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The development of research activity with schoolchildren

Maiya Kayumova [a], Toraighyrov University, Department of Psychology and Pedagogy, Pavlodar, Republic of Kazakhstan, https://orcid.org/0000-0003-0409-668X

Saule Xembayeva [b*], Department of Psychology and Pedagogy, Toraighyrov University, Pavlodar, Republic of Kazakhstan, https://orcid.org/0000-0001-6926-1514

Nataliia Fominykh [c], Plekhanov Russian University of Economics, Foreign Languages Department No 1, Moscow, Russian Federation, https://orcid.org/0000-0002-1534-7782

Nelli Pfeifer [d], Toraighyrov University, Department of Psychology and Pedagogy, Pavlodar, Republic of Kazakhstan, https://orcid.org/0000-0001-6540-9446

Kainysh Zumadirova [e], Toraighyrov University, Department of Personal Development and Education, Pavlodar, Republic of Kazakhstan, https://orcid.org/0000-0002-6101-775X

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Abstract

The primary goal of this study was to unveil the key features of research activity in the context of school education and identify the most significant barriers to it. This was to be achieved by conducting a structured survey of 174 teachers. Further interviewing of 10 teachers of the most successful schools in these terms intended to detail the characteristics of research activities in the considered educational institutions. The systematization and generalization of the collected results was the final stage of this analysis. The data obtained in the course of the investigation confirmed the idea that most students should take a special course on introduction to research from their first days at a university. In practice, the research results can be used in the implementation of STEM methods, scientific education, and the involvement of schoolchildren in research activities in the educational programs of most developing countries that have similar problems.

Keywords: entrepreneurial education; research activity; science education; soft skills; STEM; university preparation programs.

* ADDRESS FOR CORRESPONDENCE: Saule Xembayeva, Toraighyrov University, Department of Psychology and Pedagogy, Lomov st. 64, Pavlodar, 140000, Republic of Kazakhstan,

E-mail address: saule_xembayeva@rambler.ru , ksembayeva.s@teachers.tou.edu.kz / Tel.: 87014237899

1. Introduction

1.1. Conceptual or Theoretical Framework

The requirements for the training of professional specialists in the field of entrepreneurship, IT, management and high-tech fields are constantly increasing the requirements for the quality of school education and preparation for entering the university. The problem of high-quality university preparation programs is acute in both developing and developed countries (Kilpatrick et al., 2021). By 2015, many universities in the Republic of Kazakhstan began to actively introduce entrepreneurial education. Toraigyrov University supported this initiative. A Startup Academy was created at the university, Demo Days were actively held. Successful people were invited to share their experiences, and students planning their own projects gave presentations.

The integration of different areas such as mathematics, science, and technology is inevitable for students and teachers in the 21st century. The best example of such an integration is STEM pedagogy, with its four pillars – science, technologies, engineering, and mathematics – merged into one. Although very effective, this approach requires profound field knowledge to unite several streams of study and assure a proper framework for such a strategy's implementation in academic institutions (Sorby et al., 2018).

Addressing this topic has shown that research problems are considered in many works, consider the issues of participation of teachers in research activities, proposing strategies of action for them in a complex university life (Chan et al., 2021; Tziortzioti et al., 2020). Some researches address the topic of providing opportunities for research experiences for medical students (Izagirre-Olaizola & Morandeira-Arca, 2020; Öcek et al., 2021), consider training in business processes using new technologies. The study of Vodă and Florea (2019) is of an interest, as it considers entrepreneurial education as an opportunity to create new jobs, which is important for the economy. Prosekov et al. (2020) are closer to this study, since they presented the measures necessary for planning research activities and aimed at developing research competence among university students. The works of Kazakhstani scientists on this issue have also been studied. Mukhatayeva (2018) considered the social and pedagogical support of the process of forming the project competence of students in the system of university education. Taubayeva (2015) studied research activities from various positions.

1.2. Related Research

To solve the set tasks, a program for studying the development of research activity of schoolchildren in Pavlodar oblast was developed. Analysis of the literature showed that schoolteachers are trying to involve schoolchildren in the research process in their article examine the research collaboration of a teacher and a pupil, in which they interact with each other (Abbas et al., 2020; Bal-Taştan et al., 2018; Bolshakova et al., 2018; Henriksson, 2018).

On the other hand, researchers (Ellizar et al., 2018) declare the effectiveness of using a discovery-based approach to stimulate research activities in schools. This fact is evidenced by an experimental study conducted among senior high school students (Grades 10 and 11) during chemistry classes and focused upon such scientific methods as observation, reasoning, and analysis. In the long run, it demonstrated a significant interest of study participants in the proposed chemistry acid-base module, noticeable overall progress in chemistry, and a strong correlation between the opportunity to see the results of their activity and engagement in learning.

