EVALUATION OF EDUCATIONAL SOFTWARE FOR THE GIFTED STUDENTS

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Abstract – In order to determine level of applicability of educational mathematics software in gifted education, the study authors compiled a list of expected characteristics of gifted students with a focus on student creative thinking. The list was used to conduct summative evaluation of selected educational software packages. The evaluation results are presented both in numeric and narrative form. The results indicate that the skill-based transmission software commonly does not provide environment that allows development of creativity. In opposite, the open-ended constructivist software is a more favorable environment, in which students have opportunity to perform more complex tasks that encourage curiosity, imagination and allow risk-taking. Also, when using the open-ended constructivist educational mathematics software, students can be genuine in their work, can express fluency and flexibility. This study results can serve as a guideline for a selection of software that could be used in gifted education.

I. INTRODUCTION

While there are several different definitions and approaches to define giftedness, the single definition cannot encompass all types of abilities and characteristics that occur among gifted children. Koren defines giftedness as a set of qualities that enable individuals to consistently achieve above average results in one or more activities that are involved in [9].

Renzulli’s definition of giftedness is somewhat more extensive, he defines giftedness as a set of characteristics that enable individuals to consistently achieve average results in the activities they are involved in and that these results significant creative contribution to the field in which they occurred [7]. It is important to emphasize that this definition has limitations since it is not including students that are creative but at certain point do not achieve above average results.

It is crucial what definition of giftedness is accepted as an educational policy guideline that determines overall approach of the school system towards gifted and talented education. The Croatian National Educational Standard (CNES) states that a desirable educational approach is geared towards high educational standards and achievements [5]. Also, CNES states that it is important to strengthen methods of identification of gifted children and create opportunities for developing their aptitude in one or more areas. Teachers and other professional staff in primary schools should put more effort in identification of gifted and selection of educational approach which is best suited to the gifted child. CNES puts an emphasis on the two educational approaches. First approach focuses on the design and implementation of a special or enriched educational program where gifted students stays in the same class with their peers but work on highly individualized tasks. The second approach is based on acceleration where gifted students have opportunity to move faster through the program and to finish primary school earlier than their peers [5].

Besides clear definition of giftedness, it is crucial to define identification methods and methods of work with gifted, talented and creative children. When discussion identification methods, George emphasizes that measurement scales are more reliable than general checklists [7]. The measurement scales include subscales focusing on creativity, leaderships, motivation and learning characteristics, which are in a correlation with gifted students’ characteristics.

This study focuses on Guilford's and George's determinants of creativity [7]. Although creativity determinants are recognizable and easily described, literature does not provide a precise definition of creativity and clear identification instruments. George writes that Guilford argues that creativity includes innate ability and sensitivity to the problems and ability to redefine and elaborate [7]. Furthermore,
Guilford lists four main abilities related to creativity: fluency, flexibility, originality, and elaboration. In addition George lists additional four abilities that could be used as determinants for creative thinking: curiosity, complexity, risk taking, and imagination [7].

II. TEACHING METHODS FOR WORK WITH GIFTED STUDENTS

Cvetković-Lay and Sekulić Majurec list five main methods that have proven effective in working with gifted students: work on the project, work in small groups, individual work, extracurricular activities, and additional resources and materials [6].

- The project includes project planning during which students receive or select a specific task. The work on the project is independent while teacher should create favorable conditions for the work on the project. Furthermore, students during their work on the project use variety of skills in a greater breadth and depth.

- Work in small groups is of great importance for gifted students. In this type of activities it is possible to cooperate and socialize with other students.

- Individual work is extremely important for the gifted student development. The emphasis may be on the use of technology when there is a possibility for a provision of an individualized approach. Well designed software are created with the goal to expand knowledge and make learning easier, more interesting and better adjusted to the students’ needs. Individual work should be based on the student interest, working pace and methods.

- During extracurricular activities there is a lot of flexibility and the teacher should devote time to individual activities.

- Additional sources and materials are essential in working with gifted students, since they provide opportunity for the engagement of their specific abilities (e.g., abstract and creative thinking, problem solving, accuracy, pace of work). Resources and materials that may be used are: books, complex logical and didactic games, and multimedia programs.

III. EDUCATIONAL TECHNOLOGY FOR WORK WITH GIFTED STUDENTS

Individualized teaching which commonly includes use of technology is very important in work with gifted students. Richey writes that focus of educational technology is on study of the theory and practice of learning which facilitates creation and use and management of technological processes [14]. Educational technology includes, but is not limited to use of software, hardware, Internet applications and various educational activities. According to The Association for Educational Communications and Technology, educational technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning [16].

Along with clear definition of educational technology, when dealing with the gifted education, it is crucial to review methods and benefits of technology use. Cvetković-Lay and Sekulić Majurec list a number of advantages of computer-aided learning in gifted education. It is possible to group these advantages into three groups: step-by-step learning, opportunities for repetition and practice, and interesting content presentation [6].

