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IS IT POSSIBLE TO USE STEAM TECHNOLOGIES TO DEVELOP THE CHILDREN`S SUCCESS: AN EMPIRICAL RESEARCH IN PRESCHOOL EDUCATION

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Keywords: STEAM technology, personal and team success of preschool children, soft skills

ABSTRACT

The purpose of the study is to identify the pedagogical potential of STEAM technology in the development of success (personal and team) of preschool children in interdisciplinary activities (cognitive-mathematical, LEGO-constructive, social and communicative). As the main methods of empirical research we chose conversations with preschoolers about the products of design activity (robots, bridges, communication machines, success, artistic image), the method of problem-search situations, children's case studies, modeling, mini-projects and constructions according to the model, diagram, drawing, experimentation (graphic, linear, volumetric, descriptive), graphic drawings, computer graphics. The following research results are presented in the article: an interdisciplinary program for preschool education "Perceiving the World"; scientific-based results of using STEAM technology in the development of the children's personal and team success; a developing effect of STEAM technology in cognitive-mathematical, LEGO-constructive, social and communicative activities; products of children's activities are described: projects, robots; the criteria and indicators of personal and team success of preschoolers are presented. An empirical research led to the conclusion, that the pedagogical potential of STEAM technology lies in various interdisciplinary discourses of the children's activities (cognitive-mathematical, LEGO-constructive, social and communicative activities), in methods of encouraging children to achieve personal or team success, in integration into the activities' types connected with the problem-search situations; in creating an event-driven communication environment to ensure the personal and team success of preschoolers.

Keywords: STEAM technology, personal and team success of preschool children, soft skills

INTRODUCTION

The relevance of the problem

The demand for STEAM technology is due to modern megatrends: commercialization, informatization, globalization, the duality of material well-being and spiritual harmony, maximum introduction of the engineering education and strengthening of the graduates' technological training (Livanov 2016; Miller 2008). The problem of STEAM technology is updated in a message to the Federal Assembly by the President of the Russian Federation V.V. Putin, who pointed out the need to bring the engineering education in Russia to the world level, increase STEAM literacy of students and expand their opportunities to choose the technical or scientific direction of a career in future, "master the skills of highly organized thinking" (Krylov 2010). A.O. Repin writes: "On the whole, the importance of the education reform in the STEAM direction can be expressed through three key factors: the first is related to the global economic problems that every nation faces; the second represents the changing labor requirements, which require more comprehensive and flexible knowledge, skills, meeting the requirements of the 21st century; and the third one emphasizes the demand for STEAM literacy, necessary to solve global technological and environmental problems" (Repin 2017).

Edutainment, gamification of education, e-learning are becoming priority areas of research in the field of preschool pedagogy. STEAM technology acts as a multimodal educational space in which serious games are realized, aimed at developing the critical engineering thinking of children and their creativity. A number of researchers define engineering thinking as a complex system education uniting different types of thinking: logical, figuratively-intuitive, practical, scientific, aesthetic, economic, environmental, ergonomic, managerial and communicative, creative. Other definitions present it as synthesis of figurative and logical thinking or synthesis of scientific and practical thinking (Godunova 2017; Gutareva 2017; Jamil 2018; Linder and Stegelin 2018; Rozhdestvenskaya 2017; Stolyarenko 2001; Tserkovnaya 2017). STEAM technology, thanks to humanitarian content and communication, allows a child from an early age to "learn to distinguish between creative and destructive style of thinking, making an informed choice in favor of creative style not only in the field of art, but also in the professional and personal sphere" (Dukhanova 2019; Morozova 2019). Formed by STEAM technology, the spatial thinking determines the successful social realization and adaptation of a child.

In different studies, the emergence of STEM education is provoked by three factors: global economic problems that every nation faces; changing labor requirements, which require more comprehensive and flexible knowledge, skills that meet the requirements of the 21st century; the demand for STEM literacy needed to solve global technological and environmental problems (Bybee 2009; Chemekov 2015; Krylov 2015; Pitt 2009). A scientific analysis of the STEAM technology phenomenon in the educational environment made it possible to determine its strategic potential in changing the social life of people. M. Honey, G. Pearson, H. Schweingruber noted that the importance of STEAM technology is being updated in the transition to new standards, as it contains communicative

content, such as discussion, disputation, joint decision making, as well as scaffolding techniques and peer collaboration (Honey 2014; Pearson 2014; Schweingruber 2014). In Singapore, the Kinderlab program (Kinderlab, Kibo for children 4-6 years old) has been introduced, aimed at "nurturing" the generation of the newest specialists in the field of robotics, and at developing the creative makings of a preschool child. The authors believe that robots created by children are an important factor in the socialization of avoidant children, helping them to confide and improve their social skills (Rosenberg 2018; Shabalin, 2019).

