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Intelligence Amplification in Distance Learning through the Binary Tree of Question-answer System

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Abstract

The pedagogical science develops together with the information technologies. Advanced theoretical and practical exploratory works of scientists in smart information systems are looked for that can be implemented with the current capacities in the well-known and widely used distance learning systems, with moral and ethic aspects of human life borne in mind. The authors have revealed that the most promising direction is the student's intelligence amplification using the educational information structuring methods. The paper gives a way of bringing into life an intelligence amplification method using the construction of binary tree of question-answer system. The authors suggest implementing the tree using Lesson activity in a distance learning system, e.g. Moodle. They also offer their own way of the tree implementing in this activity via Add a content page. The paper contains new reference points for further research. The authors have given a well-illustrated example of implementation of a small binary tree of question-answer system by Lesson activity.

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1. Introduction

The pedagogical science is currently developed together with the information technologies, and it is only their correct joint use that will allow enhancing the quality of education. Distance learning is this kind of their combination (Polat, Moiseeva & Petrov, 2006).

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This kind of learning has got a number of positive and negative features (Dostoinstva i nedostatki distancionnogo obuchenija, 2010) distinguishing it from the classical learning. This is why such technologies and methods of distance learning are currently being developed (Polat, Moiseeva & Petrov, 2006) as to allow automating most elements borrowed from the classical learning, introducing something new from the information technologies while also keeping the valuable properties of interpersonal relations of the classical learning.

Preventing distance learning from developing is clearly wrong, as classical learning cannot already manage the great scope of information available in today's world. Hence problem-oriented information systems have to be used in distance learning that allow collecting, processing and transferring huge amounts of educational information.

For instance, a relevant and actively developing technology of distance learning is the use of artificial intelligence that allows adapting to needs of a certain learner (Malitikov, Karpenko, Kolmogorov, 2000; Hutorskoj, 2001). This technology is however hard to implement today within the known distance learning systems, e.g. Moodle.

2. Objectives

The goal of the research is advanced theoretical and practical exploratory studies of scientists in the area of smart information systems that can be implemented by the available opportunities in the well-known and widely used distance learning systems, with moral and ethic aspects of human life borne in mind.

This goal takes into account the fact that most pedagogues using the distance learning systems for making up courses are not obliged to be professionals in knowledge databases, smart systems etc. programming – all they have to be is a confident user of the PC and the Internet environment.

We also have to remember that not all directions of artificial intelligence can be up to moral principles and views of both the pedagogue and the learners.

3. Methodology

Let us make a comparative analysis of the existing artificial intelligence directions (Table 1) for selecting the most appropriate scientific theory that will allow collecting, processing and transferring huge amounts of educational information adequately.

Selection criteria will be as follows:
- moral and ethic norms current in society as of now;
- the opportunity of practical employment in open distance learning systems such as Moodle.

<table>
<thead>
<tr>
<th>Current directions and technologies</th>
<th>Moral and ethic norms current in society as of now</th>
<th>Practical employment in open systems of distance learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>artificial intelligence replacing man</td>
<td>questionable</td>
<td>cannot be employed</td>
</tr>
<tr>
<td>intelligence amplification</td>
<td>there are appropriate technologies</td>
<td>can be employed</td>
</tr>
</tbody>
</table>

What has also to be checked is how this learning technology will fit into the existing distance learning methodologies (Table 2). Another point is suggesting our own way for implementing this distance learning technology within the most suitable distance learning methodologies, having specified resources and activities and given an example of the implementation.

<table>
<thead>
<tr>
<th>Name of distance learning methodology</th>
<th>Kind of learning</th>
<th>Problems solved in learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>collaborative learning</td>
<td>group</td>
<td>non-formalized</td>
</tr>
<tr>
<td>cooperative learning</td>
<td>group</td>
<td>non-formalized</td>
</tr>
<tr>
<td>project method</td>
<td>combined</td>
<td>non-formalized</td>
</tr>
</tbody>
</table>
4. Research design

4.1. Analysis of current directions of the modern artificial intelligence (AI)

At present there are two basic directions in the modern AI – the artificial mind replacing man in solving a number of problems, as well as amplification of human intelligence by bringing the specialized AI technologies close to human opportunities, their integration that is ensured by the human nature (Ashby, 1956).

