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THE PARTICIPANTS INTERACTION MODEL OF EDUCATIONAL PROCESS WITHIN STEAM-ORIENTED EDUCATIONAL ENVIRONMENT OF GENERAL EDUCATION INSTITUTION

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The paper features the specifics of participants interaction in STEAM-oriented educational environment of school at application of the project method. The participants interaction model of educational process within STEAM-oriented educational environment of general education institution is substantiated and offered, and the roles of participants of this environment according to their kind of activity are defined. The main stages of implementation of the educational project in the general educational institution are singled out: creation of the main content of the project, covering the topic, idea, tasks, time limits of the learning and teaching activities and the result; creating a plan for organizing and implementing the project for teachers and students; planning activities in the project for its various participants; research of the project topic; demonstration of results; reflection. The main participants of the STEAM educational project and their roles according to their activities at each stage within the participants interaction model of the educational process, which takes place in the STEAM-oriented educational environment of the general education institution, are identified, namely: the creation of the main content of the project is ensured by the activities of the teacher-leader, who offers the content, indicative plan, a deadline *for each stage, main activities, tasks and the result of the project, that is, develops the Technical task, teachers offer their ideas for supplementing or adjusting the terms of reference of the project, create indicative plans for the organization and implementation of the project for teachers and students, inform students about the main details of the project, unite students in*

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groups, give them advice, students in groups perform the tasks of the project its main issues, explore the topic to achieve the result of the project, demonstrate the result; evaluate their work and the work of others, identify interesting solutions and the importance of results, shortcomings and problems in the activities to achieve the result of the project/ It is concluded that the success of the educational project and achieving its goal within the STEAM-oriented educational environment depends on creating conditions for the interaction of its participants, namely: clearly defined content of the project; achieving mutual understanding between its participants; compliance to ethical and psychological principles, in particular the willingness and ability to be a facilitator for teachers and students; organization of interaction with the help of tools convenient for all participants of the project, in particular, web services.

Key words: *STEAM-oriented educational environment, educational project, project method, participants interaction model of educational process in STEAM-oriented educational environment of general education institution.*

МОДЕЛЬ ВЗАЄМОДІЇ УЧАСНИКІВ НАВЧАЛЬНОГО ПРОЦЕСУ У STEAM-ОРІЄНТОВАНОМУ ОСВІТНЬОМУ СЕРЕДОВИЩІ ЗАКЛАДУ ЗАГАЛЬНОЇ СЕРЕДНЬОЇ ОСВІТИ

Н. В. Сороко, І. В. Дзекунова

У статті розглянуто варіанти взаємодії учасників STEAM-орієнтованого освітнього закладу загальної середньої освіти при застосуванні методу проєктів. Обґрунтовано та запропоновано модель взаємодії суб'єктів навчального процесу в межах STEAM-орієнтованого освітнього середовища закладу загальної середньої освіти та виокремити ролі учасників цього середовища відповідно до їхнього виду діяльності. Виокремлено основні етапи впровадження навчального проєкту у загальний заклад освіти: створення основного змісту проєкту, що охоплює тему, ідею, завдання, часові межі навчального процесу та результат; створення плану організації та реалізації проєкту для вчителів та учнів; планування діяльності в проєкті для різних його учасників; дослідження теми проєкту; демонстрація результатів; рефлексія. Визначені основні учасники навчального проєкту STEAM та їхні ролі відповідно до їхньої діяльності на кожному з етапів у межах моделі взаємодії учасників навчального процесу, що відбувається у STEAM-орієнтованому освітньому середовищі закладу загальної освіти, а саме: створення основного змісту проєкту запезпечується діяльністю учителя-лідера, який пропонує зміст, орієнтовний план, час виконання, основні заходи, завдання і результат проєкту, тобто розробляє технічне завдання; вчителі пропонують свої ідеї щодо доповнення або корегування технічного завдання проєкту, створюють орієнтовні плани організації та реалізації проєкту для вчителів та учнів, інформують учнів щодо основних деталей проєкту, об'єднують учнів у групи, надають їм консультації; учні у групах виконують завдання проєкту для рішення основних його питань, досліджують тему для досягнення результату проєкту, демонструють результат; оцінюють свою роботу та роботу інших, визначають цікаві рішення та важливість результатів, недоліки та проблеми у діяльності щодо досягнення результату проєкту. Зроблено висновок, що успіх проведення навчального проєкту та досягнення його мети у межах STEAM-орієнтованого освітнього середовища залежить від створення умов для взаємодії його учасників, а саме: чітко визначеного змісту проєкту; досягнення взаєморозуміння між його учасниками; дотримання етико-психологічних принципів, зокрема готовність і вміння бути фасилітатором для вчителів і учнів; організація взаємодії за допомогою зручних для всіх учасників проєкту інструментів, зокрема, вебсервісів.

