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СОДЕРЖАНИЕ

Инженерное образование

Инженерное образование

UDC 378

Control the complexity of the presentation of educational material in the classroom on the basis of a computer model of fuzzy sets

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Abstract
The purpose of this article is to demonstrate a computer implementation method of fuzzy set theory and fuzzy logic to control the complexity of presenting teaching material in class. Among the tasks that arise in this case, only one was singled out: the implementation of pedagogical modeling on the basis of the most powerful information system of fuzzy logic – Fuzzy Logic Toolbox (Mat Lab program). Approaches in formalization of statements of pedagogical orientation are shown. Examples related to the management of feeding difficulties learning material in class on the motivation and speed of learning new material. The results of the experiment on the influence of negative and positive motivation of students on the selection of the complexity of the educational material are presented. The forms of visualization of the analysis results in one-dimensional (graphics) and three-dimensional (surfaces) form are presented. These fuzzy inference surfaces allow you to determine the dependence of the values of the source variable on the values of the input variables of the fuzzy model. It is concluded that on the basis of the theory of fuzzy logic and fuzzy sets, it is possible to accurately and objectively perform calculations of the motivational component of learning and the rate of assimilation of new material from the position of its complexity. In this way, the teacher can guarantee to predict the results of future classes, which he prepares. The model, based on a computer system of fuzzy logic, allows the teacher to control the complexity of the presentation of the material in the classroom, which avoids subjectivity in the selection of the level of complexity of the educational material, and thus significantly improve the quality of training.

Introduction

In pedagogic in contrast to other fields of knowledge, teachers state their standpoint or analyze educational process in the form of judgments of fuzzy, and vague nature. The following statements, as: "better – worse" (e.g. material mastering), "enhanced – weakened" (e.g. preparation), "raised - lowered" (e.g. academic progress), "raised – lowered» (e.g. intellectual growth level) are involved in their speeches. When specifying characteristics and qualities of educational process elements, intermediate ranking is used: "enhanced a little", "improved enough", "weakened below average", "implemented over the limit" etc. Such judgments are hard for formalization and particularly for determining strict and distinct summaries, interferences and conclusions.

In this specially developed concepts are used – these are the theory of fuzzy sets and the theory of fuzzy logic in software systems, among which the most powerful one is Fuzzy Logic Toolbox software package from matrix laboratory system "MatLab" by MathWorks.

Many thorough scientific researches deal with education management. For example, the works of Russian scientists consider issues of relevant information support for managing educational facilities. Among researches of a considered problem the most significant works are by Y. A. Konarzhevskiy (2000), V. S. Lazarev (1995), V. S. Pikelnaya (1990), M. M. Potashnik (1997), E. N. Khrikov (2006).

In terms of this scientific inquiry important ones are the works by V. P. Bespal'ka (1989), V. A. Slastenin (1997), S. A. Smirnov (2000), which cover the problems of work optimization with institutional and administrative information, meeting information needs of pedagogical staff, building administrative culture of teachers etc.

A. G. Guralyuk (2008), D. V. Demidov (2009), G. A. Sukhovich (2008) considered In their researches the complexity management issues in delivering education material, but only at theoretical and methodological level. The development process is following the way of integrating pedagogical researches and discoveries in the field of the exact sciences. In mathematics there are significant practices in terms of formalizing social and educational mechanisms implemented in analysis/decision-making computer systems. However the problem of managing the complexity of teaching material presentation is still insufficiently researched both in theoretical and in practical aspects. Such an important question as consideration of fuzzy model computer implementation for managing the complexity of teaching material presentation at lessons has left overlooked for now.

At the same time, regarding the practical importance managing the complexity of teaching material presentation for high quality education results, absence of a theoretical basis and practical use of such system in educational facilities, the article heading has been selected: «*Managing the complexity of teaching material presentation using a fuzzy set model*».

For school teachers, lecturers, department heads and deans of higher education institutions this research area is very interesting, and its development becomes not only a theoretical and methodological basis for improvement of educational measurements and scientometrics, but also for practical use in education processes management.

Article purpose – to demonstrate a computer realization of fuzzy set theory and fuzzy logic theory for managing complexity of teaching material presentation at lessons.

Among **tasks** which arise herewith, only one has been determined: the implementation of pedagogical modeling on the basis of the most powerful up-to-date information system of fuzzy logic – Fuzzy Logic Toolbox (through matrix laboratory software package Mat Lab, ver. R2013a).

Management of complexity of giving of a teaching material on employment by means of the program of fuzzy logic toolbox

On the basis of concepts presented by fuzzy sets, there is a possibility to interpret human judgments which can be used further for modeling and forecasting of administrative education processes.