Analysis of the literature showed that schoolteachers are trying to involve schoolchildren in the research process in their article examine the research collaboration of a teacher and a pupil, in which

they interact with each other (Abbas et al., 2020; Bal-Taştan et al., 2018; Bolshakova et al., 2018; Henriksson, 2018). Evidence from available works on the matter and the own experience of authors allowed determining the main objective of this article: to clarify the state of the problem of the development of research activity in schools of Pavlodar oblast.

1.3. Purpose of the Study

This study aims to define the central features of research activity in the context of school education in the Pavlodar oblast of the Republic of Kazakhstan and identify the most significant barriers to it. This would allow unveiling new aspects of research activity continuation in the educational environment of Kazakhstan and generalizing the leverages of schoolchildren's involvement in research typical for all developing countries.

To do this, the following objectives are to be accomplished:

- conduct a mass survey to study the opinion of teachers in schools in Pavlodar oblast about the current state of research activity. Based on the presented analysis, find out how schoolteachers see the process of further development of schoolchildren's research skills at a university level;

- conduct an expert survey of teachers; for this, create a research group of at least 10 people;

- draw conclusions about the state of development of research activity in schools of the Pavlodar oblast and summarize the views of teachers on how to continue the development of research work at a university.

2. Materials and methods

2.1. Research Model

In the first stage of the study, we used surveys of schoolteachers on the Google platform in order to identify the content of research activity in schools of the Pavlodar oblast of the Republic of Kazakhstan (all of these educators were engaged in nature-study teaching). The questionnaire used for this purpose was composed of 12 questions developed by the authors based on a theoretical analysis of the literature on the problems of forming research motivation among students. They were designed in a way to describe the current state of research activity in schools within the studied area. The experts had two weeks to complete the questionnaire and send the results. In general, all teachers met the specified deadline and answered all the submitted questions. The choice of the Google platform was made for the reason of its availability to teachers of urban and rural schools. The mailout was carried out randomly, trying to make the survey wider; for this, we used the e-mail addresses of schools and sent a link to schools in the cities of Pavlodar region, as well as to rural district schools. Authors asked all teachers to answer questions on the Google platform, prepared a survey of teachers of secondary schools in Pavlodar oblast on the google platform at the following link: https://clck.ru/UhQsn.

For purpose of the study, age, gender or the period of service of the teachers or the subject taught is not important. Since authors believe that research activity should be carried out at any stage of schoolchildren's learning process in school, it does not matter what subject it is. The answers from schoolteachers were expected within 14 days. In total, 174 people were interviewed; these are schoolteachers in the districts of Pavlodar oblast of the Republic of Kazakhstan. Taking into account the size of the general sample (the number of teachers in the schools of the region), the admissible sampling error does not exceed 1.47. Thus, the sample can be considered statistically representative.

In the second stage, an expert survey was conducted; teachers of schools who were successful in organizing research activities with schoolchildren were selected as experts. The purpose of this step

was to clarify what is the content of teachers' work with schoolchildren who have achievements in research activity, expressed by prizes in school, city, regional and other competitions. The interview type selected for this purpose was an unstructured interview. In total, it involved 10 teachers, the selection of whom was carried out based on an analysis of the website of the education department and a review of school websites. For 10 days, we were in contact with teachers. The main purpose of this interview was to deeply study the opinions of teachers on how research activity is developing at schools and how research skills should be further developed at the next stage of student development – university. Interviews with members of the expert group were conducted at schools, some of them were invited to the university, and teachers from rural schools were interviewed through Zoom. The place of the interview was previously discussed with the teachers; hence, the place and time were agreed upon in advance.

The third stage presupposed a comprehensive analysis of the results obtained from both the sample of teachers and the sample of experts to identify a vector of research conclusions and generalize them.

2.2. Participants

The research base is the schools of the Pavlodar oblast, and in particular, the schools of the city of Pavlodar: No. 39, 25, 42, 19, 22, 35, 41, lyceum 10, the regional multidisciplinary boarding school for gifted children, school No. 2 in Ekibastuz of the Pavlodar oblast, school No. 2 of the village of Terenkol, the school of the village of Kalkaman of the Aksu district, the Oktyabrskaya school of the Terenkol district, the school-lyceum of the city of Aksu, and Toraigyrov University.

The survey covered 174 teachers from the above educational institutions, selected by a random sample. Among the teachers, the majority were women (the share of females was 74%, while males – 26%, *MA*=41.7, *n*=5). Also, 10 teachers, based on familiarization and evaluation by the authors of their achievements in organizing research activity with schoolchildren, based on an analysis of the website of the education department and a review of school websites and personal interviews, were selected as experts for an unstructured survey. The gender structure of the experts was 50% to 50% to maximize the study's relevance (*MA*=48.5; *n*=2). The experts in this study were teachers from the cities of Pavlodar, Ekibastuz and Aksu, and schools of the Terenkol district of Pavlodar oblast. Interviewing of the sample was performed by the authors together with the expert teachers, which significantly facilitated the collected results' processing.

