Methodology of Research Study in Multi-Intelligent Online Learning

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Subjects

Thirty-four people participated in the research study. In order to broaden the study, the decision was made to develop two independent prototype learning modules, one for technical participants involved in Web technology and software development, and the other on an overview level, for Web users without a background in technology development. The research participants were divided into two equal size groups, one consisting of software engineers and Web developers, referred to as the Technical Participant group, and the other consisting of non-technical users of the Web, referred to as the Web User Participant group.

A cross-section of both technical and non-technical participants was recruited to reflect diversity in location, ethnic background, age, and gender. Since the focus group was conducted completely online, participants could be located in geographically distinct locations and could conduct their research study activities at times of their own choosing. Therefore, a geographically dispersed population, located in various parts of the United States and Canada, was recruited through postings to appropriate Web-based communities and email messages sent to various individuals, requesting forwarding of the message to others who were also suitable participants for the study.

Table 1 shows demographic information for the group of 17 Technical Participants. Table 2 contains demographic information for the 17 non-technical Web User Participants. In order to protect the confidentiality of research subjects participating in the study, subjects are referred to as ST1 through ST17 in the Technical Participant group and SU1 through SU17 in the Web User Participant group. In Tables 1 and 2, “work” indicates the current occupation listed by the participant. The heading “Computer Exp.” signifies the number of years of computer experience reported by each participant. To indicate the extent of a participant’s prior experience with online learning systems, the following choices were given: “none till I used this module” (abbreviated as “none” in the tables), “a little” (listed as “a little” in the tables), “moderate amount” (abbreviated as “moderate” in the tables), and “extensive experience” (abbreviated as “extensive” in the tables).

Table 1 Demographic Information for Technical Participants

Particip. #	Gender	Age	Location	Ethnicity	Education Level	Work	Computer Exp.	Online Learning Exp.
ST1	F	45	CA	Cauc.	B.A.	Course Develop.	25 yrs.	A little
ST2	F	45	CA	Cauc.	B.S.	Web-master	20 yrs.	Moderate
ST3	F	28	CA	Asian	M.S.	Software Engineer	5 yrs.	A little
ST4	M	17	CA	Asian	H.S. senior	Student, Web-master	7 yrs.	None
ST5	M	49	CA	Cauc.	Ph.D.	Software Engineer	30 yrs.	A little
ST6	F	46	CA	Cauc.	M.S.	Tech Support	12 yrs.	None
ST7	M	43	CA	African Amer	BSEE	Software Engineer Manager	15 yrs.	Moderate
ST8	M	18	AZ	Cauc.	College student	Comp Sci Student	5 yrs.	Moderate
ST9	M	55	CA	African Amer/ Native Amer	B.S.	Tech Writer	25 yrs.	A little
ST10	M	46	VA	African Amer	Ph.D.	Senior Program Director	25 yrs.	Moderate
ST11	M	25	CA	Cauc.	B.B.A.	Sales Engineer	2 yrs.	Extensive
ST12	F	48	CA	Asian	M.S.	CEO	25 yrs.	Moderate
ST13	M	52	CA	Asian	M.B.A.	Senior Director	30 yrs.	None
ST14	M	43	CA	Asian	B.S.	VP Prod. Manage.	20 yrs.	A little
ST15	M	47	CA	Cauc.	Ph.D.	Software Engineer	28 yrs.	A little
ST16	M	24	Ontario, Canada	Cauc.	B.A.	Prog. Analyst	2 yrs.	Moderate
ST17	M	17	CA	Asian/ Cauc.	H.S. senior	Student	9 yrs.	Extensive
		Mean Age= 38 Median Age = 45					Computer Exp Mean = 16.7yrs.	

Note: ST indicates Subject Technical to indicate a Technical Participant.