They have not succeeded in creating the artificial mind so far. However, even if it is created, many issues arise related to the possibility of trusting the artificial mind when obtaining knowledge having refused a living pedagogue. Certain moral and ethic aspects emerge that are irresolvable at the moment. Some of them are reflected in the modern art works and feature films, e.g. ones telling about machine mind taking over the world.

Hence the authors believe that artificial intelligence as an element of artificial mind can only be applied for solving formalized problems which are repeated frequently and deal with large volumes of information, ones difficult for man to complete. Such problems get automated well. The results of their solution can be controlled by the teacher. E.g. selection of materials for organizing learning which the teacher can organize as an author's pedagogical design.

Decision making support systems can be used for this, but they cannot be implemented within the open distance learning systems. Very few modern teachers have such a level of knowledge as to enable him to implement or use the available decision making support system. Research in this area is as a rule one of dissertation paper level.

Among methods of human intelligence amplification, there are ones to be rejected due to moral and ethic reasons – the use of consciousness broadening ways and implantation of chips. They are also inappropriate because of the distance learning conception formed. So there only remain the intelligence amplification methods which allow keeping the conception of distance learning while not violating the moral and ethic aspects of human life, while keeping the required distance between computer technologies, latest developments in various areas of knowledge, and human body.

In such methods, a great part is assigned to personal knowledge (experience) and ability to solve non-formalized problems (use of experience). Thus, the well-known modern methods of solving non-formalized problems were made into the distance learning methodologies listed above (see Table 2). Modern methods of solving non-formalized problems that are used in decision making support systems and solving research type problems are as follows:

- interview;
- construction of scenarios;
- psycho-intellectual ideas generation;
- commissions;
- team generation;
- "Delphi";
- matrix one.

All the methods engage a group of experts that exchange knowledge in a certain manner when solving non-formalized problems. Hence we can see that methods presented in Table 2 are in line with the modern trends in intelligence amplification theory and practice.
The opportunity of their employment in open distance learning systems has to be checked in accordance with the education programs offered in higher education institutions.

4.2. Current situation in distance learning providing the state program

At present, Russian higher education institutions employ mostly modular learning where education goals, objectives and levels of study are clearly determined for each module, skills and abilities are listed, the sequence of study material learning and the level of its adoption, adoption quality control are specified.

Such a system combines well with the existing open distance learning systems, e.g. Moodle. Systems of this kind support the modular conception where the study material is well distributed in its resources and activities without modifications.

The other distance learning methodologies (see Table 2) cannot be implemented simply by resources and activities without the use of author's techniques. They also have to stay within the framework of modular learning. Due to these difficulties it is only rarely that the advanced distance learning methodologies are implemented, and this only touches upon several lectures of the course, a course project (paper) if it is on the program, or a scientific research in postgraduate studies, if it is organized by distance learning. The implementations suggested by teachers feature scientific novelty and are applicable in definite knowledge areas only.

There is no readily available technique for adapting the advanced distance learning methodologies. It is only conceptions of these distance learning methodologies that are known. At present for implementing the conception, they use wording of a non-formalized problem matching the course topic and the activities that allow organizing online communication, control and assessment of students' interaction within the distance learning methodology conception. Apparently, assessment of such interaction and its results is rather subjective, which cannot be said about the modular learning. A possible solution can be a new method of presenting the educational information by integrated activities connecting the modular learning with the distance learning world trends. This method must be close to presenting the information by the natural intelligence and objectively assessable. As it can be noticed, here it is the human intelligence amplification method that has to be used including the advanced ways of data presentation – of study knowledge offered to students within the discipline taught, i.e. structuring the information in a way good for remembering.