In pedagogic, as a rule, the easiest way for a teacher or a pupil (student) to outline some processes or phenomena of teaching and educational validity at the level of verbal descriptions, i.e. – in non-formalized form (Morze, 2013). It is more convenient to use qualitative fuzzy estimations, like "much", "a little", "high enough", "too far", "very close", "quickly", "too slowly", "average (e.g. preparation)", "too weak" etc.

Let's admit that *X = {Cambridge university, Stanford university, Moscow State University, National University of Kyiv}* – is a set of various world's top-rank universities. Then the fuzzy set *A* = "*Excellent university*" can be defined as follows:

A = {(Cambridge / 1), (Stanford / 0.8), (MSU / 0.3), (NUK / 0.1},

where the figures standing near names express the degree of reflection (approximation) of a definition "Excellent university".

It is clear that the membership function for each fuzzy set is generally defined in a subjective way. For the example above the member function form for a fuzzy set reflects an estimation variant of "F1 Study, 2010" independent reference book, which can be a agreed not by everyone.

Despite vague limits of a fuzzy set *A*, it can be precisely defined with a comparison to each element of *x*-number standing between *0* and *1*, representing its membership in *A*.

For example, membership function of an "*external conflict"* concept (a conflict out of itself) will be written in the language of the fuzzy sets theory as follows:

External conflict = {20/0.01 + 20/0.9 + 20/0.5 + 10/0.5 + 10/0.2 + 10/0.1},

here the "+" sign is not a symbol for addition but for unification;

number 20 means a conflict tendency level among people with expressed *extraversion;*

number 10 – a conflict tendency level among people with expressed *introversion*.

Any of these values *Extroverts-Introverts* values have a correspondent proximity index, for example, according to the behavior style of these individuals in external conflicts (according to the classification of an American psychologist R. Thomas). For *cooperation* this value is 0.01, for *rivalry* – 0.9, for *compromise* – 0.5, for *adaptation* – 0.2 and for *conflict avoidance* – 0.1. From the listed styles only one – cooperation, is active and effective in terms of defining result of a conflict situation. The most conflict-oriented is the second active style – rivalry (proximity index – 0.9); avoidance and adaptation are characterized by the passive form of behavior, therefore the proximity index is smaller (0.1 and 0.2). Compromise occupies an intermediate position, combining both active, and passive reaction forms (it has 0.5 index).

If to consider new judgments in relation to the basic concept - "conflict", then they can be defined in fuzzy sets theories as follows:

Incident = conflict^2 *(squared conflict);*
Challenge = conflict^3 *(cubed conflict);*
Escalation = conflict^4 *(the conflict in the fourth degree).*

In the theory of fuzzy sets membership function plays a key role as it is the basic characteristic of fuzzy object, and all actions with fuzzy objects are made through operations with their functions of an accessory. Definition of function of an accessory is the first and very important stage of modeling allowing then to operate with fuzzy objects.

There are no strict rules which could be used for a choice of corresponding membership function, as well as there are no methods of an estimation of appropriateness and correctness of membership functions put forward in various ways. The methods used for constructing a membership function, should be flexible enough so that they could be rearranged easily for action optimization of algorithms, which are using these membership functions. The problem of choosing a membership function is also essential, as the efficiency of many algorithms depends on the form of used membership function.

Due to the fact that between elements, which are members of any set or are independent, there can be no sharp edge, we often cannot give a definite answer to a question on value of a membership function in limits of traditional formal logic. The professor of the University of California Lotfi A. Zadeh in 1965 developed the basics of the fuzzy sets theory; he also offered an exit from this uneasy situation.

Linguistic variable – is a variable which accepts value from a set of words or word combinations of some natural or artificial language. The linguistic variable can be defined as a variable, the values of which are not numbers, but words or sentences in the natural language used in verbal human dialogue. For example, the linguistic variable “proficiency” can accept following values: “very weak”, “weak”, “above average”, “average”, “below average”, “high”, “very high”, etc. These values, which display degree of expressiveness of a variable, are called in the fuzzy sets theory as ***terms*** (a term – to name). It is clear that the variable “proficiency” will be a usual variable, if its values are exact numbers, and it becomes a linguistic variable as it is used in fuzzy judgments. Each value of a linguistic variable corresponds to a certain fuzzy set with its membership function. So, the linguistic value “*Excellent university*” can correspond to a membership function of some mathematical dependence, and the terms of the linguistic value can be expressed as follows: *highly excellent university, excellent university, excellent university of average type, not absolutely excellent university* etc.