In literature, at the present stage of education development, the significance of the concept of engineering education for preschool children is underlined (Carrol, 2015). STEM education in the United States is called a national priority and a priority state task, since it provides integration of the programs' content, developing the 21st century skills necessary for the future economic prosperity of the American nation (Recommendations on STEM education prepared for the Presidential Candidate 2016). STEM education allows children to explore and comprehend the world around them, to experiment, try and find new ways that give rise to confidence, self-esteem and well-being (Chilvers 2013), changing motivational, social and emotional sphere of a child (Green and Malsch 2012; Kothari 2012). In the USA, STEM technology is considered as an active method that ensures the quality of teaching mathematics, science, and engineering, basing on cooperation (Mednikova 2014; Senashenko 2014). However, scientists have a number of questions that should be studied, for example the question of early child development in mathematical education or how to integrate STEM knowledge, skills and use this technology competently for solving complex real-world problems, explain their reason, how to form the students' willingness to self-reflect on STEM problems and participate in their solution as a citizen of the world (Bybee 2013), and how to use the earlier period of preschool age in development of the children's success (Lasser and Fite 2011).

An analysis of studies has shown that global trends, the development of the society's needs in the engineering education, in new means of production (robotics), the emergence of creative industries, etc., actualize the importance of constructive activity, mathematical education in early childhood and innovative teaching technologies for preschoolers, in particular STEAM technology, transforming activities and changing the personality of a preschool child.

Materials and methods of empirical research

An empirical research is aimed at the creation and scientific justification of *pedagogical conditions for the development of the children's success* in an older preschool age (7 years old) with STEAM technology in interdisciplinary activities (cognitive - mathematical, LEGO-constructive, social and communicative).

In an empirical research, the following methods were used (diagnostic and developing):

- conversations with preschoolers, allowing to identify features of ideas about the engineer as a profession, their design activities and robots, their purpose in human life;

- the study of LEGO products, design activities (robots, bridges, cars, etc.), reflecting the preschoolers' indicators of creativity and success and providing an opportunity to carry out a comparative analysis of ideas about the design activities of engineers, about robots and products of design created by children;
- a method of problem-search situations that create an opportunity for preschoolers to make their own decisions in an uncertain situation and with lack of information (details, drawing of the structure being created);
- case studies for children (cognitive, constructive, social and communicative) that encourage preschoolers to independently find ways to resolve situations (analytical, practical, game, algorithmic, etc.);
- modeling of mini-projects, a developing method that encourages preschoolers to learn design methods, teamwork, creative self-realization;
- samples, diagrams, drawings of robots with various design were used as stimulating means for preschoolers to independently carry out creative work and achieve success in activities;
- experimentation (graphic, linear, volumetric, descriptive), graphic drawings, computer graphics as types of individual productive activities that determine the success of a preschooler.
- The reliability assessment of experimental methods is determined by the following factors: - detailing of teaching units in the design of the content of an interdisciplinary program;
- collection and analysis of statistical data after testing STEAM technology in various types of the children's productive activities;
- processing empirical data using the same methods and comparing the initial data (the beginning of the experiment) with empirical data after testing an interdisciplinary program, regarding the criteria and success indicators of preschool age children;
- testing hypothesized pedagogical conditions in various types of the children's activities.
- The study was conducted in stages:
- during the theoretical-search stage the degree of problem development was determined – the use of STEAM technology in interdisciplinary types of the children's activities in the Russian practice of preschool education, using methods of content analysis, scientific literature analysis, theoretical analysis and comparison of scientific data;
- the design stage included the formulation and concretization of the problem, goal, research objectives, hypothesis as the proposed way to solve the tasks, determining the stages of the pedagogical experiment (ascertaining, forming, control), in which the following methods were used: the study of the products of the children's activities, children's case studies, designing algorithms for experimental activities and models of pedagogical conditions for the development of success in preschool children with STEAM technology;
- the test-effective stage, at which the effectiveness of the pedagogical conditions, indicated in the hypothesis, was tested in the development of personal and team success of preschool children in various activities. The stage also included processing (quantitative and qualitative) of the empirically obtained data and the formulation of the conclusions.
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RESULTS OF THE EMPIRICAL RESEARCH

Theoretical-search stage results:

- The relevance of the problem was proved by the society requirements for the development and implementation of breakthrough humanitarian technologies in the education of children, starting from preschool age;
- the need of the state for the development of engineering education and early profiling for the profession of an engineer, designer, creator of robotics is determined;
- a theoretical analysis of the scientific problem connected with the STEAM technology usage in educational practice was carried out, which showed insufficiently effective use of this technology in various types of the children's activities provided by the state educational standard for preschool education.