Ключові слова: *STEAM-орієнтоване освітнє середовище, навчальний проєкт, метод проєктів, модель взаємодії учасників навчального процесу у STEAM-орієнтованому освітньому середовищі закладу загальної освіти.*

Introduction of the issue. The introduction of the STEAM approach in the teaching and learning of general secondary education is one of the trends in education reform in the world. The STEAM approach (STEAM – Science, Technology, Engineering, Arts, Mathematics) is a special way to select forms, methods and tools to ensure the formation and key competencies development of young people (communication in the state languages, communication in foreign languages, mathematical competence, basic competencies in natural sciences and technologies, digital competence, lifelong learning skills, initiative and entrepreneurship, social and civic competences, awareness and self-expression in the field of culture, environmental literacy and healthy living) [7], which should ensure its competitiveness in the world labor market. Teachers should help the student to integrate into society, to form as a person, to find and reveal his abilities and talents, to teach him to solve various life problems.

Object of research: teaching and learning activities of the STEAM-oriented educational environment.

Subject of research: participants interaction in STEAM-oriented educational environment of school at application of the project method.

Aim of research is to substantiate and create a participant's interaction model of the learning process in STEAM-oriented educational environment of the general secondary education institution and to define roles of participants of this environment according to their type of activity.

Current state of the issue. Organization and implementation of educational projects in school is an important topic in the pedagogical research.

O. A. Dubasenyuk (2009) notes that the method of projects is an important pedagogical tool that a teacher should have to motivate students to learn, logically and creatively solve various educational problems [2].

S. S. Izbash (2007), during the study of project activity as a factor of social and professional adaptation of students of the pedagogical university, concludes that project-based learning is one of the options for productive learning, the purpose of which is not the acquisition of knowledge by students and mastering educational programs, but the real use, development and enrichment of their own experience and perception of the world [4].

L. G. Kondratova (2008) in the study of teacher training for the organization of primary school students in extracurricular activities project activities notes that the project-based learning provides opportunities to create conditions for the development of creative self-realization of the individual, the education of a generation of people who are able to work effectively and learn throughout life, preserve and increase cultural values and develop society [8].

N. L. Sosnytska (2019), in the study of the formation of scientific and research competence for teaching physics on the basis of STEM-education, approves that the STEM-based learning is fundamentally new goal-setting in the pedagogical process; project-oriented, problem-oriented and practice-oriented approaches to the organization of the educational process; the creation of integrative courses (interdisciplinary, transdisciplinary) with the use of mathematical knowledge and scientific concepts; the formation of STEM-competencies; definition and evaluation of learning outcomes through main and subject competence; introduction of innovative, gamebased learning technologies, case-study technologies, interactive methods of group learning, problematic methods for the development of critical and systemic thinking, etc [13].

Jacina Leong (2017), when created a model of learning and teaching through

a STEAM Network, offers six phases of STEAM project "The Cube's STEAM phases": the *"Inspire"* phase, which is the opening hook and sets the tone of the overall workshop experience; the *"Inquire"* phase, which builds on the initial "Inspire" phase to deepen student understanding about the overarching theme and workshop (facilitators use this phase to establish a collective culture of critical and creative inquiry, between peers and facilitators, and to encourage students to aggregate and recognize diverse perspectives); the *"Ideate"* phase, which provides an open space for students to develop ideas informed by the previous phases; the *"Implement"* phase, during which learners formulate physical or digital representations of their ideas, experimenting with materials and technologies to give form to their ideas; the *"Iterate"* phase, which is "designed to promote observation, listening, and questioning – for students to identify how others have approached a problem, and to consider other perspectives"; the *"Reflect"* phase, which is related to exercises that facilitate student discussion and thinking about the individual and collective learning process (facilitators encourage all students to actively present their ideas, to encourage their peers to ask questions, and provide constructive feedback [5].

Mary Dell'Erba (2019) in research on STEAM policy considerations notes that in the STEAM-oriented educational environment students ask questions, experiment, improvise, innovate and solve real-word problems, learn "experiences involve two or more standards from STEAM subjects, and the product of learning typically leverages the art form itself". Scientific focuses on six core STEAM education practices, which include: "leveraging concepts in one or more STEM disciplines to create meaning ful artwork; focusing on outcomes that have a personal and/or aesthetic meaning; conducting open exploration in the context of both science and art; designing with intention; iterating through several drafts, prototypes or models; communicating about the process and outcome" [12].

