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Static Adaptations Of Personalization Factors Included In The Development Of An Adaptive Web-Based Tutorial

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Summary

The present research divides the adaptation process into dynamic and static adaptations. The present paper introduces the static adaptations of personalization factors included in the development of an Adaptive Web-based Tutorial system. The included personalization factors are: Learning styles, intelligence types, knowledge background, special interests, learning goals and beliefs. The personalization factors were determined in order to improve the teaching-learning process of Object-Oriented Programming Languages.

Keywords: Learning styles, intelligence types, knowledge background, learning goals, special interests, beliefs.

Introduction

The present research divides the adaptation process into dynamic and static. The present paper introduces the static adaptations made by the tutorial system. The static adaptations are those which the system does when the learner uses the system for first time. This is done in order to compile the learner's characteristics and initialize the system.

Learners have to answer some psychological tests such as a learning styles inventory, a multiple intelligences test, and a questionnaire about negative beliefs; also learners have to answer some knowledge background evaluation. After the tutorial system has compiled all this information about each learner, learners can start to interact with the courseware. And from here, the tutorial system starts the dynamic adaptation process.

The dynamic adaptation process consists of the learner's evaluation of his or her changes in learning styles, intelligence types, special interests, and knowledge background. And when there are some changes in any of those personalization factors the system adapts the courseware and the base of problems to be solved by the learner.

This paper is organized as follows: Section 2 introduces related research and the novel points. Section 3 gives a brief explanation of the personalization factors and the motivation of the selection of these factors. The static adaptation can be done as follows: First, the learner has to take a knowledge background evaluation (Section 4) then the learner has to take some psychological tests (Section 5) such as: learning styles, multiple intelligences and a beliefs and attitudes questionnaire. Section 6 introduces the Special interests. Section 7 gives a brief description of the learning goals personalization factor. Section 8 introduces the expected impact of the present project in the Technology-based Education. And conclusions are given in Section 9.

Related Research

Some previous works about adaptive tutorial systems have been previously developed. Works based on adaptive approaches such as those of introduced below:

The work proposed by (Papanikolau, 2002) introduces an adaptive approach based on knowledge background. The system is text oriented, although the system controls level of difficulty and adaptive navigation. We consider levels of difficulty not only in the presentation but also in the kind of problems to be solved by the learners. This level of difficulty is based on the learner's IQ of each intelligence type.

The work proposed by (Moundridou, 2002) introduces a personalization approach based on knowledge background and learning styles. We determined that a more complete personalization approach, should considers also the learner's intelligence types, special interests, learning goals and the rectification of beliefs.
Table 1 shows the characteristics of previous developed Tutorials systems and the characteristics of the present work.

Characteristics	(Moundridou, 2002)	(Papanikolau, 2002)	Present Work
Personalization Factors	Knowledge Back-ground	Knowledge Background Learning Styles	Knowledge Background Learning Styles Special Interests Learning Goals Intelligence Types Beliefs and Attitudes
Media	Text	Text, images, audio	Text, images, audio
Avoid Cognitive Overhead and Disorientation	?	Yes	No
Level of Difficulty	Yes	Yes	Yes
Adaptive Navigation	Yes	Yes	Under development

Table 1: Comparison among previous developed tutorials and the present work.

Personalization Factors

This Section introduces the personalization factors included in the Adaptive Tutorial System. We reviewed the literature and concluded that the personalization factors considered until now are:
Knowledge background, Learning styles and Special interests.
And we go a step further and we determined that the personalization factors to be included in the adaptive approach are:

Static Adaptation:
Knowledge background, Learning Styles, Multiple intelligences, Special interests, Learning goals, and Beliefs.

Dynamic Adaptations
Knowledge background, Learning styles, Multiple intelligences, and Special interests.

We determined these personalization factors as those to be included in the development of the Adaptive Tutorial System in order to improve the learning process.