Let's consider an example connected with managing the complexity of teaching material presentation according to motivation and speed of mastering new material by students.

In this case empirical knowledge of the considered pedagogical problem can be presented in the form of heuristic rules, which are developed by a skilled teacher intuitively and internally for the case of taking an administrative decision.

The knowledge base can have such appearance:

1. If *Motivation of training is Very positive*, and *Speed of mastering of a new material* is *High,* it is necessary to give (use) a material of *Very high complexity*.

2. If *Motivation of training is Very positive*, and *Speed of mastering of a new material is Low* it is necessary to give a material of *Above average complexity*.

3. If *Motivation of training is Positive*, and *Speed of mastering of a new material is High* it is necessary to give a material of *High complexity*.

4. If *Motivation of training is Positive*, and *Speed of mastering of a new material is Low* it is necessary to give a material of *Average complexity*.

5. If *Motivation of training is Very negative*, and *Speed of mastering of a new material is Low* it is necessary to give a material of *Very low complexity*.

6. If *Motivation of training is Very negative*, and *Speed of mastering of a new material is High* it is necessary to give a material of *Below average complexity*.

7. If *Motivation of training is Negative*, and *Speed of mastering of a new material is Low* it is necessary to give a material of *Low complexity*.

8. If *Motivation of training is Negative*, and *Speed of mastering of a new material is High* it is necessary to give a material of *Average complexity*.

9. If *Motivation of training is Very positive*, and *Speed of mastering of a new material is Average* it is necessary to give a material of *High complexity*.

10. If *Motivation of training is Positive*, and *Speed of mastering of a new material is Average* it is necessary to give a material of *Above average complexity*.

11. If *Motivation of training is Very negative*, and *Speed of mastering of a new material is Average* it is necessary to give a material of *Low complexity*.

12. If *Motivation of training is Negative*, and *Speed of mastering of a new material is Average* it is necessary to give a material of *Below average complexity*.

13. If *Motivation of training is Standard* (within normal limits), and *Speed of mastering of a new material is High* it is necessary to give a material of *Above average complexity*.

14. If *Motivation of training is Standard*, and *Speed of mastering of a new material Low* it is necessary to give a material *Below average complexity*.

15. If *Motivation of training is Standard*, and *Speed of mastering of a new material is Average* it is necessary to give a material of *Average complexity*.

This information will be used at construction of base for rules of fuzzy interference system, which will allow to realize the given fuzzy model management.

Let's remind that *motives* are internal forces connected with personal needs, and engagement to educational activity; in other words, *motives – are intended, acknowledged and experienced needs, particularly an interest for educational work, cognitive activity and a considered lesson topic* etc. Motivation is measured in relative values, for example, in per cents (from 0 % to 100 %).

In pedagogic the *reason* is generally identified with such concepts, as influence, action, influence indicator and parameter. One factor is defined according to at least two or more product development reasons of the same membership groups (for example, general or specific one).

If to consider the "training motivation" didactic factor as a management system of complexity of teaching material presentation it is necessary know that this concept has a complex internal structure. The motivation of training can be *positive* and *negative*. As an example we will show product development reasons of some of such motivations (Podlasyj, 2002; p. 338):

– Reason impulse (positive – "I want" and "I can"; negative – "I must" and "I shall");

– Duration (accordingly: significant – insignificant);

– Inevitability (weak – strong);

– Cognitive organization (deliberate – mechanical);

– Intellectual flexibility (easiness of transition from some intellectual actions to other – rigidness thinking);

– Rate (heated – sluggish);

– Purpose characteristic (attractive – unpleasant);

– Emotional coloring (satisfaction – depression);

– Imagination intensity (considerable – insignificant) etc.

Speed of mastering of a new material is time for mastering of Information and meaning elements of a text (IMET) per time unit, and *complexity (difficulty) of a material* is degree of its mastering. During the lesson 0 to 15 IMET can be perceived, therefore the range of definition of this value will fluctuate in different scales. The material complexity can be measured in different scales. For convenience of the task solution, we will choose a 7-point scale which conform with seven terms below (from 1 to 7).

To form a rule base for a fuzzy interference system it is necessary to define preliminary input and output linguistic variables. From the statements above it is clear that as one of input variables it is necessary to use training motivation: x_1 – "*Training motivation*", the second linguistic variable is x_2 – «*Speed of mastering*». As an output linguistic variable a managing value of complexity of teaching material presentation will be used: y – "*Material complexity*".