5. Discussion

5.1. Structuring

"When memorizing a large quantity of information we have to structure it. Information structuring consists in, first of all, dividing the information into groups and subgroups according to a certain criterion; second, in knowing how to build logical links between the information groups thus singled out for the structure to be stored in our memory securely. Structuring is creating a solid framework based on which memorizing of all the information required will take place" (Urok 3. Strukturirovanie informacii, 2012).

This is what Evgheniy Buyanov advises to those who learn to "create a convenient and logical structure of information being remembered" (Urok 3. Strukturirovanie informacii, 2012) that will allow memorizing a large quantity of information for a long time and using it as appropriate. Exactly this is what is required from both classical and distance learning.

Apparently, the above distance learning techniques (see Table 2) are aimed at the learner being able to acquire the skill of structuring the collected educational information while performing the task set. The same can be said about classical education. And it is only the student structuring the obtained material on a regular basis who can obtain integrated profound knowledge which is to help him in structuring the new knowledge. However, not everyone can guess independently how to do this best. Meanwhile, students succeeding in structuring can have considerable difficulties when facing a large amount of information. Thus, an underperforming student is not always "lazybones" – he just failed to figure it out completely how to structure the information, he does not know how to do this and does not understand what it is for.
Therefore, the natural structuring of educational information allows enhancing one's intelligence on one's own. However, if we combine the algorithm with the capacities of computers, a more efficient intelligence amplification method can be obtained (Popova, 2014).

5.2. Mind mapping method

While the modern teaching does not use intelligence amplification methods based on structuring, psychologists and time managers use this technology quite successfully.

At present, in today's society, everything has to be done in time and so much has to be done, with the information exceeding all imaginable limits and one wanting to act in a rational, optimum etc. way. All this is fairly confusing, and one is often looking for answers to questions like "How should I act?", "What should I buy?", "Where should I go?" and so on.

The intelligence amplification method – mind mapping – is widely used (Urok 3. Strukturirovanie informacii, 2012). Mind maps can be found on specialized websites also giving technologies for drafting them (Mindmapping, 1997; Mind Map Gallery, 2010). When drafting a mind map, all initial information about the situation is taken into account, so one can make a correct decision when seeing this information in the picture. This method is distinguished by principles of reflecting the information about a situation. Here objects visualization as colored pictures and branching is used which gradually makes this or that choice certain. Colored visualization, branches and labels help the brain to structure the initial information while focusing on a certain problem. There is a huge quantity of applications, both open and paid, for drawing mind maps. However, they are not fit for good quality structuring of educational information.

The authors think mind maps help learn the educational information by heart without focusing on the essence of what is memorized. A way out is improving the method and using it for intelligence amplification in distance learning.

5.3. Structuring the educational information using a binary question-answer system tree

The authors have worked out the theory for obtaining a binary question-answer system tree – its root, intermediate nodes, and leaves of the tree (Popova, Popov & Klyuchko, 2013a; Popova, Popov & Klyuchko, 2013b). The tree suggested by the authors is a structure of data that structures the information or study knowledge in a certain manner. The tree obtaining technology is one close to the natural educational information structuring technology.

The educational information is broken down into groups and subgroups according to a certain criterion which is expressed as a property of this group or subgroup. The theory proposed by the authors helps build logical links between the information groups singled out for the structure to be stored in the student's memory securely. The binary tree is a framework built as a basis for memorizing the educational information.

Here the root and an intermediate node are questions where a certain property of an information group is reflected distinguishing it from other groups. Leafs are individual blocks of the educational information.

Such trees can be used for presenting the educational information for students to learn it, which will allow students to easily learn the material offered, because it is offered in a structured form. Binary trees can also be used for solving problems at which the structured material is aimed, i.e. used for intelligence amplification.

If distance learning methodologies given in Table 2 have to be implemented, students can be asked to obtain the said question-answer system tree as a solution of exploratory study of the given topic. Such assignment can be performed within a laboratory work, course project or a postgraduate scientific research. The results of performance can easily be checked and assessed – the validity of the structure obtained the degree of elaboration of each educational information group, and the student's personal contribution. Test on the educational information can also be carried out.