The greatest activity was shown by the teachers of the cities of Pavlodar, Aksu, Ekibastuz. As the results of the survey showed, the teachers from the cities of Pavlodar (58.62%), Aksu, Ekibastuz showed the greatest activity; we would like to note the teachers from the Terenkul district, who made up 6.32% of the total number of teachers surveyed. We expected more answers from rural school teachers, and we are grateful to our colleagues from rural schools who took part in our survey. In the breakdown, it looks like this (Figure 1).

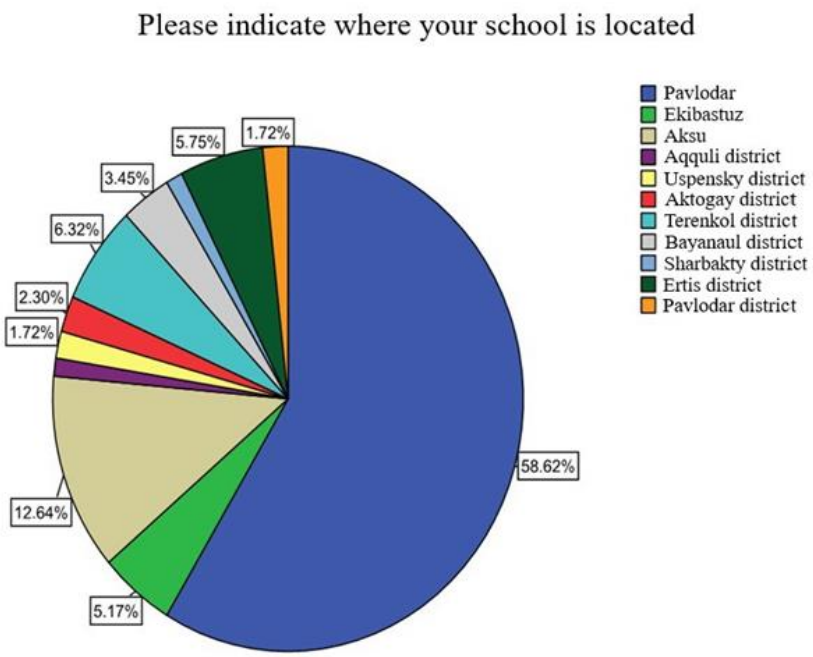

Figure 1. Geography of the survey of teachers of secondary schools of Pavlodar oblast

2.3. Data Collection Tools

The key survey tool was the Google-Forms platform, where the questionnaire for teachers was posted. Interviews with the expert group participants were conducted in schools. In line with this, some of them were invited to the university, whereas teachers of rural educational institutions were surveyed through Zoom.

2.4. Data Collection Process

Information collection process was conducted in three stages, each involving both online and face-to-face contact with the sample. As for the scientific methods of data collection, this study benefited from theoretical analysis of the literature on the topic, interviewing, expert survey, and mathematical and statistical data processing. Also, when conducting the current research, the materials collected during the work on the dissertation “Formation of research competencies of students in the process of planning startup project” were used.

2.5. Data Analysis

Statistical analysis of the survey results was carried out and data visualization for graphical presentation using the statistical software package SPSS 26.0.

2.6. Ethical issues

Due to the anonymity of the survey, no personal data of the survey participants was available to the researchers using the Google platform. The personal data of the selected expert teachers were not collected, stored or analyzed; survey results were recorded in anonymous form under impersonal numbers to ensure independence from the participant’s personal data. All participants gave their personal consent to participate in the study.

2.7. Research limitations

The study does not take into account the demographic factors of the participants, such as age, gender, or experience. Nevertheless, these factors can, in one way or another, influence the perception and performance of the research participants. Also, the survey relies on the subjective data of survey participants and does not contain objective data on their activities, which somewhat narrows its value.

3. Results

3.1. Structured teachers survey

Secondary school teachers were asked to rank possible ways of working to develop schoolchildren's research skills (Table 1)

The study authors made a request to the Startup Academy on the need to organize meetings for schoolchildren from rural schools. The Startup Academy of Toraigyrov University often holds interesting meetings with people who have achieved certain success in business. Classes are held for students starting their own Startups. Such meetings and classes can become a source of new knowledge, ideas and new acquaintances for schoolchildren.

