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Response

Foreign Scientific Consultant

For the dissertation authored by Nurym Nurdaulet Nurasyluly

"THE FORMATION OF COMPUTATIONAL THINKING BY STUDENTS OF MAIN SECONDARY SCHOOLS IN THE PROCESS OF JOINT TRAINING IN ROBOTICS"

Submitted for the award of degree Doctor of Philosophy (Ph.D.) in

The educational program "8D01502-Computer Science"

Today, a large number of scientific and educational organizations across the globe are actively pursuing research activities towards developing the thinking concept of "computational reasoning". The ability to understand and apply fundamental computational principles as well as advanced computing techniques to a wide range of human activities has been put forward as a new requirement for the qualification of contemporary expert specialists in almost every profession. It is therefore, the emerging need for a modern education system in teaching robotics in high school is to introduce new forms and methods of training and education that ensure the personal development to each student.

This dissertation research is devoted to the relevant and insufficiently investigated problem of early teaching robotics at schools. The proposed integrated educational program in robotics, which combines the contents from computer science, is especially focused on developing students' skills in problem analysis, problem solving, experiment design, abstract and generalization reasoning as well as computational thinking through the assembly, programming and launching of robots to perform dedicated tasks. In turn, this approach would enable the students to develop logical thinking, creative practice and collaboration skills. In addition, early education in robotics also provides to the teachers a new way of learning and combining knowledge in the field of robot technology with significant projects. Furthermore, along the proposed exploration taking action to develop an effective and reliable tool for measuring the computational thinking of high school students is also an important yield of this research study. In this context, I do believe that the study was actually accomplished since the goal of the study was achieved and the investigation tasks effectively implemented. For, it should be noted the scientific novelty and practical significance have been described in sufficient detail as well as validated via relevant experiments and observations.

In a summary, the purpose of the accomplished research study is to develop and present a novel pedagogically efficient methodology based on the development of students' computational thinking by organizing joint learning using physical and

virtual robots in a robotics course suitable for a primary level of high schools and beyond.

The following scientific findings and results were obtained by the Authord during his research on doctoral dissertation:

- Theoretical background and methodological feature modes of joint training in robotics have been determined;
- A methodology for teaching the educational course of robotics has been developed from the point of view of the generic formation of computational thinking in students' learning and working;
- Means and ways to develop students' computational thinking skills were proposed in the course of joint online teaching of the scientific and technological topics in the field of robotics.
- The scientific results obtained by the applicant candidate are characterized by internal integrity and unity, which ensures consistent disclosure of the topics of this dissertation research.
- The experimental work carried out corresponds to the underlying structure and logic of this study. The research area included solving a number of encountered experimental problems.

The implementation of the model developed by the applicant candidate ensures a high level of formation of the computational thinking of students of the main secondary schools. The described components (blocks) of the structural-content model of the formation of computational thinking by students of the main secondary schools are consistently interconnected, necessary and validated sufficient to achieve this goal of this research project. At the same time, the proposed model, although being a structural entity, is made open for further additions and adjustments.

This study suggests that properly organized collaborative robotics learning contributes to the computational thinking of students. With joint training, students have the opportunity to use information technology to create programs, systemic structures and various technology projects. Robotics training guarantees the formation of digital literacy, the ability to develop and implement their ideas using information and communication technologies. Thus, the applicant candidate claims that educational robotics allows you to express yourself, to be proactive participants in the contemporary digitalized world.

The practical significance of these research results lies in the implementation of the educational and methodological complex of joint training in robotics, which includes the process of creating and teaching a program, practical manuals and practical materials on robotics for teaching secondary school students. It is necessary to develop the computational thinking of students from primary school age, which shows the need to develop practical foundations for the development of computational thinking by using the attractive field of robotics through stimulating the understanding of robotics as a scientific convergence of material, i.e. so-called 'hardware' (components and devices) and information, i.e. so called 'software' (control and communication processing) technologies.

The main results of the study were presented at international scientific and technological conferences in Almaty (2022), Gorno-Altaysk of the Altai Republic (2023), Rhodes of Greece (2023), at the relevant scientific and methodological seminars, and also discussed at a meeting of the Department of Computer Science of the Kazakh National University named after Al-Farabi. The results of the dissertation were introduced into the educational process of secondary school No. 69, the physics and mathematics school "Tamos Education" in Almaty.

Furthermore the finding and results of this dissertation are reflected in six scientific publications of which these are:

1/, One (1) article in the journal included in the Scopus percentile - 95% (Web-of-Science, Q1);

2/. One (1) chapter in Springer's monograph (Scopus-60%);

3/. One (1) article in publication recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan;

4/. One (1) article in the journal included in the RSCI database;

5/. One (1) article published in Springer's publication;

6/. One (1) paper in the materials of an international conference rated with H-index=5.

Finally, to conclude, I find that the dissertation research work by applicant candidate Nurym N.N. does meet the requirements for dissertation manuscript as defined by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan. It is therefore the author Nurym N.N. deserves to be awarded a Ph.D. in the educational program "8D01502-ComputerScience".

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Dean's Office of
The Faculty of Electrical Engineering and Information Technologies verifies that Prof. Dr. Georgi M. Dimirovski is authorized for doctoral students and currently supervises one Ph.D. student at Doctoral School FEIT.

Signed,