To reduce rules recording we will use standard MatLab symbols. As terms the following is used:

For what should be ***given as a teaching material***:
Very high complexity – PB (positive big);
High complexity – PM (positive medium);
Above average complexity – PS (positive small);
Average complexity – ZE (zero);
Below average complexity – NS (negative small);
Low complexity – NM (negative medium);
Very low complexity – NB (negative big).
For ***training motivation***:
Very positive – PB;
Positive – PS;
Standard – ZE;
Negative – NS;
Very negative – NB.
For ***speed of mastering of a new material***:
High – PM;
Average – ZE;
Low – NM.

Thus, we have executed the *fuzzyfication* of input variables.

For our case the fuzzy interference system will contain 15 rules of the fuzzy knowledge database as follows:

1. **IF** «x1 is PB» **AND** »x2 there is PM» **THAT** «y is PB»
2. **IF** «x1 is PB» **AND** «x2 there is NM» **THAT** «y is PS»
3. **IF** «x1 is PS» **AND** «x2 there is PM» **THAT** «y is PM»
4. **IF** «x1 is PS» **AND** «x2 there is NM» **THAT** «y is ZE»
5. **IF** «x1 is NB» **AND** «x2 there is NM» **THAT** «y is NB»
6. **IF** «x1 is NS» **AND** «x2 there is PM» **THAT** «y is NS»
7. **IF** «x1 is NS» **AND** «x2 there is NM» **THAT** «y is NM»
8. **IF** «x1 is NS» **AND** «x2 there is PM» **THAT** «y is ZE»
9. **IF** «x1 is PB» **AND** «x2 there is ZE» **THAT** «y is PM»
10. **IF** «x1 is PS» **AND** «x2 there is ZE» **THAT** «y is PS»
11. **IF** «x1 is NB» **AND** «x2 there is ZE» **THAT** «y is NM»
12. **IF** «x1 is NS» **AND** «x2 there is ZE» **THAT** «y is NS»
13. **IF** «x1 is ZE» **AND** «x2 there is PM» **THAT** «y is PS»
14. **IF** «x1 is ZE» **AND** «x2 there is NM» **THAT** «y is NS»
15. **IF** «x1 is ZE» **AND** «x2 there is ZE» **THAT** «y is ZE»

Let's open the FiS-editor and define 2 input variables with names *x1*="*Motivation__training*" and *x2*="*Speed__mastering"* and one output variable with a name *y*="*Complexity__material"*. Through *File* → *Export* → *To File* we save the fuzzy system file under name Complexity1.fis. The screenshot of FiS-editor graphic interface for these variables is shown in Figure 1.

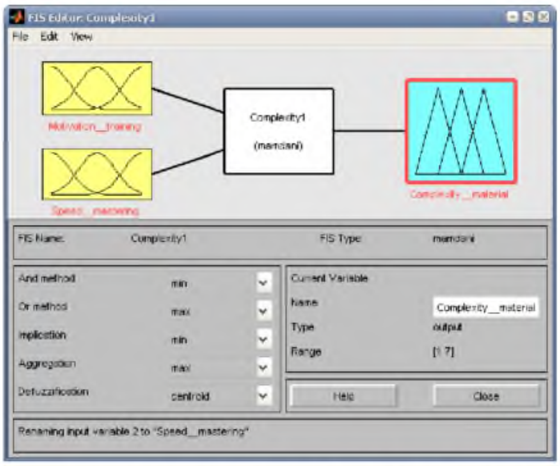

Figure 1 - The main screen of the FiS-editor for two input variables

Solving this issue we will use a fuzzy interference algorithm of Mamdani type, therefore we will leave the MatLab default type unchanged. There is no necessity to change other parameters of a developed fuzzy model set by default in Fuzzy Logic Toolbox.

Let us define functions of membership terms for each variable of a fuzzy interference variable. For this purpose we will use system membership functions editor Fuzzy Logic Toolbox.

For an input variable *x1* it is necessary to add two more additional terms to already available three ones, which are set by default, and it is necessary to define parameters of corresponding membership functions (*Edit* → *Add MFs*). Graphic interface layout of the membership functions editor after entering the first input variable is represented in Figure 2.