Table 1. Survey results on: a) opportunity to be involved in the Startup Academy; b) teachers' opinions on training courses

		Frequency		**Percentage**		**Valid percentage**		**Cumulative percentage**	
		a	**b**	**a**	**b**	**a**	**b**	**a**	**b**
Valid	**1**	18	12	10.3	6.9	10.3	6.9	10.3	6.9
	2	3	8	1.7	4.6	1.7	4.6	12.1	11.5
	3	9	7	5.2	4.0	5.2	4.0	17.2	15.5
	4	10	14	5.7	8.0	5.7	8.0	23.0	23.6
	5	25	24	14.4	13.8	14.4	13.8	37.4	37.4
	6	18	16	10.3	9.2	10.3	9.2	47.7	46.6
	7	17	18	9.8	10.3	9.8	10.3	57.5	56.9
	8	16	17	9.2	9.8	9.2	9.8	66.7	66.7
	9	8	15	4.6	8.6	4.6	8.6	71.3	75.3
	10	50	43	28.7	24.7	28.7	24.7	100.0	100.0
	Total	174	174	100.0	100.0	100	100.0		

As can be seen from the presented Table 1a, 28% of respondents consider visiting the Startup Academy as one of the important tools in the formation of schoolchildren's research skills. 10.3% of teachers do not consider visiting the Startup Academy as one of the methods of developing schoolchildren's research skills. 1.7% of respondents give a low rating to this method; it is worth noting that these are teachers from rural schools and from Aksu and Ekibastuz, we assume that they are not sufficiently informed about the work of the Startup Academy of Toraigyrov University.

The majority of teachers (24.7%) give preference to training courses, considering them an important method for developing research skills, while 6.7% of teachers do not consider training courses to be an effective method at all. Only 4.6% of the respondents noted the low effectiveness of training as a way to develop students' research skills (Table 1b).

Of the total number of teachers surveyed, 28.74% consider it necessary to conduct masterclasses on the design of scientific research and presentation of the scientific apparatus. At the same time, 9.77% of respondents do not consider this method effective. Of the total number of respondents, 4.0% consider masterclasses not the most effective method (Table 2).

Table 2. Opinions of teachers regarding masterclasses

		Masterclasses			
		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	1	17	9.8	9.8	9.8
	2	7	4.0	4.0	13.8
	3	12	6.9	6.9	20.7
	4	10	5.7	5.7	26.4
	5	18	10.3	10.3	36.8
	6	13	7.5	7.5	44.3
	7	15	8.6	8.6	52.9
	8	17	9.8	9.8	62.6
	9	15	8.6	8.6	71.3
	10	50	28.7	28.7	100.0
	Total	174	100.0	100.0	

Figure 2 shows that 55% of the teachers surveyed believe that more competitions of scientific works should be held. Participation in competitions will be a great incentive for schoolchildren.

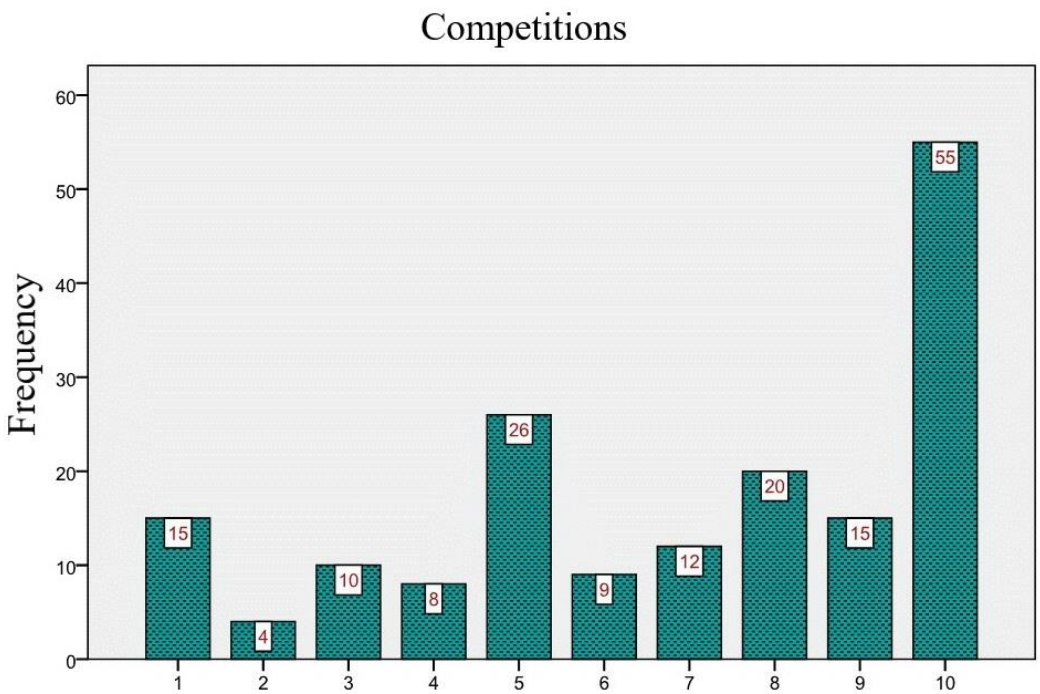

Figure 2. Opinions of teachers regarding competitions as a method of developing research skills.