- In the step-by-step learning the eligibility for reaching the next learning level is determined by the acquired knowledge and skills. Gifted students should learn on their own pace, while the pace of learning in traditional classroom is dependent on the whole class.

- The opportunities for repetition and practice of the learning content are given through the assessment of the acquired knowledge and skills. Educational software programs include numerous possibilities for student practice, monitoring of their work and feedback.

- Educational software programs may provide interesting presentation of the learning content. In addition, computer environment allows implementation of creative projects (e.g., computer programming) that are of a great importance for the gifted education.

A. Educational software

Niederhauser i Stoddart conducted a study in order to determine ways in which teachers use different types of educational software [12]. As
a part of this study the authors offered a categorization of educational software and described two large categories of software: the skill-based transmission software and the open-ended constructivist software. The skill-based transmission software helps students learn basic facts and skills. It provides opportunities for repetition and practice, feedback and follows the student progress. The examples of the skill-based transmission software packages are drill and practice and keyboarding software. Furthermore, Niederhauser and Stoddart list three types of the open-ended constructivist software: the interactive/educational games, the exploratory software, and the productivity/presentation tools [12].

- The interactive/educational games are focusing on problem solving in a structured framework. There are often several ways to solve a problem and the way of finding the solution influences a final result.
- The exploratory software supports students in discovering and managing discovery. Participants decide how to use the software and assess what they have learned.
- The productivity/presentation tools encourage students to research, organize and present information. Educational value of these tools is dependent on the way of program use. While using this type of software students may use numerous external data sources (e.g. Internet, other software).

## B. Software evaluation

Riedling emphasizes that educational software evaluation lists should reflect educational theory and should be research based, with the aim to obtain useful data [15].

There is a large number of educational software evaluation lists, while different Internet sites provide examples of educational software evaluation. For example, the Super Kids’ Reviews provide evaluations of educational software that are written by parents, teachers and students, while each of them reviews different elements. The advantage of these evaluations is that they are conducted in a real environment and that they reflect variety of users views [18].

Software evaluation checklists include different sets of questions, such as: the precision of guidelines, navigation and help issues, error correction, options for student progress monitoring.

### IV. RESEARCH METHODS

Squires and McDougall recognize different types of educational software assessment, such as software selection, reviewing and evaluation [17]. The authors emphasize that summative evaluation is commonly dealing with the quality and variety of experiences that the software can support.

In order to determine possibilities for educational software use in gifted education, the authors conducted a summative evaluation. Evaluation was based on the list of the expected characteristics of gifted students with a focus on student creative thinking. The main idea behind this evaluation was that educational software should provide an environment that supports development of creativity.

The list compiled by the authors includes Guilford’s and George’s determinants of creativity [7]. Furthermore, the list includes a short description of each ability:

- Fluency (F1) – the ability to find various solutions and options.
- Flexibility (F2) – the ability to think in number of different categories and from various points of view.
- Originality (O) – the ability to reach new, unusual, extraordinary and unique conclusions.
- Elaboration (E) – the ability to make additions and develop ideas.
- curiosity (C1) – the ability to think about ideas.
• Complexity (C2) – the ability to generate alternative ideas.
• Risk taking (RT) – the ability to give and receive criticism.
• Imagination (I) – the ability to generate ideas that go beyond facts.

This study authors selected educational software (Table 1) and sorted it according to Niederhauser and Stoddart software categorization [12]. The selected educational software is available on the Internet and its dealing with the primary school mathematics (grades 1-4). Educational software which is focusing on mathematics is selected due to its features that are suitable for work with gifted students.

Lajoie emphasizes that technology use in teaching mathematics facilitates the development of mathematical ideas and deeper understanding of mathematical postulates [10].

V. SOFTWARE EVALUATION RESULTS

Evaluation results are presented both in numeric and narrative form. The Table 2 includes numerical data on presence (1) or absence (0) of the listed determinants of creative thinking skills in selected software. The columns are marked with abbreviations representing one of the eight creativity determinants, while the rows are marked with numbers that represent matching software previously listed in Table 1. The narrative section consists of description of software and way in which the particular software is aligned with a certain creative thinking skill determinant.

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Software packages Feed Fribbit Addition [2] and Feed Fribbit Subtraction [3] in terms of fluency do not allow use of different problem solving techniques and there is no possibility for students to propose their own ideas. When it comes to flexibility, these two software packages do not offer different types of problem solving and students cannot elaborate reasons for a selection of a certain problem solving method. In terms of originality, the software packages do not allow proposing new ideas. Also students cannot show unique and unusual ways of problem solving. In regards to the elaboration, students have no opportunity to propose ideas that could clarify the basic idea, and cannot contribute with a variety of details that lead to the idea development. These software packages do encourage curiosity to some extent. The correct answers lead students to new tasks and new levels. When it comes to complexity, the software packages do not give possibility for expressing the alternative ideas. The risk-taking is related to students’ willingness to play a guessing game. These software packages do not encourage students’ imagination.