Design stage results:

- the goal of empirical research is defined, which is to identify the pedagogical potential of STEAM technology in the development of success (personal and team) of preschool children in interdisciplinary activities (cognitive - mathematical, LEGO-constructive, social and communicative activities);
- the tasks of empirical research are indicated:

1. To scientifically substantiate the pedagogical potential of STEAM technology in the development of success (personal and team) of preschool children in interdisciplinary activities (cognitive - mathematical, LEGO-constructive, social and communicative activities).

2. To develop and test an interdisciplinary program of preschool education “Perceiving the World”.

3. To develop and test technologies for the organization of cognitive - mathematical, LEGO-constructive, social and communicative activities of senior preschoolers.

4. Describe the criteria and indicators of personal and team success of preschoolers and products of the children's activities (project, robot, artistic image of the world);

- the research hypothesis is formulated, reflecting the assumptions that the effectiveness of the team and personal success development of a senior preschool age child (7 years old) is provided by a number of pedagogical conditions:

1. STEAM technology is understood as a developing, stimulating, socially significant, positively emotionally colored pedagogical tool;

2. STEAM technology is defined as a motivator of activity, a stimulator, an interaction communicator, an activator of self-esteem and self-reflection;

- An interdisciplinary program of children's activities was developed (cognitive - mathematical, LEGO-constructive, social and communicative activities);
- LEGO-constructive activity is designed in a certain logic as an algorithm for the gradual independent progress of a preschooler to achieve the results of productive activities (robot, machine, TV tower, etc.);
- in children of preschool age, an understanding of personal success is formed, as an independent achievement of the result in productive team activities;

- criteria and indicators of success for 7 years old children were defined:

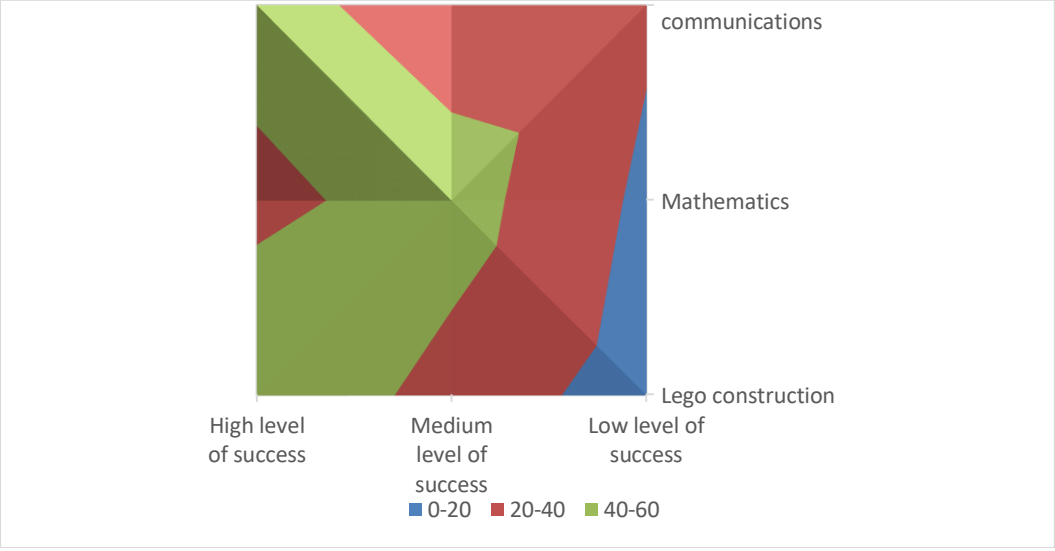
1. team success is manifested in indicators such as understanding the goal of productive team activities; joint discussion of ideas, problems, goals of activity; acceptance of rules governing relations and promoting the team to the goal; positive intra-team and cross-team interactions; acceptance of judgments and opinions of all participants in the activity and understanding of the personal role in it; team self-reflection about the result;

2. personal success is ensured and manifests itself in accurate representations of the goal and understanding of the means to achieve it (information and communication, technical, constructive, emphatic, expressive and communicative), as well as in regulatory, communicative ways and auto-communicative skills.