Also, it was found that 15% of teachers do not consider holding competitions as a method of developing research skills and 4% do not consider this method to be effective.

Teachers noted (33.3%) that financial incentives for teachers engaged in research work would have a positive effect, and this method received the highest rating. Collectively, 75.7% of teachers support the idea that financial incentives will have a positive effect. And, 9.2% of teachers do not need financial stimulation at all. 4.0% of teachers are also not sure if this is an effective method (Table 3a).

Table 3. Survey results on: a) financial incentives for teachers engaged in research activity; b) the matter of sponsorship acquisition

		Frequency		Percentage		Valid percentage		Cumulative percentage	
		a	b	a	b	a	b	a	b
Valid	1	16	15	9.2	8.6	9.2	8.6	9.2	8.6
	2	7	10	4.0	5.7	4.0	5.7	13.2	14.4
	3	7	14	4.0	8.0	4.0	8.0	17.2	22.4
	4	12	8	6.9	4.6	6.9	4.6	24.1	27.0
	5	19	22	10.9	12.6	10.9	12.6	35.1	39.7
	6	11	13	6.3	7.5	6.3	7.5	41.4	47.1
	7	11	13	6.3	7.5	6.3	7.5	47.7	54.6
	8	19	15	10.9	8.6	10.9	8.6	58.6	63.2
	9	14	11	8.0	6.3	8.0	6.3	66.7	69.5
	10	58	53	33.3	30.5	33.3	30.5	100.0	100.0
	Total	174	174	100.0	100.0	100.0	100.0		8.6

Of the total number of respondents, 30.5% consider it effective to acquire sponsors who could assist in the acquisition of the necessary materials for successful research activity.

The data for this survey are presented in Table 3b. As shown in the table, 8.6% of respondents do not see the effect of sponsorship assistance.

It should also be noted that almost a third (31%) of the surveyed were interested in entrepreneurial grants from the business sector, while 12% did not see any sense in them (Table 4a).

Table 4. Survey results on the issue of grants from entrepreneurs and organizations to: a) educators actively engaged in research activity; b) schoolchildren actively engaged in research activity

		Frequency		Percentage		Valid percentage		Cumulative percentage	
		A	b	a	b	a	b	a	b
Valid	1	21	23	12.1	13.2	12.1	13.2	12.1	13.2
	2	11	7	6.3	4.0	6.3	4.0	18.4	17.2
	3	11	10	6.3	5.7	6.3	5.7	24.7	23.0
	4	7	8	4.0	4.6	4.0	4.6	28.7	27.6
	5	20	18	11.5	10.3	11.5	10.3	40.2	37.9
	6	15	21	8.6	12.1	8.6	12.1	48.9	50.0
	7	10	6	5.7	3.4	5.7	3.4	54.6	53.4
	8	12	11	6.9	6.3	6.9	6.3	61.5	59.8
	9	13	8	7.5	4.6	7.5	4.6	69.0	64.4
	10	54	62	31.0	35.6	31.0	35.6	100.0	100.0
	Total	174	174	100.0	100.0	100.0	100.0		

The same grants for schoolchildren were supported by 35.6% of teachers, while 13.2% of teachers did not consider this a necessity. In total, 62% of respondents considered this method to be effective (Table 4b).

Networking became an interest for 39% of teachers (Figure 3). They praised this method, while 18% did not consider networking as a method of developing research skills.