Table 2 Demographic Information for Web User Participants

Particip. #	Gender	Age	Location	Ethnicity	Education Level	Work	Computer Exp.	Online Learning Exp.
SU1	M	50	NJ	Cauc.	PhD cand.	Org Dev	25 yrs.	Moderate
SU2	F	32	CA	Cauc.	PhD	Biomed	12 yrs.	None
SU3	M	53	VA	Cauc.	MBA	Acctg	17 yrs.	A little
SU4	F	21	NY	Cauc.	B.F.A.	Theatre	6-7 yrs.	None
SU5	F	40	CA	Asian	PhD	Life Science Research	15 yrs.	None
SU6	F	54	CA	Cauc.	M.A.	Art gallery	30 yrs.	A little
SU7*	M	Comp Problems	CT	Cauc.	PhD cand.	Insurance	Comp Problems	Comp Problems
SU8	F	53	NM	Cauc.	PhD student	Counselor	4 yrs	None
SU9	F	57	CA	Cauc.	M.S.	Prof. Organizer	10 yrs.	A little
SU10	F	48	CA	Cauc.	MBA	CPA	10 yrs.	None
SU11	M	39	CA	Cauc.	B.A.	Drum teacher	3 yrs.	None
SU12	F	53	CA	Cauc.	PhD	Ed Consult	17 yrs.	None
SU13	M	54	CA	Cauc.	MBA	Software Co. CEO	32 yrs.	None
SU14	M	22	NY	Cauc.	B.F.A.	Designer	10 yrs.	Moderate
SU15	F	41	CA	Cauc.	PhD student	Consult	8-10 yrs?	None
SU16	F	39	CA	Cauc.	B.A.	Consult	20 yrs.	None
SU17	M	45	CA	Cauc.	PhD	Consult	21 yrs.	Extensive
		Mean Age = 41.6 Median Age = 45					Mean Comp. Exp. = 15	

Note1: SU indicates Subject User to indicate a non-technical Web User Participant.

Note2: * indicates that SU7 was unable to complete the study due to computer problems.

Summarizing the demographic information of the participants in Tables 1 and 2, the composition of the online focus group can be described as follows:

- Seventeen technical participants, Web developers and software engineers
- Seventeen non-technical participants, Web users without technical backgrounds
- Age range from 17 years old to 57 years old
- Nineteen males and fifteen females
- Ethnic diversity, including: twenty-four Caucasians, six Asians, two African Americans, one Asian/Caucasian, and one African American/Native American
- Geographic distribution – seven states and Canada, including Arizona, California, Connecticut, New Jersey, New Mexico, New York, Virginia, and Ontario, Canada
- Mix of sets of three most developed intelligences, representing each of the eight intelligences in the user characterization of the three most developed intelligences
- High school through doctoral level educational background
- Mix of occupational areas, including the arts, biomedical and life sciences research, training, counseling, accounting, insurance, software development, industry management, and students.
- Range in experience with online learning from no previous experience to extensive prior experience using online learning systems
- Range in years of computer experience from two to thirty-two years.

Instruments

Four self-report questionnaires were administered on the Web to assess the three most developed intelligences and technical background for each participant in the first stage of the study. In eight cases, an additional self-report questionnaire was administered via postal mail or fax. Figure 1 shows a shaded box on the left side for the questionnaires administered to determine the three most developed intelligences and technical background for participants.

The first questionnaire was a self-ranked list of multiple intelligences with descriptive text and graphics so that participants would know what each intelligence meant. The text in the first questionnaire was derived from a questionnaire developed by Leslie Shelton and the Project

Read team under her direction at the South San Francisco Public Library (Shelton, 1991) based on Howard Gardner's development of the Theory of Multiple Intelligences (Gardner, 1983/1993).