- diagnostic techniques were determined (the study of products of the children's activities, children's case studies);
- the design of the experimental activity algorithm and the modeling of pedagogical conditions for the development of success of preschoolers by STEAM technology in various types of the interdisciplinary children's activities were carried out.

Test-effective stage results:

- The effectiveness of the pedagogical conditions indicated in the hypothesis was proved by indicators (children's success, creative product, methods of cognition, design, critical thinking, information and communication skills, regulatory and communicative methods, expressive and communicative tools, auto-communicative skills);
- the development dynamics of the personal and team success of preschoolers in various types of interdisciplinary activities (primary and final diagnosis) are determined (Figure 1, 2);



- the conclusions of the empirical research are formulated.

Figure 1. The diagram. Correlation of STEAM education and success of preschool children (primary diagnosis as%)

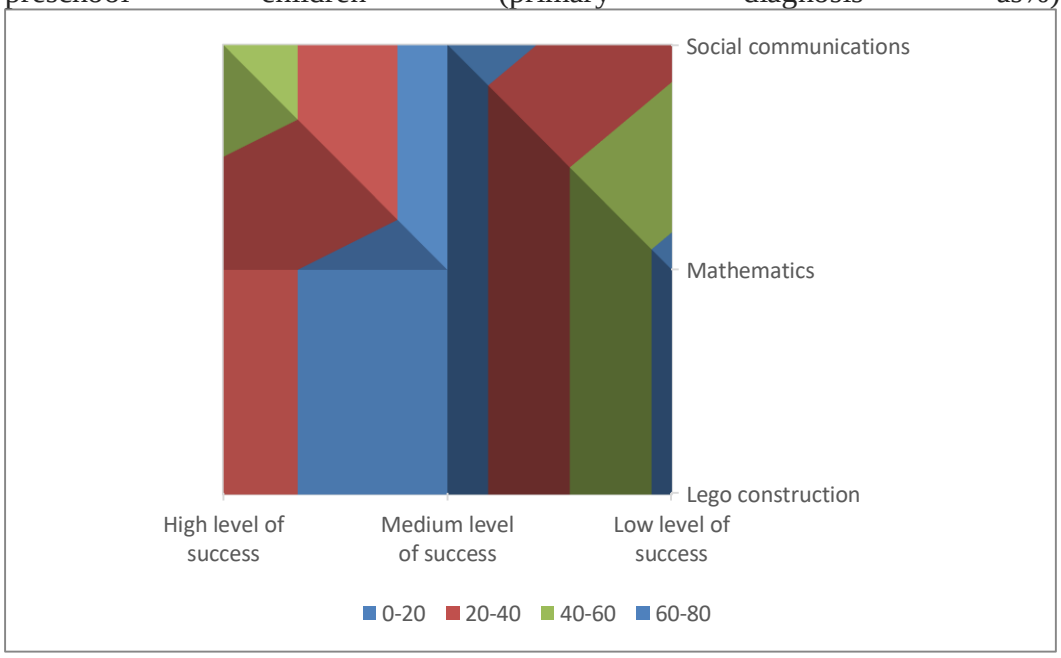


Figure 2. The diagram. Correlation of STEAM education and success of preschool children
(final diagnosis as %)

DISCUSSION

In the study by Kulikovskaya (2013), Kudinova (2019), Savinskaya (2016), Sovgir (2003), Chumicheva (2019) STEM technology is defined as a humanitarian technology for the development of logic, argumentation, abstract thinking of a preschooler, flexibly, adjusting the interface to the interests of boys and girls. The study established the social significance of STEAM technology in joint productive activities: the development of the socio-communicative experience of a preschooler, the skills of constructing social models, objects, which is very important for maintaining the balance of the future professional activity of an engineer and child-adult relationships. STEAM technology helps to create social dialogues and design role-playing situations, aligning gender roles and normative ideas about the boundaries of the acceptable behavior for boys and girls in various activities, as well as providing effective ways to involve girls in technology professions. The pedagogical potential of STEAM technology for preschool children consists in the developmental effect, focused on the zone of proximal development. STEAM technology contains problematic as a contradiction, stimulating a child to productive activities and social communication. It also has an ability to simultaneously provide two processes: personal and collective self-realization, personal and team success.

