FIRST STEPS IN CONSTRUCTING A THEORY OF EDUCATIONAL DIALOGUE COMPUTER PROGRAMS

Ridvan Mustafov Itsufov [1], Philip Petrov Petrov [2]

Educational Dialogue Computer Programs (EDCP) were invented back in the 80s. These programs were led by a logical scheme called "Didactical Block Scheme". There have been university courses since 1990 in the Sofia University "St. Kliment Ohridski" and the Southwest University "Neofit Rilski" that provide ground for the development of EDCP applications by students.
Initially the technical realization of the applications has been achieved through different set of programming languages. Starting in 2003 the first author initiated a project which aimed at the implementation of different commercial software products in the development of EDCP applications. This approach simplified the creation process.
In the last two years the second author has extended the project with focus on software systems for the development of EDCP. During the 38th Spring Conference of the Union of the Bulgarian Mathematicians (UMB) two independent software systems for EDCP development were presented. The experience gathered throughout these practical projects was sufficient to allow the separation of scientific elements and to lead us to the construction of a theory. The focus of the current paper is to outline the initial steps in constructing a theory of EDCP.

The paper will present:
   - Didactical Block Scheme of EDCP;
   - Creation of patterns and approaches for the development of EDCP;
   - Technologies for the development of EDCP.

Key words: *scenario, basic aid, more aid system of anti-Vari of search solutions (answer), automatic evaluation of diagnostic error*

1. Introduction

The purpose of „educational dialogue computer programs" (EDCP) is to allow us to model the learning process in the traditional classroom and to present it with the help of modern computer technology. This includes the use of multimedia for the interactive presentation of information when new knowledge is acquired, as well as a purely programming approach to structuring, control, and evaluation of exercises.

R. Itsufov, Ph. Petrov
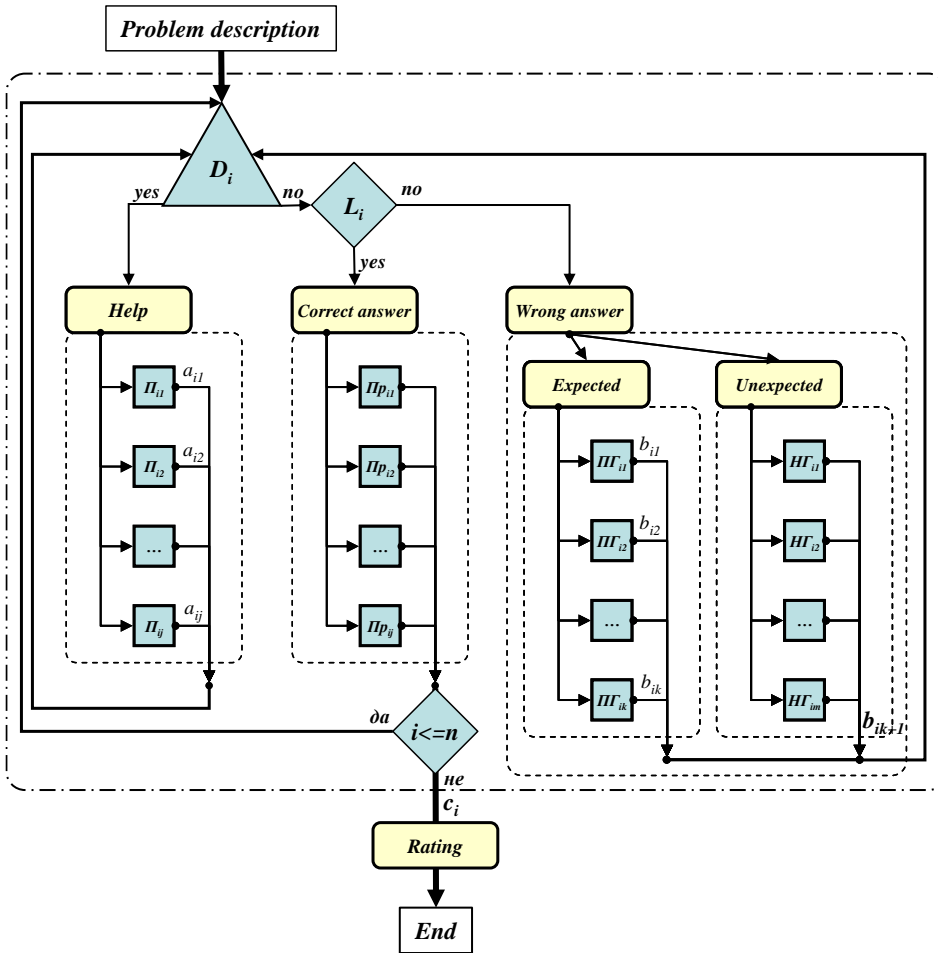
A Logically-Didactical Block Diagram

Fig. 1

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△ – Didactical Block, ◇ – Logical Block, ▢ – Scenario;