Number Twins [4] software evaluation determined that this software allows different ways of problem solving and to some extent encourages fluency. However, students have no opportunity to propose their own ideas. This software allows use of different problem solving techniques, so that it promotes flexibility. In this software, there is no possibility for students to propose new ideas. Hence, students cannot express their original ways of thinking. Possible ways of problem solving that could be used are listed at the start of the program. The students have no opportunity to propose ideas, so that this software does not encourage elaboration. The software content can stimulate curiosity, because correct answers lead students to new tasks and levels. The software does not promote complex tasks, and does not provide students with opportunity to express alternative ideas. Risk-taking is linked to the guessing of answers to the posted questions. Nevertheless, this software allows students to select the problem solving techniques and encourages students’ imagination.

Thinking Blocks [11] software encourages fluency due to options that allow different ways of problem solving. These options can be selected according to student needs and abilities. The software is easily adapted to the individual user needs, but the advancement is linked to the speed of problem solving. The tasks can be tackled in different ways and this contributes to the software flexibility. The tasks encourage students original problem solving, nevertheless the students cannot elaborate on their ideas. The

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content partially stimulates curiosity of students, since correct answers lead to the new and more complex tasks. The software does not allow implementation of complex ideas and it is not possible to link problem solving technique to the task type. If students take a risk and play a guessing game this could prevent them from proceeding to the higher level tasks. The software stimulates imagination through the variety of learning games.

Planet Turtle [1] software leaves the possibility for use of a variety of problem solving techniques. Students can select these techniques according to their needs and abilities. The software content can be adjusted to individual needs and encourages fluency. Although the tasks are clearly structured, the student selects the problem solving technique, pace of work and accuracy. The software does not promote flexibility because the limited number of problem solving techniques is offered and students cannot elaborate on reasons for a selection of the problem solving technique. Planet Turtle software can be used by more than one student at the same time, and this option encourages originality. The students decide on the pace of work. Nevertheless, there is no possibility for students to elaborate their ideas. The software content does encourage curiosity, since correct answers lead to the new tasks and levels. Also, there is a possibility for students to further explore virtual world. The software does not allow implementation of complex ideas. The risk-taking is linked to guessing. It is important that this software encourages role-play which is linked to development of imagination. Student takes a role of turtle and learns through play.

Fantastic Contraption [13] software allows problem solving according to individual abilities. The student determines the speed of problem solving. Hence, it is possible to conclude that this type of software encourages fluency. This software encourages flexibility because students choose tasks to solve and ways of problem solving; also it is important that the tasks can be solved in different ways. Since it provides a unique and individualized problem solutions, this software encourages original ways of thinking. Although students are working individually on their tasks the software allows students to elaborate their ideas. The software contents and setup encourages student’s curiosity. At higher levels, this software allows implementation of complex and alternative ideas. Furthermore, when working on their tasks students can play a guessing game and take a risk. The software encourages imagination, since students decides in what way and what time they will work on certain tasks.

The Geometer’s Sketchpad [8] promotes fluency through different ways of problem solving activities and the options for work on mathematical calculations, charts and diagrams. This software includes tasks that are previously set, nevertheless the software encourages flexibility due to the fact that students decide on problem solving technique and work on their own pace. This software allows original problem solutions; the student has opportunity to work individually and to elaborate ideas. The software content stimulates curiosity. It includes numerous options and possibilities for problem solving. The user can draw complex geometric features. This is open constructivist software and students have a large freedom in implementation of their ideas. This option encourages risk-taking. Visually rich environment provides students with opportunity to implement various ideas and develop their imagination.

VI. CONCLUSION

Studies on use of technology in gifted education are rare. The software evaluated in this study is available on the Internet, and the study results could be used to facilitate work with gifted students in schools. The selected educational software is dealing with primary school mathematics, since earlier research studies indicate usefulness of technology use in learning mathematics. Also, educational mathematics software commonly has features that are useful in work with gifted students.

The selected software is evaluated according to the list of creative thinking determinants. The list includes both Guilford’s and George’s determinants. The Guilford theory includes four determinants that are related to the development of creativity: fluency, flexibility, originality and elaboration. While George lists four additional determinants: curiosity, complexity, risk-taking and imagination.

The evaluation results indicate that the skill-based transmission software commonly does not provide environment that allows development of creativity. In opposite, the open-ended constructivist software is more favorable environment, in which students have opportunity to perform more complex tasks that encourage curiosity and imagination and allow risk-taking. Also, student can be genuine in his work, can express fluency and flexibility.
Finally, it is possible to conclude that the basic determinants of the ability of creative thinking, made on the basis of Guilford theory and George’s list of additional creative thinking determinants can serve as guideline for a selection of software that could be used in gifted education.

REFERENCES