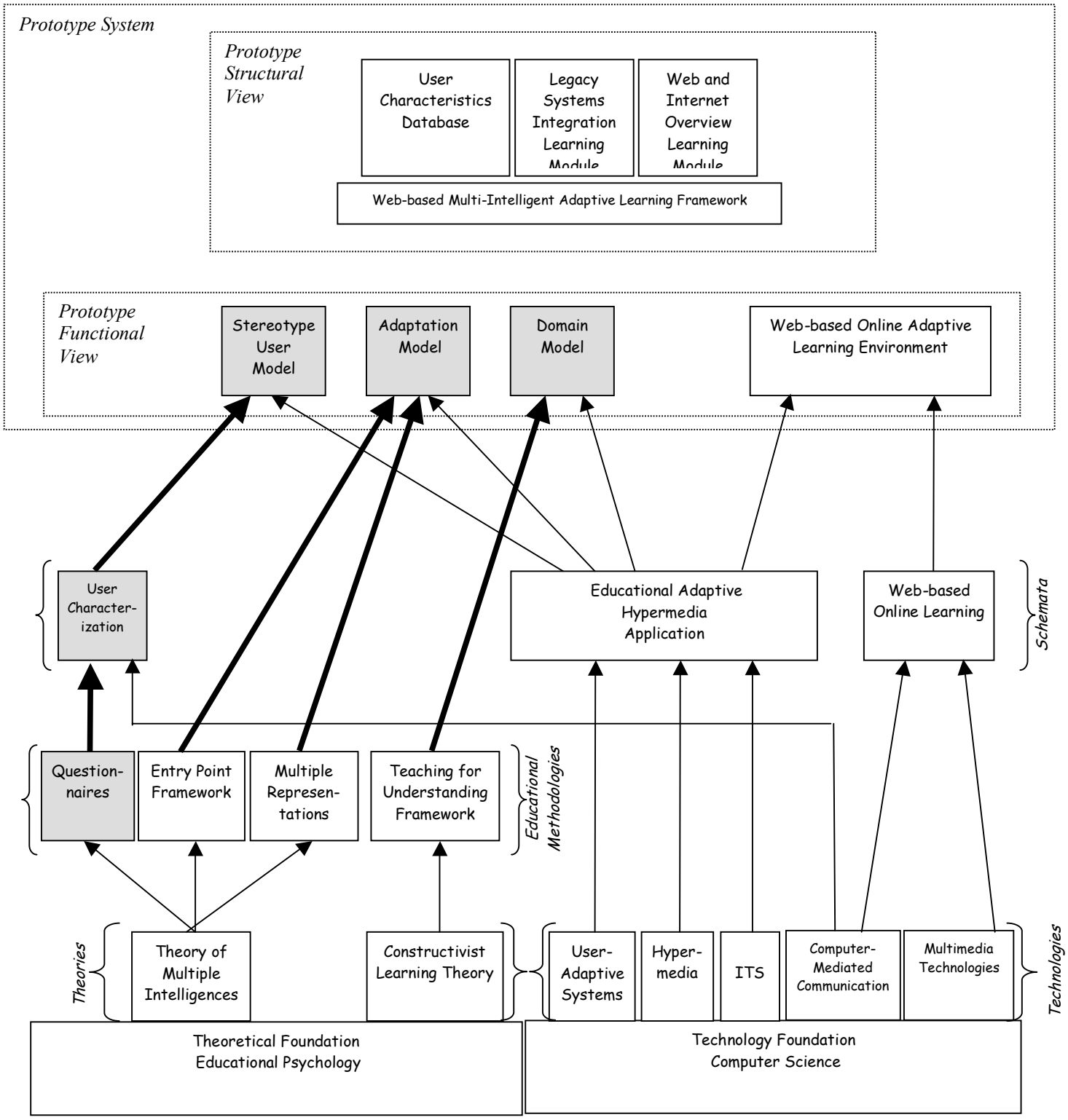
The second questionnaire was a four-page list of brief descriptions, designed to help assess intellectual and learning strengths through a self-report process. In filling out the second questionnaire, the participant checked a box (on a Web form) to indicate which of the descriptions applied to him/her. The second questionnaire was based on questions developed by Leslie Shelton and the Project Read team (Shelton, 1991) and by Thomas Armstrong (Armstrong, 1993/1999, 2000), with questions originally based on the work of Howard Gardner (1983/1993).

A third questionnaire attempted to assess learning difficulties or issues that a person might have in the use of certain intellectual faculties. These questions were based on the work of Thomas Armstrong (1993/1999, 2000) and originally based on the work of Howard Gardner (1983/1993). As with the second questionnaire, a list of short descriptions was supplied with a checkbox to indicate that a particular description applied to the participant.

A subset of the research study population (four participants in each group) also filled out The Multiple Intelligences Development Assessment Scales (MIDAS), developed by C. Branton Shearer (Shearer, 1996). This instrument has been clinically developed in order to offer a standardized approach similar to that used in an inventory of learning styles.

A prerequisite knowledge questionnaire was included as the fourth online questionnaire. The questionnaire was designed based on the researcher's experience in teaching Web Technology and Legacy Systems Integration courses. To assist in module design, this questionnaire was designed to provide an understanding of each participant's background knowledge so that the modules could be designed to fit the technical background of the participants. Each participant was assigned a research study participant identification code (ID), which he/she used to fill out the questionnaires, to gain access to the learning modules online, and to fill out the final feedback questionnaire. Participants filled out the form-based questionnaires and submitted their data via Web forms. The questionnaire information was automatically emailed to the researcher's email inbox with the data provided by the participant.