Results and discussion. It is important to create appropriate STEAM-oriented educational environment of the school, for the interaction of the participants depends on the main direction that the teacher chooses in the organization of education. Thus, scientists focus their attention on the existence of the following areas in this environment.

1. The STEAM-oriented learning environment is one of the main trends in the world education, which is defined by the scientists as follows:

- an environment that should provide its users with tools for research in STEM fields involving, where appropriate, the arts, such as music, dance, the visual arts, literature, theatrical arts, humour, or any activity related to the use of art, including visiting museums, listening to lectures, observing various processes, scientific problems or reading scientific literature (Mark E. Rabalais, 2014) [10];
- an environment that should cover such components as object templates according to the learning requests and the students' educational research in STEM fields; software, platforms and other ICTs to provide visualization of educational and scientific materials; training laboratories; study contract – an interactive tool for maintaining a social network that allows students to execute study contracts and connect with other students' communities for logical purposes; training based on the use of blogs by teachers, scholars, students; a system of on-line monitoring and assessment of teachers' professional competencies and students' STEAM competencies (Maïté Debry and Dr. Agueda Gras-Velazquez, 2016) [9];

- an environment that should provide strategies for improving the engineering and technological education of students (Connor, A.M., Karmokar, S., & Whittington, C., 2015) [1];
- an environment that should encompass online teacher communication services with students and colleagues to address learning problems; applications for exchanging information on STEAM training activities and for the ICT participants' hands-on activities; platforms for providing on-line learning and teaching; tools for creating questionnaires and tests; open online libraries and more (Jacina Leong, 2017; Judith Bazler, Meta Van Sickle and Letitia Graybill, 2017; Yakman Georgette, 2008) [5; 6; 14].

2. The "Inquiry-based science education" (IBSE) is of particular importance for the information society development:

- an intentional student-centered pedagogy that challenges the learner to explore concepts, ideas, and/or phenomena before formal explanations are provided by the teacher and/or other students (Fitzgerald, M., McKinnon, D., Danaia, L., & Deehan, J., 2016; Marshall, J.C., Smart, J.B., & Alston, D.M., 2016) [3; 11];
- Inquiry-based science education is the project-based learning, that is one of the options for productive learning, the purpose of which is not the acquisition of knowledge by students and their passing of educational programs, but the real use, development and enrichment of their own experience and perception of the world [2; 4; 6; 7; 14].