▭ - Scenarios (Help, Rule, and Error);

⌐⌐ - Actions, ⌐⌐ - Activities;

n – number of activities, i – activities $i=1...n$,

i – index of the sequential problem activity;

D_i – Didactical process (Help, Answer),

Help – a way to enable offering help, **Answer** – a way to enable entering an answer.

L_i – Logical process (A True or False answer);

j, k , m – number of the scenarios in the activity,

Scenarios of the Activity:

Π_{ij} –**Help**, Πp_{ij} – **Correct,**   ⟶ - Transition towards a scenario;

$\Pi\Gamma_{i\kappa}$ – **A predictable error**,   ⟶ - Transition towards the Didactical block;

$H\Gamma_{im}$ – **An unpredictable error**,   ⟶ - Input and output of activities.

Evaluation Element:

    ▭ – Scenarios (Score);

j – index for help used;

a_{ij} – evaluation scale for the sequential number of the requested help;

b_{im} – evaluation scale for a particular predictable error;

b_{im+1} – evaluation scale for an unpredictable error;

c_i – a positive evaluation scale for a particular activity;

2. Section

Basic Stages in the Development of EDCP Scenarios

1. Study the problem text.
2. Develop an algorithm to solve the problem.
3. Determine the activities required to solve the problem.
4. Create a scenario for each separate activity:
    4.1. Question about the required solution (answer).
    4.2. Help hints.
    4.3. Correct.
    4.4. Errors.
        4.4.1. Predictable.
        4.4.2. Unpredictable.
5. Create an evaluation scale for each action.
6. Enter the data in the EDCP environment.

Development of EDCP Content

Regarding the Basic Stages of a Problem to Solve a Square Equation

1. ***Study the problem text:***

    Create a scenario to prompt the student to write down the problem text.

    Write down in your notebooks the following problem:

    Solve this square equation: $x^2-3x+2=C$

2. **Develop an algorithm to solve the problem:**

    The description of the algorithm can be verbal (using natural language words), symbolic, or in the form of a block diagram. It is up to the tutor to decide on that. In this example we shall use a verbal variant.

$$ax^2+bx+c=0, a\neq 0 \qquad\qquad x^2-3x+2=0, a\neq 0$$
$$a=?, b=?, c=? \qquad\qquad\qquad a=1, b=-3, c=2$$
$$D=b^2-4ac \qquad\qquad\qquad D=b^2-4ac=(-3)^2-4\cdot1\cdot2=9-8=1$$
$$D<0\to \text{нрк}$$
$$D=0\to x=\frac{-b}{2a} \qquad\qquad D>0\to x_{1,2}=\frac{-b\pm\sqrt{D}}{2a}=\frac{-(-3)\pm\sqrt{1}}{2\cdot1}=\frac{3\pm1}{2}$$
$$D>0\to x_{1,2}=\frac{-b\pm\sqrt{D}}{2a} \qquad x_1=\frac{3-1}{2}=\frac{2}{2}=1$$
$$x_2=\frac{3+1}{2}=\frac{4}{2}=2$$
$$a=1, b=-3, c=2, D=1, x_1=1, x_2=2.$$

3. Determine the activities required to solve the problem:

The activities related to solving the square equation can be several varieties and we can create different EDCPs differentiated based on the knowledge and skills of the student.

1. $a=?, b=?, c=?, D=?, x_1=?, x_2=?$; - EDCP for students, who are solving a square equation for the first time.

2. $D=?, x_1=?, x_2=?$; - EDCP for students, who know how to find the coefficients in a square equation.

3. $x_1=?, x_2=?$; - EDCP for students, who know how to find the coefficients and the discriminant in a square equation.