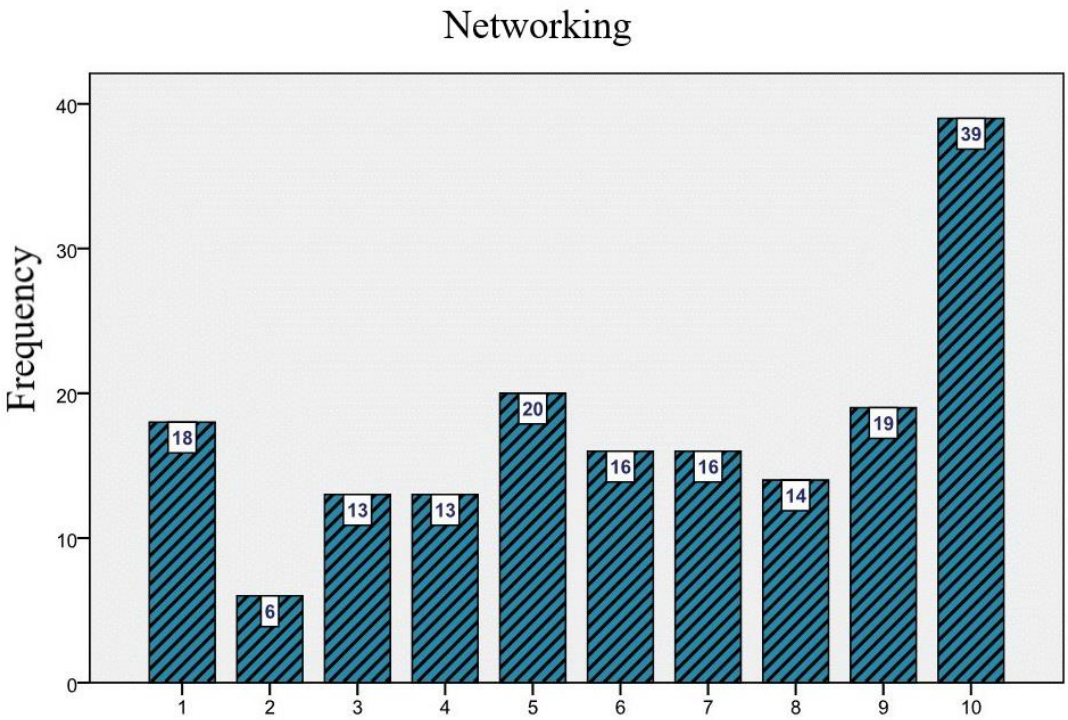

Figure 3. Opinions of teachers regarding networking as a method of developing research skills

Our proposal for developing research activity plan at schools resonated with 31.6% of teachers. At the same time, 8.6% did not consider it necessary to work according to the general school plan of research activity (Table 5a).

Table 5. Survey results on: a) developing a school work plan for research activities; b) providing teachers with opportunities to improve their research skills

		Frequency		Percentage		Valid percentage		Cumulative percentage	
		a	b	a	b	a	b	a	b
Valid	1	15	13	8.6	7.5	8.6	7.5	8.6	7.5
	2	6	9	3.4	5.2	3.4	5.2	12.1	12.6
	3	9	12	5.2	6.9	5.2	6.9	17.2	19.5
	4	11	7	6.3	4.0	6.3	4.0	23.6	23.6
	5	23	23	13.2	13.2	13.2	13.2	36.8	36.8
	6	18	10	10.3	5.7	10.3	5.7	47.1	42.5
	7	12	14	6.9	8.0	6.9	8.0	54.0	50.6
	8	12	16	6.9	9.2	6.9	9.2	60.9	59.8
	9	13	11	7.5	6.3	7.5	6.3	68.4	66.1

	10	55	59	31.6	33.9	31.6	33.9	100.0	100.0
	Total	174	174	100.0	100.0	100.0	100.0		

The survey clarified the opinion of schoolteachers on how advanced training opportunities for teachers would affect the development of research activity that is important for this research. As can be seen from Table 5, 33.9% of teachers put this question in first place; it was also revealed that 7.5% of teachers did not think that it is effective (Table 5b).

The survey also clarified the opinion of educators on whether a favorable research environment will affect the effectiveness of research activity.

Table 6. Creating a favorable research environment at schools

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	1	11	6.3	6.3	6.3
	2	13	7.5	7.5	13.8
	3	12	6.9	6.9	20.7
	4	11	6.3	6.3	27.0
	5	16	9.2	9.2	36.2
	6	9	5.2	5.2	41.4
	7	11	6.3	6.3	47.7
	8	13	7.5	7.5	55.2
	9	13	7.5	7.5	62.6
	10	65	37.4	37.4	100.0
	Total	174	100.0	100.0	

As can be seen from Table 6 presented, 37.4% of teachers considered the creation of a favorable research environment to be the most effective method of developing research activity in schools. It was revealed that 6.3% of teachers did not see any need for this.

Along with this, teachers to a greater extent noted the practical effectiveness of digital technologies in improving students' academic performance. Hence, about 84% of them claimed that digital learning is more beneficial than traditional training mode due to the overall upward trend of student academic achievements.

3.2. Unstructured experts survey

To adequately assess the answers of experts and judge the state of the educational environment in schools of the Pavlodar region of Kazakhstan, the authors needed an answer to the question of how the process of research cooperation is going on in schools in Pavlodar oblast. Graduates of schools in this region make up the majority of the Toraigyrov University contingent. According to the information of the admissions committee, 2555 people entered the university in 2020 for bachelor's degree, of which 2340 are graduates of schools in Pavlodar oblast, which is 91.5%. It means that it is very important to know how teachers of schools in our oblast relate to the process of developing research competencies.

The mathematics teacher who has been teaching mathematics at the secondary school of Pavlodar for 10 years noted that he was trying to increase the number of schoolchildren participating in the city research competition. To do this, from the first lessons, the teacher encourages those who ask questions, always marks interesting questions, and points out the most interesting question in the

lesson. He attaches great importance to the formation of schoolchildren's skills in formulating definitions of new concepts. According to the teacher, this approach allows to awaken the research interest that underlies the future research project.

However, it should be noted that all of these activities are held once a year and involve about 5% of all schoolchildren. We are interested in systematic continuous work to develop the research skills of schoolchildren.