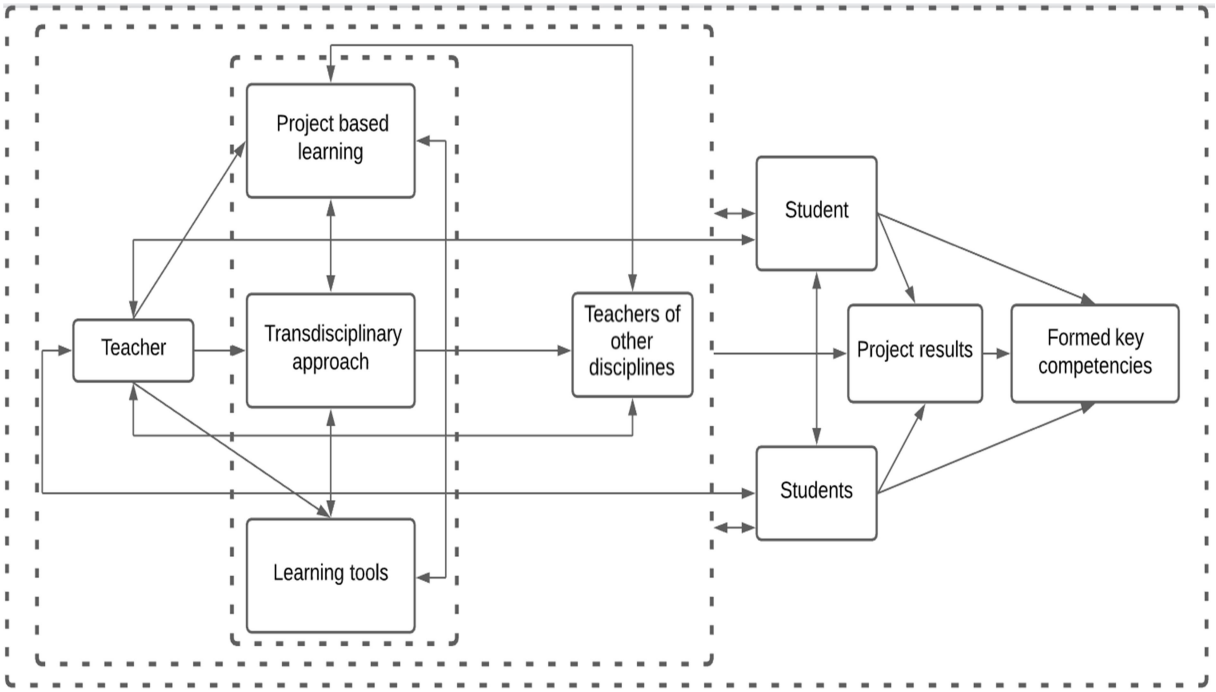

Fig. 1. The participants interaction model of educational process within STEAM-oriented educational environment of general education institution

Scientists determined that [2; 4; 7; 14] it is possible to distinguish the following stages of implementation of the educational project: 1 – creation of the basic maintenance of the project covering a subject, idea, tasks, time limits of performance of educational and teaching activity and result; 2 – creating a plan for the organization and implementation of the project for teachers and students; 3 – planning activities in the project for its various

participants; 4 – research of the project topic; 5 – demonstration of results; 6 – reflection. The project participant's specific role at each stage of creation, organization and implementation of the educational project must be determined.

The model presented in Figure 1 includes three blocks of interaction: teacher-teacher of other disciplines STEAM, teacher-student, teacher-group of students, student-group of students. The purpose of the model is to achieve the planned result of the educational project, and to predict the positive impact on the formation of key competencies of students. The intermediate block of particular importance is the reason for establishing the interaction of participants in the educational process, namely: educational project-compatible disciplines-teaching aids. Teachers should prescribe this block as a project plan for teachers.

For example, the project "Fish is the perfect food", created by teachers of Brovary Secondary School of the 1st-3rd Grade and Semipolkivskyi Secondary School of the 1st-3rd Grade, is based on the STEAM approach and developed according to the plan proposed in Table 1 of the "Fish is the perfect food" educational project plan.

Table 1

Example of the "Fish is the perfect food" educational project plan

№	Project components	Content
1	Title	Fish is the perfect food
2	Abstract	To acquaint students with the diversity of fish, finding the dependence of the diversity of fish on the conditions of the aquatic environment; to expand the idea of the class of bony and cartilaginous fish, the taxonomy of fish, acquainting with the main series of bony fish, the peculiarities of their organization, their role in nature and human life
3	Keywords	STEAM education, STEM lesson, STEAM project, Biology, Computer science, geography, language (Ukrainian and foreign language)
4	Key real-life topic	Fish diversity, dependence of fish diversity on aquatic conditions; features of their organization, their role in nature and human life
5	Age of students	12-14
6	Preparation time	7 days
7	Teaching time	135 minutes
8	Online teaching materials	General educational resources: Flash Cards and Quizzes Apps and Websites; electronic libraries; Web services for teamwork; tools for creating mental maps; search engines. *Resources for specific purposes of the STEAM-oriented learning environment*: to review and study various scientific concepts by using models and simulations, programs and websites of Robotics, online resource centers; labs; simulators. *General educational resources*: Google Classroom, Google Forms, Google Sites, Google slides, Google Suite + Lucidchart, Google Earth VR, Google Play, Google Lens, etc.

		Resources for specific purposes: Biology Interactive Library (http://onlinelabs.in/biology); Google Earth VR, Ultimate Fishing Simulator (https://www.labster.com/simulations/marine-biology/), Cooking Simulator on STEAM (https://store.steampowered.com/app/641320/Cooking_Simulator/)
9	Offline teaching material	hygiene products: napkins, surgical gloves etc.; paper, glue, knife, scissors, pencils, water, fish model; fishes
10	Aim of the biology lesson, as example (it is necessary to prescribe to all teachers the topics on which the project will be conducted)	To acquaint students with the diversity of fish, finding the dependence of the diversity of fish on the conditions of the aquatic environment; to expand the idea of the class of bony and cartilaginous fish, the taxonomy of fish, acquainting with the main series of bony fish, the peculiarities of their organization, their role in nature and human life
11	Outcome of the lesson	The fish dish (river or sea) prepared by students in a group, an explanation of why it was necessary to cook fish, a story about how to clean fish. Presentation (PPT) "Features of the structure and life processes of fish"
12	Trends	Inquiry-based science education and Project-Based Learning: students get fact-based tasks, problems to solve and they work in groups. This kind of learning usually transcends traditional subjects. Collaborative Learning: a strong focus on group work. STEM Learning: Increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum. Learning materials: shift from textbooks to web resources and open source books. Snack Learning: small and attractive bits of learning rather than pro-longed forms of study
13	Assessment	Students can make peer and self assessment decisions on various assessment forms including essays, reports, presentations, performances, projects. Peer and self assessment can play a vital role in formative assessment and can also be used as a component for summative assessment, helping to provide the following outcomes: a desire to want to learn (intrinsic motivation); a need to learn (extrinsic motivation); learning by doing (practice, trial and error); learning through feedback (praise, constructive criticism)