The social context of STEAM technology in preschool education, implemented in interdisciplinary productive activities for children (cognitive - mathematical, LEGO-constructive, social and communicative activities), is represented by three components: the cognitive experience, the child's social and communicative experience, personal and team success. The socio-communicative experience of a preschooler refers to “soft” skills: the ability to navigate norms and rules in joint productive activities and show initiative, independence, flexibility in making

decisions on the ways to achieve the results of joint productive activities; take a reasonable position in conflict resolution (compromise, dialogue, persuasion, argumentation) in the activity; have skills to manage the behavior in various (uncertain, contradictory, conflict) social situations; ability to respect the rights of other people in the communication process; reflect actions and behavior in productive activities and communication; understand one's place, role, function in achieving overall success in a joint productive activity.

In the course of the study, the effectiveness of STEAM technology in the development of personal and team success, in understanding the belonging to a group of peers in the process of joint productive activity was proved. STEAM technology helps a child to determine his/her position in a team as a leader, creator of ideas, organizer, performer, as well as to master the rules of teamwork leading to the team success: discuss the problem, goals, idea, rules of relationships, moving the team towards the goal. It maintains positive relationships among children within the team, teaches to understand the goals of the team, respect the opinions of other project participants.

The specifics of using STEAM technology is determined in a productive LEGO-constructive, cognitive - mathematical, social and communicative activity, as a motivator at the beginning of activity (discussion of the goal and purpose), a stimulator in solving the problem (finding the best way to solve the problem and achieve the goal), the communicator in the process of interaction and the implementation of actions to create an image of the result (robot, bridge, etc.), an activator of self-esteem, self-control, individual and team self-reflection of the result (product activity and level of mastered competencies), child success rate (information and communication skills, regulatory and communicative methods, expressive and communicative means, auto-communicative skills).

STEAM technology in productive LEGO-constructive activity is an adequate tool of both the activity and development of a preschool child (Leontiev 1975). In the pedagogical science and practice of preschool education, the developing potential of constructive activity is reflected in the following features:

- developing constructive skills, constructive creativity, collectivism (Lishtvan 1969);
- providing a demiurgical, creative nature of the activity (Paramonova 2002);
- fostering independence, initiative, hard work, accuracy, developing the ability to work in a team (Davidchuk 1990);
- contributing to the implementation of various projects according to the plan and at personal pace, independent solution of tasks, designing of personal spaces (Feshin 2012);
- forming interest in the creative solution of tasks, ingenuity, independence, initiative, the desire to search for new and original solutions (Ishmakova 2013);
- forming focus, graphic literacy, the ability to design, construct, practically use constructions and projects in the children's activities (Lashkova 2018; Shants 2018);
- developing algorithmic thinking, providing an opportunity for everyone to try one's hand at constructive activity with new means (Sorokina 2019).

The study proved that STEAM technology develops in a child such a personal quality as success, that is to say the ability to achieve goals in productive activities environmentally-friendly, in harmony with one's-self and the laws of society (in other words I determined my place in activity; I do what I need; what I choose independently or as agreed with peers; I achieved the goal, felt the success of personal and team productive activities). In the concept of "success", the main point is to refer to the time limits of achieving the goal of a productive, LEGO-constructive activity: to be on time, at exactly appointed time. STEAM technology provides for a child, who gets acquainted with the concept of time and learns to manage it, the following:

- the acquisition of methods to achieve the goal of productive activities on time;
- mastering the ability to determine the time required for the implementation of the project;
- the opportunity to see in one's-self and partners the advantages that help to achieving the results of productive activities;
- the development of unique cognitive competencies that help to know in small ways the properties and phenomena of the world;
- the accuracy of the project idea forming and specificity in determining how to achieve the results of productive activities.

CONCLUSION

The results of an empirical research have scientific significance that lies in the pedagogical potential of STEAM technology, the criteria and indicators of personal and team success of preschoolers; the practical value for the system of preschool education: discourses of interdisciplinary activities (cognitive - mathematical, LEGO-constructive, social and communicative activities), the organization forms of interdisciplinary activities, the interdisciplinary program "Perceiving the World", the integration of STEAM technology, virtual and developing technologies.

The revealed developing pedagogical potential of STEAM technology will provide the possibility of transferring it to various educational fields, indicated in the Federal State Educational Standard, which will allow teacher to achieve the targets of the educational standard. The transfer of STEAM technology to artistic, aesthetic, environmental, design, research activities opens up new possibilities for scientific research and modernization of the preschool education practice.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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