Teachers’ Training Design Model and Decision Support System

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Abstract: This paper discusses the problems in the design of teacher’s training as a form of professional development. The research is focused on design of support tools for teachers helping them to apply in effective way digital technologies in their practice. The complexity of such instructional design goal contributed to design of fuzzy logic based model. On its base was developed expert system (ES) to support decisions during the course design. In this paper we present the experts methodology for knowledge formalization. Further we describe the theoretical framework including main components in the model, their characteristics and relations. Implemented prototype of the fuzzy logic based expert system Open Virtual World (OVW) is presented, as well.

Keywords: Adaptive teachers training design; Fuzzy logic; Expert System; Decision support system; Intelligent systems.

1 Introduction

In last decade learning environment drastically was changed: a huge amount of Information and Communication Technologies (ICT) tools appears in schools. Many researchers and politicians hope that ICT itself will dramatically change the education. But it is not enough just ICT to be available in the schools. Often ICT are not effectively used, and in some cases not used at all. One of the conclusions of the Institute for Prospective Technological Studies report [1] is that in order to have effective use of technology in the school, it is necessary teachers to be trained appropriately. Looking on past experience, in many countries massive teachers training on ICT were done in recent years (Bulgaria, Romania, etc.). In other countries like UK teacher professional development is embedded in the school systems. Then, why the expected change is still not visible? One of the reasons for ineffectiveness of the ICT use in schools is related to the design for teachers training.

Teacher training is one of the four forms of the professional development [6]. In-service teachers’ courses format is appropriate and very effective when educators need to obtain information about new programs, new instructional approaches, or changes in school policy and regulation, as well as some innovations are introduced and small number of people is well informed about them [2]. Teachers training in field of integration of technology across curricula can be referred to this format.

During the design of teacher training, the characteristics of professional developments of adult should be taken in account. It is not enough to build the knowledge for a technology per se. The effective teaching of technology requires an understanding of how technology relates to the pedagogy and content. The designers of teachers training should aim to build Technological Pedagogical Subject Knowledge [3]. We need a model to support decisions during the teacher training course design. The characteristics of teachers training in such model are very complex. Furthermore the model should be adaptable to different technologies, users and their objectives.

In section 2 we present describe the theoretical framework including main components in the model, their characteristics and relations. The decision support system prototype based on Fuzzy Logic is presented in section 3. The conclusion briefly sketches some further steps in the research.

2 Theoretical framework

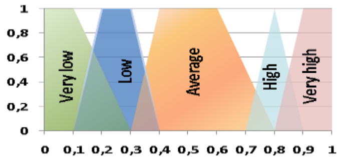
The domain model is too complex and there is no consensus of the experts in the area. That is why abstract model OVW based on teachers and teacher trainers' opinion and experience was developed. For formal modeling in such cases, it is appropriate a Fuzzy Logic [8, 9] based Expert System [4] to be developed. The design process starts with collection and conversion of the experts' knowledge to the conceptual abstract model. Further the implemented system can be used by course designers to derive the conclusions from the model through the expert system. All these steps are described below.

Components identification is based on collecting experts' understanding on importance of the factors related to teachers training in digital technologies for education. Only those of them that have great impact in effective use of ICT in school practice are took in consideration. In this phase 23 experts from Bulgaria were involved. They are mainly experts in the field of training teachers for effective integration of ICT in education. Methodology used to collect experts opinion follow the structured participative approach called Group Concept Mapping, used for similar research [7]. Through the analysis of the collected results four top factors, rated by participants, are identified to be main components of the model. Namely: Methodology, Objectives, User, and Technology. The listed by participants main reasons related to each of the factors is detected as important characteristic of the component. On their base main variables of the each component are drawn [5].

Variables values identification was done through the collection of expert opinions. For instance, the Table I represents the learner's activity values.

Relations between components characteristics definition based on expert knowledge was next phase of the model development. The survey was used also to collect the experts' knowledge on relations between variables. On that base the rules were proposed. An excerpt of list of extracted rules from defined relations is presented on Figure 1.

TABLE I. Sample of methodology linguistic variable *learner's activity* values set

Linguistic variable: *Learners activity* – la			
Linguistic value	Notation	Numerical Range (normalized)	Fuzzy Sets of la
Very Low	VL	[0, 0.3]	
Low	L	[0.1, 0.4]	
Intermediate	I	[0.3, 0.8]	
High	H	[0.7, 0.9]	
Very High	VH	[0.8, 1]	