4. Create a scenario for each separate activity:

After the activities and the activities variant have been determined, the next step is to create the respective scenarios. In this case we shall not present a description of the scenario. Instead, we shall explain what the description of a scenario must contain. The scenario is created by the tutor based on the knowledge and skills of the students in the class. In this case we shall present only the first activity for the **a** coefficient.

4.1. Question about the required solution (answer):

Then we create a scenario that prompts the student to enter the required solution (answer), i.e. the first determined activity – the a coefficient. The frame must contain instruments for Help, Enter, and Check of the entered answer. This answer is compared and depending on the answer, the student is shown the respective scenario. This frame is called a Didactical block and it is the dialog communication between the student and the EDCP. In EDCP it is identified as $\boxed{D_1}$ {Enter the $a=?$ coefficient}

4.2. Help Hints:
Here we create the scenarios for the particular activity, i.e. for the a coefficient. The tutor decides how many help hints to include. The help hints must be created in such a way that they give direction in a gradual manner, not the correct value of the a coefficient. The help hints in the first activity are identified as $\boxed{\Pi_{11}}, \boxed{\Pi_{12}}, \boxed{\Pi_{13}}, \ldots$

4.3. Correct:

We create the scenarios for the particular activity – i.e. the a coefficient. When the student enters the correct answer, he or she is shown a rewards scenario. These scenarios must be created in such a way that the rewards are escalating.

- If the student has entered the correct answer the first time he or she tried, he or she will be given the first scenario.

- If the student has entered the correct answer the second time he or she tried (and before that he had entered a wrong answer or had requested help), the student will be given the second scenario. The number of the scenarios for Correct must be equal to the number of help hints. The Corrects in the first activity are identified as TP_{1}, TP_{2}, TP_{3} ... .

4.4. Errors:

Here we create the scenarios for the particular activity – i.e. the a coefficient. When the student enters an erroneous answer, he or she is presented with a scenario for a wrong answer.

4.4.1   Predictable: Here we create the scenarios for the particular activity, i.e. the a coefficient. Predictable errors are those errors, which happen when a clever guy makes calculations and they go wrong. The task here is to analyze the answer the student has given and try to figure out where the mistake in his or her calculations is in order to get this particular answer. We create a scenario for that particular answer and our task is to direct student's attention to the very place where he or she has made a mistake. In the example with the $x^2-3x+2=0$ square equation, we could predict the following predictable wrong answers (3, -3, 2, x, -3x, 3x, 0, ...). For the first activity Predictable errors are identified as TPL_{1}, TPL_{2}, TPL_{3} ... . We use the same approach to predict the errors in the remaining activities (b, c, D, x_1, x_2). If we take into account the third variant of the activities (x_1, x_2), then the predictable errors are included in the previous activities and we only need to create the appropriate scenarios.

It is important to make a clarification about x_1 and x_2. If we enter the answer for x_2 in x_1, then the scenario will prompt to enter the other root for x_1. In the case we have a predictable error about x_2, the prompt will be to enter the x_1 root.

4.4.2   Unpredictable: Here we create the scenarios for the particular activity, i.e. the a coefficient. When the student enters a wrong answer, he or she is presented with a scenario that the entered answer is not correct. Scenarios must be created in a sequential manner and gradually for each sequential error.

- If the student has entered a wrong answer the first time he or she tried, he or she will be given a scenario that he or she has made a mistake.

- If the student has entered a wrong answer the second time he or she tried, he or she will get the second scenario for an error. Unpredictable errors in the first activity are identified as TTL_{1}, TTL_{2}, TTL_{3} ... .

The above process for scenario creation continues for the next activities (*b, c, D, x_1, x_2*) as well.

5.   Create an evaluation scale for each action:

We need to make an evaluation of the difficulty of each question (positive evaluation scales the student accumulates when he or she enters a correct answer) and of the weight of any errors/help requested (negative evaluation scales the student accumulates when he or she enters a wrong answer or uses help).

6. Enter the data in the EDCP environment:

In this step we use a development environment to create an EDCP.

Organizational Description of the Content Part of EDCP

Scenario creation and description must be sequential because this makes it easy to navigate when scenarios are created and used. This can be achieved if the logical organization of the "Logical-Didactical Block Diagram" is followed. Each element in the diagram must be related to the particular scenario. Scenarios must be identified in accordance with the indications in the Block Diagram. For that purpose, scenarios can be structured in blocks with indices, description of the given scenario, and an evaluation scale. An example of such a block is given in Fig. 2.