The personalization factors were considered thinking about the learner:

a. What does the learner already know? (Knowledge background)
We tried to implement what Piaget said. Piaget said that for an effective learning new knowledge must be related with prior knowledge. So in order to include this Constructivist guideline in the development of the Adaptive Tutorial System, we think that a prior evaluation of the learner's knowledge background (Static Adaptation) and then a dynamic learner's knowledge evaluation would be very useful to improve the learning process. Furthermore, we tried to related prior knowledge with new knowledge, taking as the learner's domain his or her major, that is to say that the courseware was designed thinking about an engineering major and the explanations, problems, exercises, etcetera contained in the courseware were designed for an engineering course.
The courseware was designed based on the three first levels of the Bloom's Taxonomy (Knowledge, Comprehension and Application) and we consider that if some learner masters a given level before using the tutorial, it would be repetitive and waste of time to make him or her to study from the beginning.

b. How does the learner learn? (Learning Styles)
Matching the learner's learning styles will improve the learning process (Valdes-Salmeron, 1999). The learner's learning styles say to us how the learner experiences the learning process. We think that a courseware designed to match learning styles will do easier the learner's learning process.

c. Which is the adequate level of difficulty of the problems to be solved by the learner? (IQ and intelligence type)
Gardner (Gardner, 1983) said that each person has many intelligence types developed in several grades. Gardner believed that using the traditional approach of teaching educational programs to focus only on a preponderance of linguistic and mathematical intelligences minimize the importance of other forms of intelligences. When this happens, learners who fail to demonstrate the traditional academic intelligences are held in low esteem and their strengths may remain unrealized and lost to both the school and society at large.

d. What does the learner like? (Special interests)
We think that when a learner enjoys doing something, they learn easier.

e. What does the learner want to learn? (Learning goals)
The learning goals are based on the answer of this question in order to establish the course's objective.

f. What are the learner's beliefs about OOPL? (Beliefs)
We consider that it is very important that negative beliefs be changed prior to the use of the tutorial, because positive beliefs foster positive attitudes.

Knowledge Background Evaluation

The knowledge background evaluation was designed following the Blooms' Taxonomy hierarchy (Cooper, 2003). Only the three first levels were considered: Knowledge, Comprehension, and Application. This is because the knowledge domain of the tutorial system is an introductory course to OOPL (Object Oriented Programming Language) using C#. The knowledge background evaluations consist of questions about concepts and syntax about the C# programming language. The types of evaluations are true/false answers, complete sentences and selection of options.
Examples of questions classified according to the Bloom's Taxonomy (Cooper, 2003) are as follow:
Knowledge level

- Define the concept of a class.
- Identify which is a well-formed identifier of a class
- Name 3 valid identifiers for classes

Comprehension Level

- Convert the following invalid identifiers to valid identifiers
- Distinguish which are valid keywords in a C# program
- Explain why is important to use valid identifiers

Application Level

- Compute the addition of two rational numbers given by the user.
- Implement the Goldbach Conjecture for the numbers from 100000 to 1000000.
- Implement a program in C# in which the output are figures that can be drawn using lines.

After the learner has taken the knowledge background evaluation and the psychological tests given in the next Section, the system introduces to him or her the knowledge content of the courseware adapted to his or her needs.

Psychological Tests

In this Section some psychological tests, which measure learning styles, multiple intelligences and a questionnaire about beliefs and attitudes are introduced.

Learning Styles

This Section introduces the learning styles inventories. The inventories introduced in this section are: Kolb (Valdes-Salmeron, 1999) and VARK (VARK Inventory) inventories.

Kolb Inventory

Kolb (Valdes-Salmeron, 1999) said that the good learners start with a meaningful experiential activity (Concrete Experience). Through a carefully observation, the learners understand the meaning of ideas and situations (Observation and Reflection). The learners reflect and generate an idea (Abstract Conceptualization), and act or decide what to do in order to reach the objective (Active Experimentation).
Although the organization of the courseware was designed following the Kolb's learning styles, the learners have not to take the Kolb inventory.