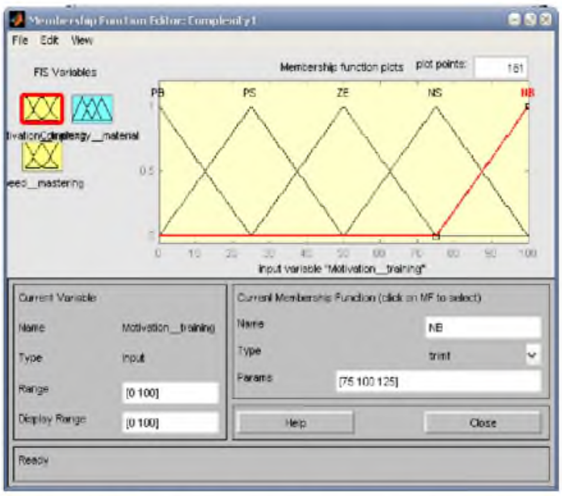

Figure 2: - Membership functions editor screen "Motivation__training" after filling its action range and terms names

For the second input variable *x2* it is necessary to leave 3 default terms and to change only membership functions type and parameters. For an input variable *y* it is necessary to add 4 terms to 3 default ones, and to set parameters of corresponding membership functions. Graphic interface layout of the membership functions editor after entering an output variable is represented in Figure 3.

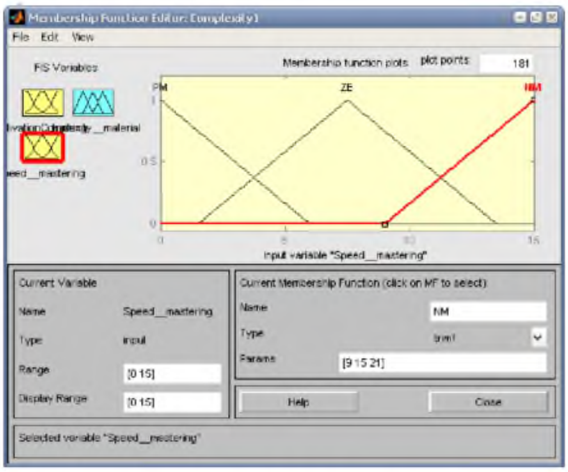

Figure 3 - Membership functions editor screen "Speed__mastering" after filling its action range and terms names

In the same way we will edit parameters of entering values for output membership function "*Complexity__material*". The screen layout the rules editor for output function is presented in Figure 4.

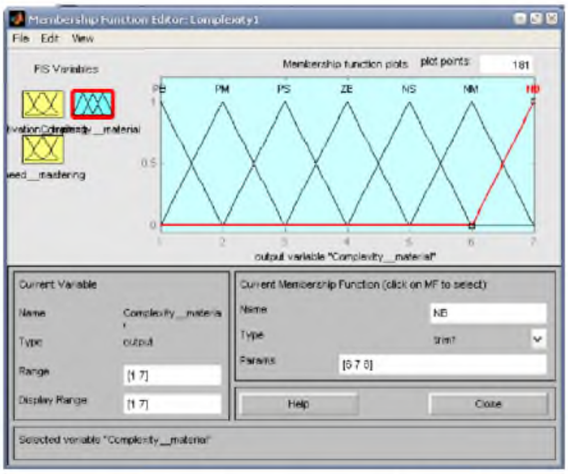

Figure 4 -The graphic interface of the membership function editor "Complexity material" after filling parameters of the fuzzy interference system

Now we will set 15 rules for a developed fuzzy interference system. For this purpose we will use the Fuzzy Logic Toolbox rules editor (*Edit* → *Rules*). The graphic interface layout of the editor after entering all 15 fuzzy interference rules is represented in Figure 5.

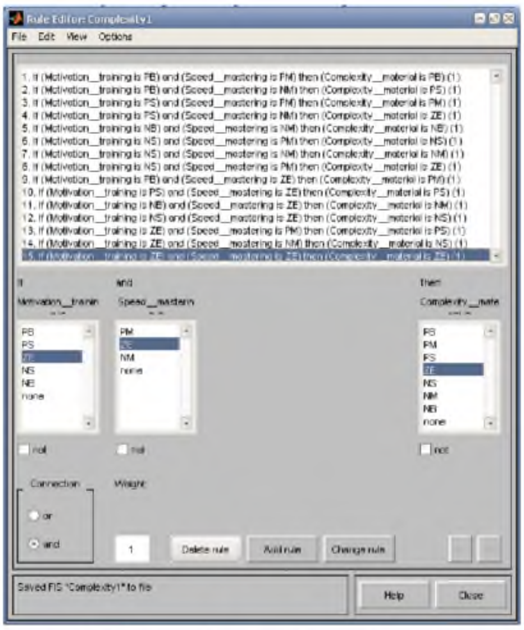

Figure 5 - The graphic interface of the editor after entering the knowledge database of the fuzzy interference system

To provide fine adjustment of the fuzzy model constructed by us, it is possible to enter other parameters, but for this purpose it is necessary to know definitely the membership function type.