It is necessary to take into account the activities of STEAM-project participants at each of its stages within the model of interaction of participants in the STEAM-oriented educational environment of general education, namely: the creation of the main content of the project is generated by the teacher-leader, which offers the content, indicative plan, time of implementation, main activities, tasks and results of the project; others

teachers offer their ideas for supplementing or adjusting the technical task of the project, create indicative plans for the organization and implementation of the project for teachers and students, inform students about the main details of the project (theme, question, plan, activities, results, etc.), unite students in groups, provide them with consultations; students in groups perform the tasks of the project to solve its main issues, explore the topic to achieve the result of the project, demonstrate the result; evaluate their work and the work of others, identify interesting solutions and the importance of results, shortcomings and problems in the activities to achieve the project result.

Each of the teachers, who involved in the project, must to create individual curriculum plans for student's project activities.

For example, we described the plan for student's project activities in the project "Fish is the perfect food", which offered in the table 1, in the table 2.

Table 2

Example of the "Fish is the perfect food" educational project plan for student's project activities

Name of activity	Procedure	Time
To study of differences between fish living in fresh water and sea water, their body structure, living conditions to further clarify their role in human life	To investigate and find out the differences between fish living in rivers and fish living in the sea: - theory: to study the structure of fish, to find out the features of the organism (Biology Interactive Library; Ultimate Fishing Simulator (Marine Biology: Investigate a massive fish death:) https://www.labster.com/simulations/marine-biology; etc.); - practice: in groups, clean the fish that live in the river and the fish that live in the sea, find out the differences between these fish and offer a justification for the differences between these fish and the same characteristics.	45 min
Project "The diversity of fish, their role in nature and importance in human life": to find out what is the difference between cooking fried fish from the river and fish from the sea; what fish is useful to man	Group discussion and presentation of proposals from the group on what is the difference between cooking fried fish from the river and fish from the sea; what fish is useful to man; how to cook fish living in the river and how to cook fish living in the sea. You can use resources for specific purposes: Biology Interactive Library (http://onlinelabs.in/biology); Google Earth VR, Ultimate Fishing Simulator, Cooking Simulator on STEAM	45 min
Discussion of results	Tasting fish dishes, assessing the work of students in a group, students passing an online test on the topic (https://study.com/academy/practice/fish-	45 min

	quiz-worksheet-for-kids.html; https://lovebiology.co.uk/quizzes.php; https://www.biologycorner.com/quizzes/; https://www.fisheries.noaa.gov/new-england-mid-atlantic/quiz-page-test-your-knowledge; https://www.biologyjunction.com). Teacher can create a personal test using Google Forms, Kahoot! etc.	

It should be changed that for the implementation of certain interactions it is necessary to select and implement ICT for different activities within the STEAM-oriented educational environment. Web services for group work are especially important with this, such as Google Apps for Education: for group collaboration on documents of various formats – Documents, Slides, Tables, Disk, Jamboard; for communication with project participants – Gmail, Chat, VideoMeet, Padlet; for class management – Class, Forms, Tasks.

Conclusions and research perspectives. The success of the educational project and the achievement of its goal within the STEAM-oriented educational environment depends on the creation of conditions for the interaction of its participants, namely: clearly defined content of the project; achieving mutual understanding between its participants; adherence to ethical and psychological principles, in particular the willingness and ability to be a facilitator for teachers and students; organization of interaction with the help of tools convenient for all participants of the project, in particular, web services.

Thus, defining the main stages of organizing educational projects in STEAM-oriented educational environment of general education institution according to the roles and interaction of participants in the educational process is important for STEAM education, creating STEAM-oriented health care environment, motivating students to study and research within STEAM.

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