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IF meth.la=VH THEN
      (u.m=V OR u.m=EX) AND
      (obj.s=A OR obj.s=P) AND
      (u.q=I OR u.q=A)
IF tech.cp=H THEN tech.u=L
IF meth.po=H THEN
      (u.m=V OR u.m=EX) AND
      (obj.c=A OR obj.x=P) AND
      (u.cm=A OR u.cm=P)
IF tech.c=H THEN tech.u=L
IF meth.ti=L THEN u.m=L AND tech.u=L
```

Figure. 1. Sample rules in OVW

Model testing was performed through four pilot trainings, designed and conducted by teachers and teacher educators. The input data for the design of these trainings are available and used to generate inference based on fuzzy logic centroid technique. To compare the results inferred by the model with reality the surveys with the participants in each of these trainings were conducted.

3 System Architecture and Design

On the base of the model, a Fuzzy Logic based Expert System was developed. The system contains four main modules (Figure 2) with the following functionality:

User interface module supports user's registration, maintains all users' activities, and provides tools for design of training model development, update and storage.

Analyzing module evaluates the training design model and provides feedback for Methodology, Technology, User, and Objectives, based on Knowledge base with fuzzy logic rules. It provides features for testing the user's expectations about the calculated values and the result provided by system – for OVW system evaluation purposes and for tuning the fuzzy logic rules.

Testing module can be used to compare two designs of training or models, to aggregate with common (or more general) feature of two trainings' models in order to provide the individual and group suitable training.

Supporting module realizes searches in the existing repository of appropriate materials according to training model and supports the training design process.

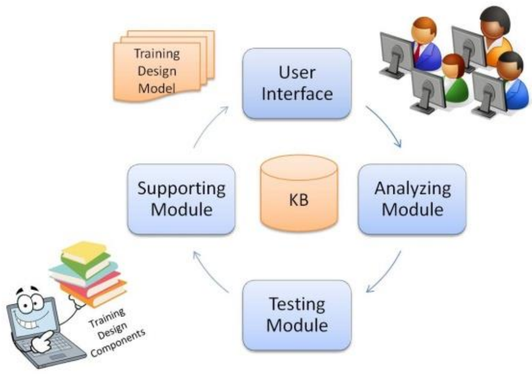

Figure. 2. System Architecture

The important decisions during the system design are related to **the user interface**. Two main issues are: (1) how to collect the input values of the variables from the training designers; (2) how to present the system's inference to them. In both cases system should communicate with them in comprehensive and clear language and style. The decisions taken in these two directions are presented below.

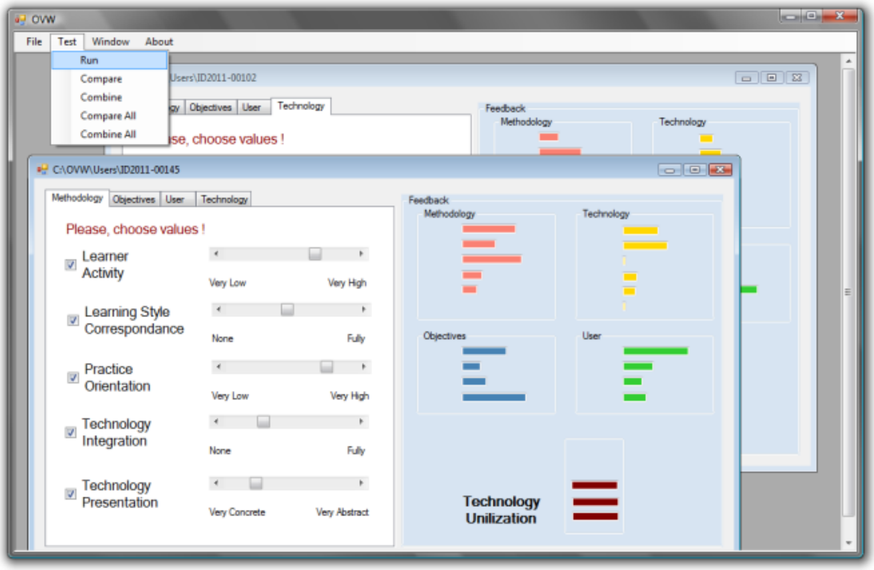

Figure. 3. User interface of the system

a) User interface solution for entering variables values by training designers. Many systems based on fuzzy logic collect values of linguistic variables directly from the environment through sensors when the event happens (e.g. temperature becoming high). In the prototype of the OVW system this solution is not possible, because the values should be collected in advance of the event: training is still in the phase of design and all values of variables related to it could just be planned by training designers. As the variables should be collected from the user, it is important to make it as easy and intuitive as possible. Therefore each components of the model is presented at separate tab, each variable of the component is presented at separated row and the values of the variables are entered by sliders, not as numbers. The solution takes into account human-computer interaction issue related to the user, who prefers to slide between two extreme values instead of entering numbers. This makes the input of the values really easy and intuitive.

b) User interface solution for presenting the information and the inference to training designers in order to support decisions.

Graphical representation of the information enhances readability of the inferred results. The primary objective of user interface in OVW system is to present graphically the inferred value for technology utilization (Figure 3). The generated value is based on the user input for linguistic variables, using rules and applying fuzzy logic centroid technique.

4 Conclusions

In current paper we describe work in progress. Performed experiments and tests with the designed model and the developed prototype of system so far demonstrate that they can be applicable in practice. The prototype of the system will be further tested with instructional designers of teachers' trainings and improved based on the results from these experiments.

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