The most striking achievements of teachers in joint activities with schoolchildren were the successes of schoolchildren in city, regional and republican competitions. Especially striking achievements were among teachers of geography, mathematics, chemistry and biology.

When interviewing a research group about what kind of soft skills schoolchildren should have, the following results were obtained: 5 teachers out of 10 gave first priority to planning, time management, and teamwork. When asked about soft skills, respondents immediately spoke about them, already ranking them in advance according to their preference. This approach to substantiating their answers suggests that respondents were reflecting on research activity at school and began talking about those soft skills that, in their opinion, are the most effective. Of the 10 teachers interviewed, five people immediately said that above all, they try to teach schoolchildren to plan their activities, and this skill is necessary for a person throughout their life. If schoolchildren learn to plan, then their achievements in scientific activity will be logical and consistent.

According to the results of an expert survey regarding the methods used in research activities with schoolchildren, it can be stated that the project method is used in the work of 4 teachers out of 10 respondents, and 3 teachers use traditional methods in their work. Teachers scored winning places of schoolchildren, which they held at city and regional competitions as the most striking achievements in their research activity. The students of the geography teacher were able to win the republican competitions. We tried to clarify what other competitions were held, but none of the teachers could name any other competitions. In addition, those contests that the teachers talked about are held once a year, and there is a certain hierarchy: the winners of school contests can take part in the city competition, and the winners of city competitions can get to the republican contests.

This study's most important question on how to continue developing research skills at the university was not of interest for schoolteachers. Were received stock responses, such as: use mostly project-based teaching (teacher of Russian language and literature), there are many opportunities for research in the university, so you should just motivate students (teacher of chemistry). The history teacher suggested joint projects where a student with some experience could lead a research project for schoolchildren. The geography teacher said that the university has a Startup Academy that could lead the research work of schoolchildren, invite them to student meetups, Demo Days and other events. The biology teacher said that those students who are passionate about research will get involved in some kind of activity and emphasized the fact that more attention should be paid to those who show significant passion for research activities at this stage (for whom it would be a part of their future life).

4. Discussion

The problem of high-quality preparation of schoolchildren for entering universities and their further professional training is acute all over the world (Mukhatayeva, 2018; Tomio et al., 2017). A significant number of researchers consider the so-called scientific education to be the most important factor in improving the quality of training. Empirical research covers the use of elements of science education

from the late preschool and primary school period (Karpov, 2017; Yeboah et al., 2019; Yunus, 2021). In accordance with the opinion of the experts interviewed in our study, it is optimal to carry out scientific and technical orientation of schoolchildren and orientation in the future choice of a profession even in secondary school (Prosekov et al., 2020). Also, researchers from developing countries emphasize the lack of the necessary materials, equipment and laboratory conditions in the school for a better scientific education (Öcek et al., 2021; Ybyraimzhanov et al., 2020; Yeboah et al., 2019).

In most cases, researchers propose engaging students in science education in two ways. The first of them is the use of practical lessons with the participation of visual experiments, solving practical problems in the classroom using laboratory equipment and conducting independent calculations and even planning experiments (Chan et al., 2021; Hetherington et al., 2020). Most of the techniques in this direction are incorporated into the STEM approach, which is gaining more and more popularity in the world (Depuydt et al., 2018; Hetherington et al., 2020; Honorato-Zimmer et al., 2019). The second way to attract schoolchildren to science is to involve them in solving real problems of a city or place of residence through scientific research. Most often, such studies relate to the field of ecology, to a lesser extent, issues of transport or others (Fankhauser & Lijek, 2016; Harlow et al., 2018; Vossen et al., 2018). Student participation may include collecting statistical material, doing simple experiments in practice, participating in analytical data processing, and some other activities (Kiessling et al., 2021; Leblebicioğlu et al., 2020; Vivar et al., 2018). Virtual or augmented reality methods are gaining more and more popularity in terms of online elementary teaching (Sahin & Yilmaz, 2020). This activity is combined with the curriculum of the corresponding subjects of the school course (Tziortzioti et al., 2020).

The actualization of the digital format intensified with the formation of a new generation in the early 2000s (Dewi et al., 2021). Individuals born during this period of time, namely Generation Z, witnessed the emergence of social media as well as digital applications for businesses and civic infrastructure, which became a strong impetus for the formation of a “postmodern, digital” identity. Currently, researchers (Susilawati et al., 2021) argue about the exceptional success of the use of social media as a means of learning and supervising students, as Generation Z representatives are indeed very familiar with social media (it is part of their world).

Indonesian scholars give increased consideration to the importance of digitalization within the limits of students’ interest in research activity. In this context, they argue that a significant number of studies do not take into account the special needs of individuals who may have psychological or physical disabilities, even though they should never be neglected. By enrolling a number of third-graders with computing impairments (and thus some problems with mathematics) in a comprehensive diagnostic test, researchers concluded that the use of interactive media materials can significantly improve students’ ability to learn. The truth of these judgments was confirmed by the average validity of 3.2 (Patricia & Zamzam, 2021).