Fig. 2.

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1. Scenario identification.
2. Scenario description and.
3. Evaluation scale.

This is a possible way to organize scenarios. Let's illustrate this with an example. The example follows the structure of the "Logical-Didactical Block Diagram" and this diagram is shown in Fig. 3.

The other activities are arranged in a similar way. The entire organization of all activities can be done manually on paper or in electronic form. This decision is up to the person, who creates the diagram, i.e. the tutor. This organizational approach will ease the creation and development of EDCP and it will allow not to waste precious time in the distribution and organization of scenarios, but to focus the attention on the content part of EDCP.
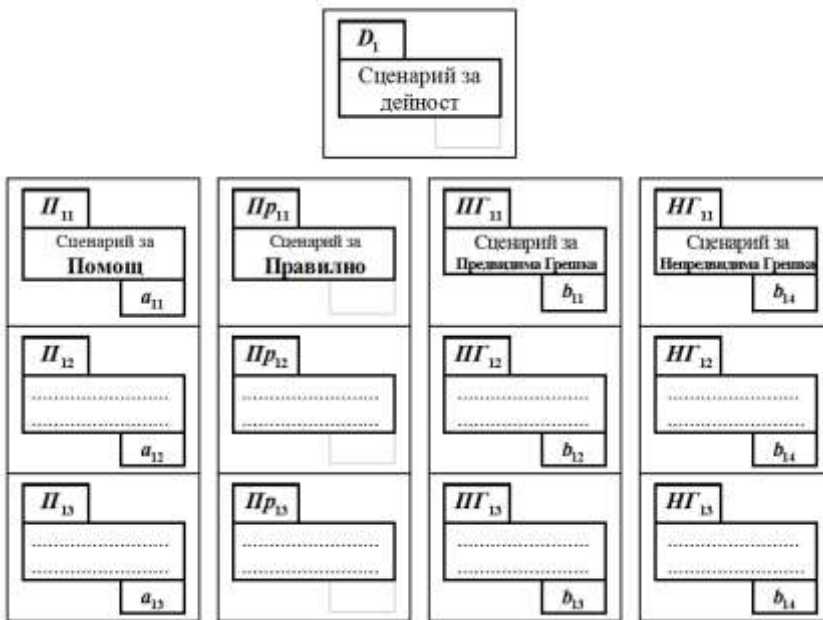
Fig. 3

Development Technology in the EDCP Environment

The development technology is implemented after the scenarios are created and the EDCP development stages are taken into account. Then it is possible to introduce it into EDC environment. Here we shall briefly present 6 of the basic stages for entering scenarios in EDCP. Development in EDCP environment [6][7][8]:

1. Problem text:

Enter the scenario described in the Problem text. Before you do this, you must have entered the name and the category of the problem (first) and the scenario (second).

2. A scenario for each separate activity:

Enter all scenarios for the activity – Help Hints, Correct, Error (Predictable Error and Unpredictable Error). You also need to enter the correct answer, the predictable wrong answers and the evaluation scale.

Perform the same steps for each of the activities.

The theory we described enables the tutor to easily develop EDCP by following the "Logical-Didactical Block Diagram", the stages and organizational blocks for each activity. Since these are the first steps in the creation of a EDCP development theory, the plans for the future include improvements in the content part and presentation of the core of the environment for EDCP.

Those experts, who are familiar with synergetics and reflection, will notice at

once that the offered theory is in accordance with the requirements of order (reduction of chaos and hectic search) for the development of educational programs. This theory requires in-depth knowledge and self-awareness of one's own behavior in regards to the discovery and execution of the separate steps to solve the problems that need to be solved by the respective educational programs. At the same time, when a EDCP is in accordance with the above mentioned requirements, it helps to turn education into a thinking activity, where chaos is reduced and the separate steps are conscious. For our future projects we plan to combine all this with systematization of knowledge based on the activities where it can be applied. This approach is used in Mathematics education and it has been first implemented in Bulgaria [1] in the 60s and 70s of the 20th century. Now this approach is being transferred to the education in Informatics and Information Technology.

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[1]*Sofia University "St. Kliment Ohridski"*
Faculty of Mathematics and Informatics
Sofia 1164, BULGARIA,
e-mail: ridvan@fmi.uni-sofia.bg

[2]*Technical University of Sofia*
Sofia 1000, BULGARIA
e-mail: philip@abv.bg