The VARK Inventory

The VARK inventory (VARK Inventory) proposes 5 learning styles: Visual, Verbal, Active, Reflexive and Kinesthetic.
The table 2 shows the learning styles and their characteristics proposed in the VARK inventory (VARK Inventory).
The results of the VARK inventory are numbers called Learning Styles Quotient (LSQ). This numbers are saved on the student model after the static adaptation is done in order to initialize the system. Learners may have different or the same LSQ in each learning style. The highest LSQ will indicate to the tutorial system which learning style should be applied first for the design of the knowledge content.
The VARK (VARK Inventory) inventory's learning styles can be used to design the presentation of the knowledge content.

Evolutionary Intelligence Inventory

The Evolutionary Intelligence Inventory (Jacobsen, 1999) measures the IQ of each intelligence type of each learner. This inventory is based on the Intelligence types given by Gardner. Howard Gardner (Gardner, 1983) defines intelligence as the capacity to solve problems or to fashion products that are valued in one or more cultural settings. His pluralistic view of intelligence suggests that all people possess at least seven different intelligences, which operate in varying degrees depending upon each person's individual profile of intelligences. Table 3 shows the Gardner (Gardner, 1983) identified types of intelligences.
We think that the intelligence types of each person can be tested using for example the Evolutionary Intelligence Inventory (Jacobsen, 1999). The inventory's results were the basis for the design of a base of problems classified according to each intelligence type and according to each range of Intelligence Quotients (IQ). And this control of difficulty through a classified base of problems will make easier the learner's learning process because if the problems are too easy or too difficult the learners can get bored or frustrated.
The result of the Evolutionary Intelligence inventory is an I.Q. for each intelligence type. These IQs and the intelligence types will be very useful for the system in order to select for the learner the adequate set of problems.

Beliefs and Attitudes Questionnaire

The learner's negative beliefs can be identified through the application of a questionnaire. In this questionnaire questions about the learners' negative beliefs were included. The questionnaire includes questions about what are the negative beliefs about the learning of OOPL. In the questionnaire is requested to the learner to list his/her negative beliefs about three OOPLs. This questionnaire will be the input for the Neurolinguistics Programming activities (NLP). The NLP activities will help the learner to change his or her negative beliefs into positive beliefs through mental exercises.

The questionnaire used by the system to compile the learner's negative beliefs is given below:

Questionnaire

1. List the negative beliefs about Programming languages
2. List the negative beliefs about Object Oriented Programming Languages
3. List the negative beliefs about C#
4. List the negative beliefs about the instructor of the course

Learning Style	Characteristics
Active	The active learners will remember better something that they have already done than something that they just have listened or seen.
Reflexive	The reflexive learners would rather think before trying something new or different.
Visual	The visual learners prefer to receive new information with images or graphics
Verbal	The verbal learners remember better words and verbal descriptions.
Kinesthetic	The kinesthetic learners have a special ability to perform actions with their bodies..

Table 2: Learning Styles and their characteristics

Special Interests

This Section introduces how the static adaptations of special interests is done. There is no inventory to determine the learner's special interests. However, the tutorial system provides some areas related to engineering such as mathematics, statistics, and etcetera. These areas were selected because the tutorial's domain is an introductory course to OOPL using C#, and in the most of cases this kind of course is given for engineering students.
The tutorial system provides a list of problems classified by area (mathematics, statistics, etcetera) and the learner will be free of choose any of them. The system learns what are the areas accessed by the learner and the next time when she or he uses the tutorial system there will be an adapted list of problems.

Intelligence Type	*Characteristics*
Spatial	These persons have the capacity to think visually and spatially.
Linguistic	These persons have a language facility.
Musical	These persons have the capacity of musical appreciation and play instruments.
Logical-mathematical	These persons have the capacity to think logically.
Bodily-kinesthetic	These persons have the capacity of using their own body as a means of expression.
Interpersonal	These persons have the capacity of establishing relationships with other people.
Intrapersonal	These persons have the capacity to know themselves

Table 3: Intelligence Types and their characteristics

Learning Goals

The specific learners' learning goals are a motivation for learning, which can improve the learning process. In order to establish the course's objective the tutorial system provides to the learners two options: the first one is to learn about a specific topic, and the second one provides an option to study a complete course. The option learning about a specific topic will introduce two more options: The first option is program implementation and the second option is learning about a specific topic. In the program implementation option the learners can learn how to implement a given problem, through modeling, problem solving and project development. In the second option the system gives to the learners the facility of learning about a specific topic by selecting a theme or searching a keyword.