Both of the described ways of involvement fully coincide with the results of the survey of experts and teachers in our study. Only Kazakh teachers, as well as researchers from developing countries, note the lack of funding for useful collaborative projects and insufficient laboratory equipment (Momunaliev, 2019; Ybyraimzhanov et al., 2020; Yeboah et al., 2019). In contrast to our study, developed and developing countries do not describe the practice of special fundraising for the development of science education from the business side.

On the other hand, some researchers discuss the prime importance for teachers and students to adopt digital technology for educational purposes. Even though the available data evidence that

educators are less attracted to adopting new teaching methods, the cohort of students is characterized by a highly positive attitude toward learning via new technologies. What is more, business representatives also support learners as they are highly interested in implementing new educational technologies and digitalization. They unanimously claim the positive impact of the labor market transformation and digitalization when educational structures move to technological devices (Qureshi et al., 2021).

From a methodological point of view, it should be noted that the results obtained in similar studies conducted in developed countries notably differ from those presented in the current paper. Most often, scientific education includes the maximum practical load, the use of intensive laboratory studies or classes that include numerous actions performed by the children themselves in the course of solving real problems (Leblebicioğlu et al., 2020; Tomio et al., 2017; Tziortzioti et al., 2020; Vossen et al., 2018). While the results of our survey indicate that no more than 5% of students are covered by the development of research skills, then the available academic empirical and experimental research suggests full coverage of the class, school, or even the entire education system (Henriksson, 2018; Hung et al., 2015). The scale of coverage is determined by the choice and motivation of teachers and decisions of educational administrations (Bal-Taştan et al., 2018). A number of studies indicate that the coverage of STEM methods and scientific education in developed countries is much higher than in developing countries, and in some cases, can cover the entire school system as a whole (Kruse et al., 2020; Öcek et al., 2021).

The findings of a related survey addressed to Slovenian students and teachers have many in common with the conclusions of the present work. More precisely, researchers sought to assess attitudes toward the use of digital technologies in education along four dimensions: teaching and learning, assessment and critical thinking, empowering learners, and facilitating learners' digital competence. Self-reported proficiency in using digital technology was also measured on four groups of digital technologies: digital resources, communication tools, digital tools, and online learning tools. The collected assessment results unveiled that Slovenian student teachers predominantly hold positive attitudes toward using digital technologies in education, but they assessed themselves as low-level users. Along with this, the student teachers' attitudes toward using digital technologies in education were proved as an important predictor of their digital proficiency (Štemberger & Konrad, 2021).

5. Conclusion

Intensification of training for specialists in knowledge-intensive fields of knowledge is important, especially for developing countries. Most researchers agree that the foundation for effective preparation must start with primary school age. The aim of this study was to shape the problems of the development of natural-science education in schools of the Pavlodar oblast (Kazakhstan). The structured survey of 174 teachers of the Pavlodar oblast was conducted. Teachers who are constantly engaged in research activities measure the success of their activities by the number of awards at city, regional, republican competitions. The competitions are held once a year; the solution is possible through joint activities with universities, the participation of schoolchildren in research competitions together with scientists. Schoolteachers see the process of further development of students' research skills at the university level as an obvious process: those students who were engaged in research activities at school do not require additional training. An expert survey of teachers (10 people in total) confirmed our conclusions on the state of research activity in schools of the region and clarified the used methods of work on the development of research skills of schoolchildren. The findings confirmed the idea that most students should take a special course on introduction to research from their first

days at a university. The conducted research allowed us to draw the following conclusions: schoolteachers are engaged in research activity with a small part of schoolchildren (5%); to involve a larger number of schoolchildren in research work, there is often not enough resources and teachers' personal time. It is possible to improve the quality of research activity in schools in close cooperation between the university and schools; and it would be effective to carry out various activities for both schoolchildren and schoolteachers. At the same time, in the survey on the soft skills students should possess, 50% of teachers prioritized planning, time management, and teamwork. Further research should be aimed at a more detailed study of the methods of preparing schoolchildren and predictors of their academic success at the university. Practically the results can be used in the implementation of scientific education and the involvement of schoolchildren in research activities in the educational programs of most developing countries. Also, the conclusions made can be used as a foundation for elaborating curricula and syllabi that would allow for the peculiarities of the development of students' research potential and contribute to learning effectiveness increase.

5.1. Recommendations

As for the recommendations for future related research, we propose paying particular attention to the study of the integration of research practices and forced distance learning, allowing the exchange of knowledge with fellows from other cities (countries) and improving the intellectual potential of society. Also, special consideration should be given to the influence of external factors (legislation, resources, etc.) that affect the implementation of research activities in schools, especially in developing states like Kazakhstan, the subject of this paper.

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