Now let us open the viewer of fuzzy logic system rules (*View* → *Rules*) and look at the calculated result (Figure 6).

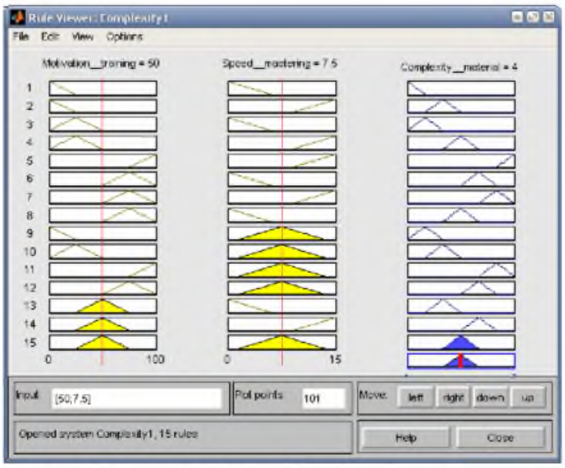

Figure 6 - Visualization of the fuzzy logic system to determine material complexity in Rule Viewer

And now we will perform an experiment, for this purpose we will enter values of input variables for a particular case when the motivation of training is negative (NS) and is 25 % (on a 100-point scale), and speed of mastering of a teaching material is average (ZE) and makes 7 IMET/lesson (on a 15-point scale). After performing the fuzzy interference procedure for our model, the system will return a result of an output variable according to the material complexity of 3 points (on a 7-point scale). That means that under such input parameters the teacher should select (and use) a material of below average complexity (NS) during the lesson presentation (Figure 7).

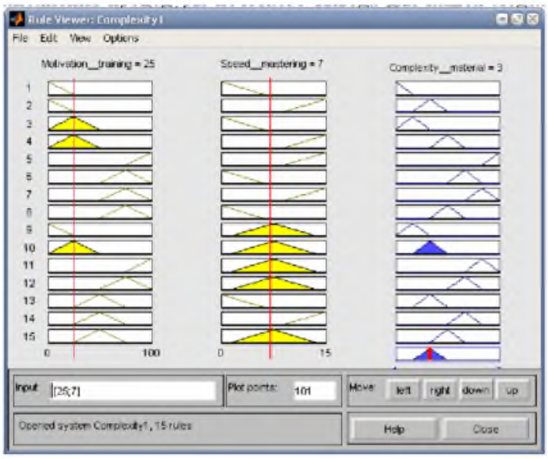

Figure 7 - Prognostic experiment: Motivation__training value – negative (25 %), *Speed__mastering* – average (7 IMET/lesson)

This value shows a good consistency of the model and submits its correspondence to current pedagogic reality.

And what will happen, if the motivation of training of students is absolutely absent (0 %), but, at the same time speed of mastering of a material will make the maximum size (that is 15 IMET/lesson)? What complexity of a material should be set for a lesson then? To these questions the fuzzy logic system gives the exact answer: complexity degree of 3 points (on a 7-point scale) (Figure 8). As we see it is the same complexity, as well as in the previous case, and here emerges a new question.

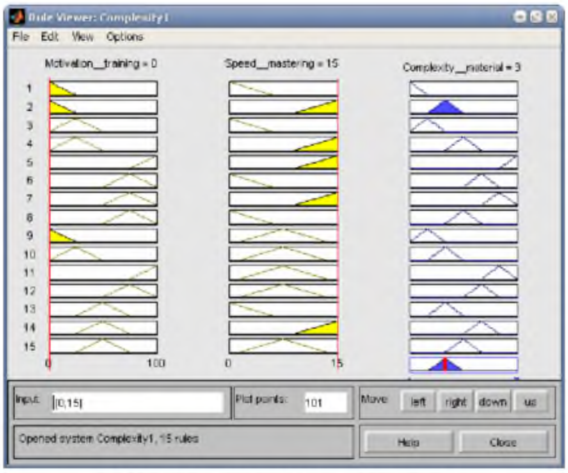

Figure 8 - Prognostic experiment: Motivation__training value - zero (i.e. it is absent – 0 %), *Speed__mastering* – high (15 IMET/lesson)

What is the reason for equal results under absence of motivation? In our opinion it is possible only when the teacher uses active methods of training during the lesson, that means such actions leading to a productive result. Certainly, here there is nothing to do without modern educational technologies.

As we see, such modeling on the basis of computer fuzzy logic system provides a magnificent result of a pedagogical forecast.

Sometimes for the general analysis of a developed expert prognostic system a visualization of a corresponding fuzzy interference surface (*View → Surface*) can be useful as well (Figure 9).