As the authors believe, the percentage of answers to "be able to" and "master" questions will be higher with students learned using this teaching technology because when singling out knowledge groups according to
properties a student learns to distinguish objects, methods, and problems. Having made out logical links, the student learns to master the information studied during the course.

The binary trees can be supplemented with new educational information by the next students group (if there is a lot of educational information), implemented by software means in various programming languages (studying the two disciplines can be combined, one of them being programming in a certain language). The question-answer system binary tree can be used as a task for course project work in disciplines where course project work is hard to be implemented due to the study program but can be presented as exploratory research.

The tree obtained as a result of exploratory research can be published as scientific research results. It can be supplemented by new elements meanwhile, with students and postgraduate students being able to act as representatives of a certain scientific school.

5.4. The method for implementing a binary question-answer system tree in the open distance learning system suggested by the authors

The authors have studied activities (Table 3) and resources (Table 4) integrated into an open distance learning system e.g. Moodle. Among all activities, they have selected one capable of reflecting the elements and properties of a binary question-answer system tree. So, the main search elements were resources able to output text information accompanied by explanatory illustrations, as well as ones able to jump from one to another between blocks. The first search element allows implementing the root, intermediate nodes and leaves of the binary question-answer system tree. The second search element organizes structural links between elements of the question-answer system tree.

It has become apparent from Tables 3 and 4 that only two activities suit the expected requirements – Lesson and Book. We can note that the activities are used in Moodle for visualizing the study material having certain particularities that reflect the modular learning conception, i.e., it can be concluded that the required contact of modular learning and the latest distance learning methodology trends has been found.

The authors have selected an efficient in every respect activity – Lesson – for implementing the method. It allows making jumps between its blocks by various ways. The authors present the simplest for implementing one; advanced users of Moodle and other open distance learning systems can select another way if they have to make change as appropriate to the conception suggested by the authors.

Table 3. An activity of Moodle.

<table>
<thead>
<tr>
<th>Activity name</th>
<th>Text information and illustrations</th>
<th>Jumps between blocks in the activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Chat</td>
<td>presented weakly</td>
<td>-</td>
</tr>
<tr>
<td>Choice</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Database</td>
<td>stored in files</td>
<td>-</td>
</tr>
<tr>
<td>External tool</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Forum</td>
<td>presented weakly</td>
<td>-</td>
</tr>
<tr>
<td>Glossary</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Lesson</td>
<td>presented significantly</td>
<td>presented significantly</td>
</tr>
<tr>
<td>Quiz</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>SCORM package</td>
<td>stored in files</td>
<td>-</td>
</tr>
<tr>
<td>Survey</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Wiki</td>
<td>external source</td>
<td>-</td>
</tr>
<tr>
<td>Workshop</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4. A resource of Moodle.

<table>
<thead>
<tr>
<th>Name of the course resource</th>
<th>Text information and illustrations</th>
<th>Jumps between blocks</th>
</tr>
</thead>
</table>
To select jumping down the tree to the left (the yes option), Yes button in the menu located under the illustrated text has to be pressed. Jumping down the tree to the right (the no option) is performed similarly by pressing No button in the same menu. No and Yes buttons are linked with the following blocks consisting of text, pictures, and menu. All blocks have to be linked according to the structure obtained in the binary question-answer system tree.

As we can see, the interface suggested is intuitive and simple to implement. The connection between blocks is set up in Jump section where the next information block has to be selected. In other systems, the implementation of binary question-answer system trees requires knowing a programming language.

Let us give an example of creating a binary question-answer system tree in Lesson activity. Its structure is shown in Figure 1 below.

First we have to add the Lesson activity into the required course section, give it a name, describe it and input general and special settings according to our needs (see Figure 2). After this, the page should be saved.