Expected Impact Of This Project On Technology-Based Education

This Section gives a brief introduction of the expected impact of the Adaptive Web-based Tutorial System on the Technology-based Education. We expect that the introduced Adaptive Web-based Tutorial System has a high impact in the learners' learning process. Our high expectations are based on:

a) Selection of the Constructivist Paradigm

After a comparison analysis among several educational paradigms we concluded that the best paradigm to be implemented in the Web-based Tutorial System is the Constructuvist Paradigm. This is because Constructivist teaching-learning activities can be implemented easily in the Tutorial System and those applications help the learner to construct his or her own knowledge. Furthermore, we proposed to combine Social and Cognitive Constructivism into one teaching-learning process model and this model was tested and proved to be effective.

b) Analysis of the Personalization factors

In Section 3 we give the reasons for the selection of the personalization factors included in the implementation of the Web-based Tutorial System.

c) Determination of a novel teaching-learning approach for an OOPL

The proposed approach is based on the combination of the Constructivist paradigms (Cognitive Constructivism and Social Constructivism), Bloom's Taxonomy and learning strategies (Modeling, Problem Solving and Project Development) in an iterative process. The objective of incorporating the Bloom's Taxonomy is to measure how well the learning goals are met. Furthermore, the objective of incorporating the learning strategies is to provide an easy and effective framework for mastery an OOPL. At the same time, the evaluations given after completing each learning strategy will make it possible to adapt the teaching-learning process to meet the learner's needs.

d) Design of the Tutorial system

The design of the Tutorial System consists of the following modules: The dynamic evaluation module controls the application of psychological tests, questionnaires and activities; the learners' results are saved on the student model. The pedagogical module controls the teaching process. This module decides what topic to present, when to review and the generation of the courseware. The pedagogical module accesses the knowledge domain in order to generate courseware dynamically and accesses the student model in order to gather the learner's personal characteristics. The evaluation module is the module, which compares the learners' solutions with the expert's solutions. The evaluation module saves the learner's results in the student model.

With the development of the Adaptive Web-based Tutorial System, we tried to focus our efforts to have some impact in the Technology-based Education. We tried to improve the teaching-learning process of OOPLs. Some studies suggest that the dropout and failure rate (In OOPL's courses) is as high as 30 percent (Guzdial, 2002). We think that in order to decrease that number we need to consider not only what are we going to teach but also how are we going to teach it. The teaching of an OOPL implies the teaching of concepts and the development of programming abilities. We think that the teaching-learning process of an OOPL implies to rectify the learner's negative beliefs about the learning of an OOPL and about their own capableness, then we think that we should start the teaching-learning process with a knowledge background evaluation in order to relate new knowledge with the learner's prior knowledge and based on the learner's prior knowledge we can select a base of problems to be implemented in the new programming language. Then we should teach models to the learners in order to facilitate in the learners the generation of mental models. After that, we need to give to the learners some problems and the concepts and programs which solve those problems. Then we need to foster the development of programming abilities through problem solving and project development.

We tried to improve the teaching-learning process of OOPLs, but the teaching and learning of an OOPL is only the domain of the Tutorial System, that is to say that the approach used to develop the Tutorial System can be applied in order to implement another Tutorial Systems with different domains.

Conclusions

The personalization factors were determined in order to improve the learner's learning process. These personalization factors are: Knowledge background, learning styles, intelligence types, special interests, learning goals and the rectification of beliefs. The personalization factors were considered thinking about the learner, how he or she learns, which is the adequate level of difficulty for each learner, what she or he likes, what he or she already knows and what she or he wants to learn in order to establish the course's objective and what are his or her beliefs. Several evaluation instruments such as learning styles evaluations, intelligent tests, beliefs and attitudes inventories can be found in Silver Platter

(Buros Institute, 2003). The effectiveness of each point of the personalization approach is based on the reliability and validity of the applied tests.

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