University Professor

A professor who taught undergraduate level course on strategic information system used the Website to come up with a set of ideas for course improvement for the next year. This professor had no prior knowledge about the ARCS model, or the ID models.

An announcement was given in the last class asking to voluntarily submit reactions for the course by using the Website's questionnaire. All of the 87 junior and senior students who enrolled in the course received an e-mail with the URL of the Website, with which they could access to the reaction questionnaire with a click of a mouse. Forty-one students sent their reactions, which the professor used in this experiment.

After the professor went through the tutorial session of the Website, he saw the results of his students' reactions on the Website. Table 2 shows average point for each of the ARCS questionnaire items in ascending order. First three areas were identified as weakest: (1) A1: Whether or not they felt sleepy, (2) C3: Whether or not they were able to be creative in learning, and (3) S1: Whether or not the content was readily applicable.

He then used strategy suggestion and selected his own set of motivation enhancement strategies. A total of 13 strategies were suggested for the three weakest areas, of which he selected four into his "My List." Seventy-five strategies were suggested for other area, of which he selected 25. Finally he came up with a set of seven ideas of enhancement for the next year. It took him about one hour to finish this task, including the tutorial session in the beginning.

Table 2. Results of a Case Study of a University Professor

ARCS Reaction Questionnaire: Scale (1-9)						Strategies	
Items				Ave	SD	suggested	selected
A1	**Felt sleepy**	←→	**Didn't feel sleepy**	**4.93**	1.33	**3**	**1**
C3	**Not creative in learning**	←→	**Was creative in learning**	**4.98**	1.80	**4**	**1**
S1	**Not readily applicable**	←→	**Readily applicable**	**5.45**	1.73	**6**	**2**
C2	Steady progress impossible	←→	Steady progress was possible	5.56	1.73	16	4
A3	Not stimulating	←→	Variable and stimulating	5.66	1.34	10	6
C1	Objectives were vague	←→	Objectives were clear	5.68	1.51	11	4
R3	Learning process wasn't fun	←→	Learning process was fun	5.71	1.43	3	2
S3	Evaluation not consistent	←→	Evaluation was consistent	6.12	1.33	4	0
A2	Curiosity wasn't aroused	←→	Curiosity was aroused	6.24	1.40	6	2
S2	Effort wasn't recognized	←→	Effort was recognized	6.24	2.10	7	2
R1	No relevance to me	←→	Relevant to me	6.63	1.78	9	2
R2	Didn't want to acquire	←→	Wanted to acquire content	7.00	1.81	9	3

Note: number of responses=41, items are originally in Japanese.

During the interview after the task was completed, he expressed that the ARCS model helped him conceptualized the weak areas that need enhancement. Also expressed was a convenience of thinking improvement directly based on students' reactions to the course. For him, the Website was a handy tool to think systematically of motivational enhancement to his course.

On the other hand, he was concerned with considerable variation of available number of strategies in each area. It was mainly because fewer strategies were proposed in the three weakest areas than the other nine areas in his case. He said he might have selected more strategies in those areas that had more favorable students reactions, because of the availability of more strategies in those areas. More strategies are needed especially in the areas with fewer strategies in the database, for this system to be grown out of the stage of a prototype.

4. CONCLUSION

In this study, a prototype of the Website to check and revise motivational design of instructional materials was proposed. Positive results were obtained from formative evaluation. When the strategies included in the database will be enriched, this Website should become a handy tool for designers/lecturers with limited ID expertise.

It is our hope that Web-based ID tools, such as the one proposed by this study, will be made available more in the future, so as to make the potential of ID models to be fully utilized in educational practices. By combining the development of these ID tools with advancement of ID models based on empirical studies, psychological research findings would become more readily available, through the window of ID, to support practitioners in making better quality instruction.

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