![Figure 1. Structure example of binary tree of question-answer system](image)

![Figure 2. Adding a new binary tree of question-answer system to topic of the course](image)
Let us perform the following actions in sequence according to the method of implementing the binary question-answer system tree selected by the authors. This is sequential adding of information pages with current filling them in, the quantity of pages being equal to that of activities in the tree. For this, one and the same action has to be selected, Add a content page (see Figure 3).

Other methods can also be used for implementing a binary question-answer system tree but the authors decided not to consider them in the paper.

![Example of binary tree of question-answer system](image)

**Figure 3. A list of methods implementing the elements of binary tree of question-answer system**

After selecting the activity creation method, a window opens with fields to be filled in. The tree element is Page title. The Page contents block has to be filled with educational information. Next, the names of two Yes and No menu buttons have to be assigned – this is Description field in Content 1 and Content 2 sections (see Figure 4).

![An example of adding and filling a content page](image)

**Figure 4. An example of adding and filling a content page**
Jumping to another block is specified in Jump field (Figure 4). The required tree element name (to have been created by the point of selection) can be selected from the dropdown menu. This is why the links between blocks of educational information can be setup after adding all nodes of the tree. The developed by the authors techniques of generating, testing and visualizing the binary question-answer system tree allow making no mistakes when organizing the links between elements (Popova, Popov & Klyuchko, 2013a).

The authors suggest going to Collapsed tab (see Figure 3) having constructed the jumps between blocks of educational information created. This will allow checking the binary tree structure. So, for the example given (Figure 1) it has the following appearance (Figure 5).

Let us next go to Preview tab (Figure 6) and test the obtained binary question-answer system tree. Let us jump in the tree as follows (see Figure 1, Figures 7 – 9):

Question 1 → yes → Question 2 → yes → Question 3 → no.

The answer should be block of educational information 4. As we can see, the answer matches (see Figure 9).

Similarly, the position of buttons and their quantity in Lesson activity can be edited. They can be located horizontally (see Figure 6) and vertically (see Figure 7). The quantity of buttons cannot be less than one, this is one of the rules of Lesson activity. Exit button allows logically completing the jumps down the tree. In addition, buttons for jumping up etc. can be organized. The combination of buttons and other methods (see Figure 3) will allow obtaining more complex problem-centered trees amplifying the students' intelligence. The authors give only the basic part in their paper reflecting the main theory of generating a binary question-answer system tree. We have also to point out that the educational information can be located in blocks as animation, recorded video, high quality pictures, text, formulae and presentations, which allows amplifying the students' intelligence as well. The same element is used in mind mapping, which enhances memorizing the information.

![example of binary tree of question-answer system](image-url)
Figure 6. Root of binary tree of question-answer system

Figure 7. Binary tree of question-answer system after answering Yes to Question 1

Figure 8. Binary tree of question-answer system after answering Yes to Question 2

Figure 9. Binary tree of question-answer system after answering No to Question 3
6. Conclusion

The use of distance learning is relevant today. A promising trend in distance learning methodology is using the methods contributing to students' intelligence amplification. Such methods not only increase the scope of material memorized by students but also teach them to structure the material memorized, thus enhancing the quality of education. Results of students' tests will also improve. The authors give one method developed by them using the theory of generating a binary question-answer system tree. Such trees structure the studied material well. Further search for new intelligence amplification methods or improvement of the one suggested is possible. It can also be tested on various groups of students.

However, not all promising techniques can be transferred into open distance learning systems by transposing them to activities or resources. This is why it is only modular learning that is mainly in use today. Certain methods that allow implementing the advanced distance learning methodologies within modular learning have to be applied. The authors suggest their approach to obtaining such a method in their paper. This approach can be used for generating other methods or improving the proposed one.

The intelligence amplification method suggested by the authors and implemented by a binary question-answer system tree in Lesson activity of Moodle distance learning system can be used as a course project assignment, an exploratory research for postgraduate students and as a section containing educational information compiled by a teacher. Yet, other applications of this method are possible where human intelligence should be amplified without violating one's moral and ethic views.

Acknowledgements

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References