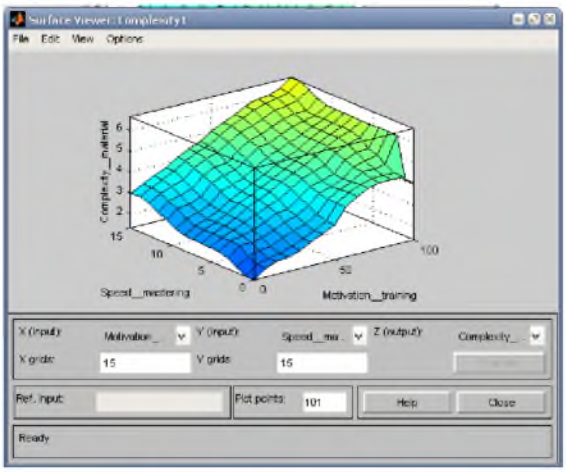

Figure 9 - Visualization of a fuzzy interference surface for material complexity

This surface allows to establish dependence of initial variable values on values of input variables of a fuzzy model of material complexity control system. This dependence can form a basis for specific recommendations for those, who conducts lesson.

In fact, we have scientifically solved the problem which in the classical theory of education management is known as a *problem of synthesis of control actions*. Thus for its decision computer means of fuzzy logic and the fuzzy sets *synthesis of operating influences* have been used.

It is sometimes very convenient to use one-dimensional diagram of dependences. For example, changing names of variables in entry fields (*X(input)* and *Y(input)*), it is possible to set one-dimensional dependence of *Complexity_material* on *Speed_mastering*.

Figure 10 represents an indicator of speed mastering continuing to increase somewhere in the middle of the diagram, but the material presentation complexity remains for some time constant (≈ at 4 points level); it is also observed both in the beginning, and in the end of this process.

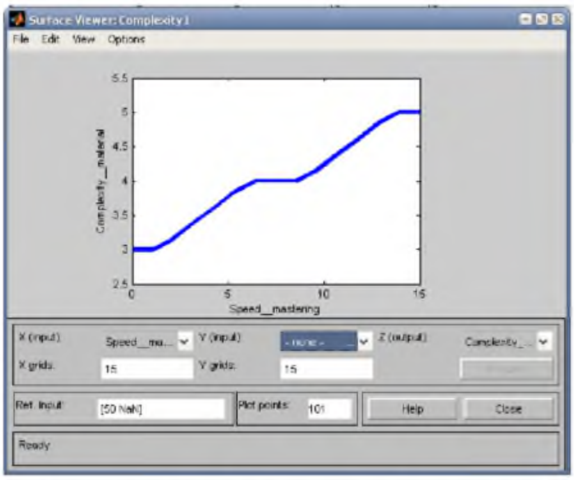

Figure 10 - Visualization of one-dimensional dependence of "Complexity_material" on "Speed_mastering"

Conclusion

Finishing the description of a computer way of managing the complexity of teaching material presentation and regarding received results, we conclude that on the basis of the fuzzy logic theory and fuzzy sets theory it is possible to carry out objective and precise calculations of a motivational component of training and speed of mastering a new material in terms of its complexity. In such a way the teacher can reliably predict the result of the future prepared lesson. Management of teaching material complexity is one of conditions for increasing lesson efficiency and for improving quantitative methods in pedagogic being an information process. In its turn it is a a component of a new branch of human knowledge –education management scientometrics. The model based on computer fuzzy logic system gives an opportunity to measure material complexity when giving it at lessons. It allows to avoid subjectivity in selection of teaching material complexity level for the lesson, and, as a result, to increase essentially the education level.

Integrating educational and information technologies is a time-bound process and so far it is impossible to draw the line between achievements in education management on the one hand and achievements in mathematics and computer technologies in taking effective pedagogical decisions on the other.