Figure 1 Instruments and Procedure

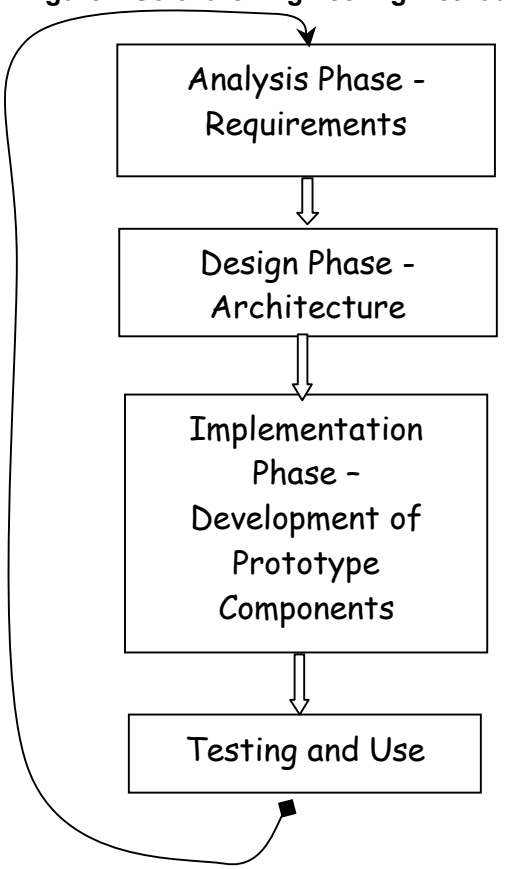


Procedure

The research study combined an online focus group for user characterization with software engineering methodology to develop a working prototype and a formative evaluation to determine improvements to the prototype. As depicted in the shaded boxes and bold arrows in Figure 1, questionnaires were used for user characterization, and the user characterization, in turn, was used to develop the stereotype user model in the prototype system.

The shaded boxes and bold arrows of Figure 1 also indicate the processes of developing the adaptation model and domain model of the prototype system based on the educational methodologies of the Entry Point Framework (Gardner, 1999), multiple representations (Gardner, 1999), and the Teaching for Understanding (TfU) Framework (Perkins, 1998). The study employed software engineering methodology in the design and development of the prototype adaptive learning framework and modules as illustrated in Figure 2 (Burback, 1997).

Figure 2 Software Engineering Methodology



There were two phases of data collection, one for the determination of the participants' most developed intelligences and technical background, and the second for feedback in the formative evaluation stage. Data collected during the first stage of the study consisted of the results of the multiple intelligence and background knowledge questionnaires. The information gathered from the questionnaires of the participants was used to develop a user characterization for each participant, including the three intelligences considered to be the most developed and the technical background of that particular individual.

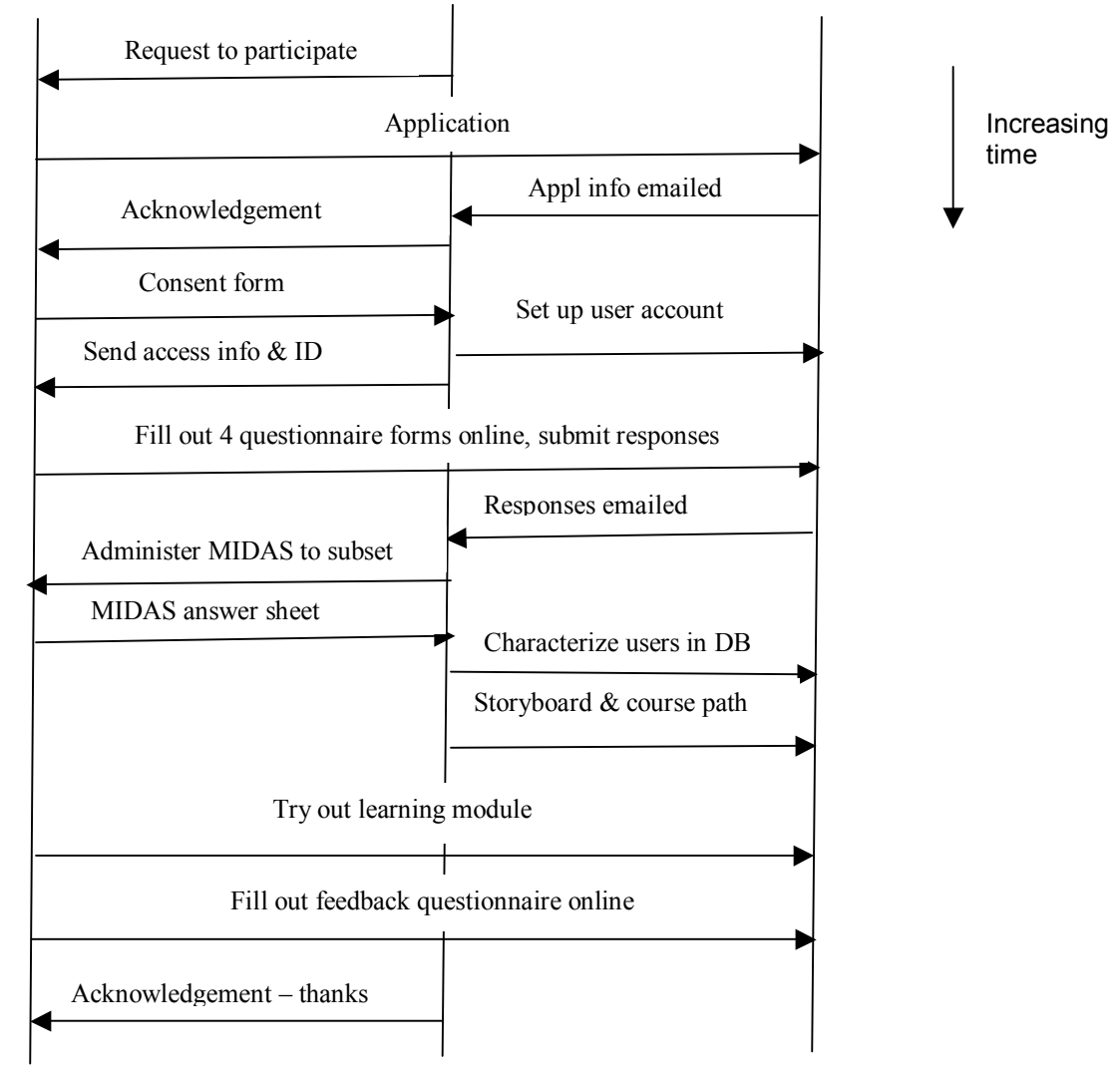
Data collected during the formative evaluation stage was gathered during and after the use of the adaptive learning modules. While using the adaptive learning modules, data was automatically collected via the Course Tracker. The data collected through the Course Tracker consisted of the amount of time spent on each section or topic in the learning module. The Course Tracker also collected data on whether and in which order participants accessed each section or topic in the learning modules. During the formative evaluation stage, data was collected through the feedback questionnaires filled out and submitted by study participants. Volunteers who participated in the first stage of user characterization also participated in the formative evaluation via the Web-based framework used for the study and to deliver the learning module content.