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Коляда М.Г., Бугаева Т.И. Управление сложностью подачи учебного материала на занятии на основе компьютерной модели нечетких множеств. *Цель статьи – наглядно показать компьютерный способ реализации теории нечетких множеств и теории нечеткой логики для управления сложностью подачи учебного материала на занятии. Среди задач, которые возникают при этом, была выделена лишь одна: реализация педагогического моделирования на основе самой мощной на сегодняшний день информационной системы нечеткой логики – Fuzzy Logic Toolbox (программы Mat Lab). Показаны подходы в формализации высказываний педагогической направленности. Рассмотрены примеры, связанные с управлением подачей сложности учебного материала на занятии относительно учета мотивации и скорости усвоения нового материала. Приведены результаты эксперимента относительно влияния отрицательной и положительной мотивации обучающихся на подбор сложности учебного материала. Представлены формы визуализации результатов анализа в одномерном (графики) и объемном (поверхности) виде. Эти поверхности нечеткого вывода позволяют установить зависимость значений исходной переменной от значений входных переменных нечеткой модели. Сделан вывод, что на основе теории нечеткой логики и нечетких множеств можно достаточно точно и объективно выполнять расчеты мотивационной составляющей обучения и скорости усвоения нового материала с позиции его сложности. Таким способом преподаватель может гарантированно прогнозировать результаты будущего занятия, которое он готовит. Модель, основанная на компьютерной системе нечеткой логики, дает возможность преподавателю дозировано управлять сложностью подачи материала на занятии, что позволяет избежать субъективизма в подборе уровня сложности учебного материала, и тем самым существенно повысить качество обучения.*

Ключевые слова*. Педагогическое прогнозирование, эффективное обучение, управление сложностью материала, компьютерная модель нечетких множеств, наукометрия, формализация человеческих высказываний.*

Коляда М.Г., Бугайова Т.І. Управління складністю подачі навчального матеріалу на занятті на основі комп'ютерної моделі нечітких множин. *Ціль статті – наочно показати комп'ютерний спосіб реалізації теорії нечітких множин і теорії нечіткої логіки для управління складністю подачі навчального матеріалу на занятті. Серед задач, що виникають при цьому, була виділена лише одна: реалізація педагогічного моделювання на* *основі самої могутньої на сьогоднішній день інформаційної системи нечіткої логіки – Fuzzy Logic Toolbox (програми Mat Lab). Показано підходи у формалізації висловлень педагогічної спрямованості. Розглянуто приклади, пов'язані з управлінням подачею складності навчального матеріалу на занятті щодо врахування мотивації і швидкості засвоєння нового матеріалу. Приведено результати експерименту щодо впливу негативної і позитивної мотивації тих, хто навчається, на підбор складності навчального матеріалу. Представлено форми візуалізації результатів аналізу в одномірному (графіки) і об'ємному (поверхні) вигляді. Ці поверхні нечіткого висновку дозволяють установити залежність значень вихідної змінної від значень вхідних змінних нечіткої моделі. Зроблено висновок, що на основі теорії нечіткої логіки і нечітких множин можна досить точно й об'єктивно виконувати розрахунки мотиваційної складової навчання і швидкості засвоєння нового матеріалу з позиції його складності. Таким способом викладач може гарантовано прогнозувати результати майбутнього заняття, яке він готує. Модель, заснована на комп'ютерній системі нечіткої логіки, дає можливість викладачу дозовано керувати складністю подачі матеріалу на занятті, що дозволяє уникнути суб'єктивізму в підборі рівня складності навчального матеріалу, і тим самим істотно підвищити якість навчання.*

Ключові слова. Педагогічне прогнозування, ефективне навчання, управління складністю матеріалу, комп'ютерна модель нечітких множин, наукометрія, формалізація людських висловлень.

Koliada M.G., Bugayova T.I. Control the complexity of the presentation of educational material in the classroom on the basis of a computer model of fuzzy sets. *The purpose of this article is to demonstrate a computer implementation method of fuzzy set theory and fuzzy logic to control the complexity of presenting teaching material in class. Among the tasks that arise in this case, only one was singled out: the implementation of pedagogical modeling on the basis of the most powerful information system of fuzzy logic – Fuzzy Logic Toolbox (Mat Lab program). Approaches in formalization of statements of pedagogical orientation are shown. Examples related to the management of feeding difficulties learning material in class on the motivation and speed of learning new material. The results of the experiment on the influence of negative and positive motivation of students on the selection of the complexity of the educational material are presented. The forms of visualization of the analysis results in one-dimensional (graphics) and three-dimensional (surfaces) form are presented. These fuzzy inference surfaces allow you to determine the dependence of the values of the source variable on the values of the input variables of the fuzzy model. It is concluded that on the basis of the theory of fuzzy logic and fuzzy sets, it is possible to accurately and objectively perform calculations of the motivational component of learning and the rate of assimilation of new material from the position of its complexity. In this way, the teacher can guarantee to predict the results of future classes, which he prepares. The model, based on a computer system of fuzzy logic, allows the teacher to control the complexity of the presentation of the material in the classroom, which avoids subjectivity in the selection of the level of complexity of the educational material, and thus significantly improve the quality of training.*

Keywords: *Pedagogical Forecasting, Effective Training, Managing material complexity, Computer model of indistinct sets, Scientometrics, Formalization of human statements.*

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