The formative evaluation stage consisted of two steps:

- Use of the prototype adaptive learning modules based on user attributes
- Feedback from participants in order to improve the prototype modules.

In order to increase the diversity of the research population and facilitate the study, the entire research study was conducted online using a Web-based framework, developed for the purposes of the research study. As a Web-based research study, communications between the researcher and research subjects were conducted completely online, using a combination of the research study Web site (http://www.dara-abrams.com/benay/research) and personal email exchanges as illustrated in Figure 3. Figure 3 depicts the temporal flow of processes and communications in the research study.

Figure 3 Flow of Processes and Communication in Research Study



Hypothesis

The research question posed at the beginning of the research study was: can the cognitive Theory of Multiple Intelligences be used to support adaptation in an online learning environment? According to Howard Gardner, the Theory of Multiple Intelligences describes eight separate intelligences, intellectual faculties which are possessed by all individuals and are both biologically determined and learned or developed (Gardner, 1983/1993). These intelligences may

be more or less developed in different individuals, resulting in variations in the set of intelligences that are most developed in each individual.

The Theory of Multiple Intelligences forms the basis of the user model for two reasons:

- The Theory of Multiple Intelligences provides a model through which to characterize individuals in terms of the different ways in which they think and learn
- The Theory of Multiple Intelligences has been applied successfully to help different types of individuals learn in classroom situations.

The hypothesis of the study is that it is possible to design an online learning environment with an adaptive strategy and user model based on the Theory of Multiple Intelligences, which holds that each individual possesses eight different intelligences, usually with some more developed than others. Testing of the hypothesis involved the actual development of a prototype multi-intelligent adaptive learning framework and two prototype multi-intelligent adaptive learning modules. Successful development of such a prototype would confirm an affirmative answer to the research question as well as the correctness of the hypothesis.

Summary

The research study was conducted online through a Web-based framework, collecting data for the development of user characteristics, including the three most developed intelligences and the technical background of research subjects. Requirements for the prototype multi-intelligent adaptive hypermedia framework and learning modules were developed prior to the design and development of the prototype itself, following software engineering methodology. Learning outcomes and understanding goals were established for the learning modules through the use of the educational methodology of the Teaching for Understanding Framework. Then the multi-intelligent adaptive hypermedia framework and online learning modules were designed and developed according to software engineering methodology. A formative evaluation of the prototype was conducted online with the original group of participants who had provided data on their most developed intelligences and technical background. Participants used the Legacy Systems Integration learning module or the Overview of Web and Internet Technology learning module and provided feedback for the improvement of the prototype modules and framework.

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