Experimental work as one aspect of the environmental education activities for rural schools in Republic of Kazakhstan

Abstract. The experimental work is one of actual directions of modern ecological education modernization. Worldwide we can often see the modern comfortable and functional campuses and buildings that harmonize with the environment around. The Republic of Kazakhstan Government accepted new National project “Green Kazakhstan” which describes the creation favorable environment for the population, sustainable development, biological education and modernizing the ecological mind of population. The environmental education plays a special role in the practical activities in school, helps to form necessary competences for students they can use in their life. Every school in Kazakhstan has its own experimental site (plot) where teacher and students can realize different environmental experiments and observe the natural objects etc. Authors consider this method of work the most reasonable for ecological breeding, as well as these activities are one of the most interesting for students. Experimental work may serve as a specific indicator for the environmental education result.

1 Introduction

The environmental education in rural schools is one of the priority areas for solving the problems identified in the concept of transition to a “green economy” of the Republic of Kazakhstan. Leading direction to proceed to a “green economy” is preparation and advanced training for teaching staff [1-10]. The solution of modern problems of education, the interest of the student's personality in the process of obtaining knowledge wants the teacher to change the teaching and educational process in biology [2]. At the same time, the development of ecological knowledge of students based on a school experimental site is of great importance, which allows a more significant understanding and assimilation of general theoretical material and its use in certain conditions. These all create the conditions for students to realize their intellectual potential [1].

The references analysis determined that in Kazakhstan there is not much attention to the question of use the experimental site to form ecological knowledge for students. Although...
The ecological and practical development of natural courses is necessary for work on the experimental site. Inefficient processes of using classes in practice lead to the superficial formation of environmental knowledge among students. The education and breeding are bilateral process; its effect achieved by joint efforts of teachers and students. That is why the growth of students’ cognitive activities in a rural school, development of creative abilities determines important aspects in educational and breeding work with students. The students’ interest to any activity area, desire to learn about it closer should form among the education. The practical implementation of this provision requires the improvement of the content and methods of development of experimental work. The development of experience in rural schools should help implement the ideas of an integrated approach to the education of schoolchildren based on the moral, labor, physical, and environmental education of students. The implementation of environmental education should be aimed at a deeper understanding of the relationships in nature. Nowadays, the Great Britain, Finland, Austria collected their experience in forming capacity for ecological culture between students in educational organizations. They use this experience as a component of the quality system, development and adaptation of the work assessment quality in the field of environmental development.

In Republic of Moldova, Belarus there is a well-developed web of public ecological associations that are engaged in the dissemination and development of environmental education according to the “green school-green college-green university” model. In a number of European countries, including the Netherlands, Norway, Italy, Hungary, Sweden, Greece and others, there are associations that actively promote the idea of “green roofs” in the ecological direction.

The environmental aspect is becoming not only a priority, but also a system-forming factor in the education of humanity. It deserves special attention in the context of a scientific approach to solving modern problems associated with the violation of ecological balance, and in the context of the increasing pace of changes in material and spiritual life, the growing social role of the individual. Therefore, John Dewey, one of the most thinkers of the twentieth century, explored the principle of “learning by doing” in which theoretical material is given to students after they have tried their hand at practical activities. According to Dewey, the theoretical content of the subject should not be presented as dogma. He believed that the material of education is an incentive for further knowledge, and it should be connected with the personal experience of the student, be in “his world”, help the child solve any life issue. He found necessary the reflection of students, the development of their critical thinking, the ability to analyze reason and predict.

The task of each educational organization is to create an educational environment conducive to the harmonious formation and development of the student’s personality, combining national and universal values, able to demonstrate functional literacy and competitiveness in any life situation. When organizing experimental work, two conditions are most important: the activity must be varied, interesting, and feasible. Such an approach to the organization of experimental work will captivate students and give them the opportunity to convince in significance of their activities, introduce them to the range of topical problems, mobilize students’ knowledge for planning and organizing their research work, its high-quality implementation, and broaden their horizons.

Recently, an analysis of the work at the experimental sites of educational organizations has shown that in the process of teaching subjects of the natural science cycle, insufficient attention paid to the issue of using the base of experimental sites for the formation of students’ environmental knowledge. The educational and cognitive function of school’s
2 Materials and methods

Authors conducted the research on the base of secondary school of Michurino town, Pavlodar region, Republic of Kazakhstan. Experimental site has been working since 2020 year. Common area is 3 hectares. The apple trees (Malus) occupy area of 600 m$^2$. There are 40 young trees of them represented by three breeds. The cherry (Prunus subg. Cerasus) garden (36 samples) occupies area of 500 m$^2$, Amelanchier (30 samples) – 400 m$^2$. Separately different fruit trees and shrubs occupy area of 800 m$^2$; among them - apple (Malus), plum (Prunus), cherry (Prunus subg. Cerasus), black currant (Ribes nigrum), red currant (Ribes rubrum), raspberries (Rubus idaeus). Garden strawberries of the Festivalnaya variety, planted in 4 rows, occupies 2 acres. Vegetables part is located in the area of 6 acres. Each vegetable crop occupies area of 2 acres – tomato (Solanum lycopersicum), cucumber (Cucumis sativus), potato (Solanum tuberosum); onion occupies two small beds. Our experimental school created a special sector for 2,5 acres. There are irises (Iris germanica), peonies (Paeonia officinalis), marigold (Calendula officinalis), and petunias (Petunia hybrida) represented. Also 10 geranium plants (Geranium sylvaticum) were planted for the summer. The lawn with meadow grasses occupies 20 acres. There are such wood and shrub plants as maple (Acer circinatum), poplar (Populus nigra), oak (Quercus subg. Quercus), bird cherry (Prunus padus), elm (Ulmus ramosa) represented in the experimental site. Students of 5-7 classes in the age of 11-14 years old participated to the work in the experimental site, common quantity of students was 137 persons. The research has been conducted in 2021-2022 study period in the experimental site of this school.
Experimental and control group were identified, including in 5 classes - 24 people control and 22 people experiment, in 6 classes - 25 people control and 22 students experiment, in 7 classes the number of students in the control and experimental groups was, respectively 23 and 21 people.

In the control groups, biology lessons have been held in the classroom, according to traditional methods, without including work or sightseeing visits to the school site. For students of the experimental groups, part of the lessons in autumn and spring has been held at the school site - with excursion reviews, the study of plant care techniques and involvement in practical work (loosening the soil, watering, fertilizing).

To identify the quality of knowledge before and after the experiment, we offered to students written tasks in the form of tests, each of which contained 10 questions. In addition, students responded orally and in writing to questions, in response to which the completeness and awareness of the answer, effectiveness, and functional literacy has been assessed. Test, oral and written tasks compiled taking into account the school curriculum in natural science or biology in each parallel.

Some tasks included knowledge of the regional component, also required the demonstration of functional literacy when working with natural objects.

During the summer holidays, students of teenage classes were involved in experimental work in the vegetable and flower departments.

The sequence of the experimental work was as follows:
1. Object definition
2. Site selection and processing
3. Drawing up a rational scheme of experience
4. Thinking about the system of accompanying observations depending on the purpose of the experiment
5. Preparation of seed (planting material)
6. Bookmark experience in accordance with the developed scheme
7. Plant care, observation

During the summer holidays, a summer practice organized based on the Michurin School, where students performed experimental work at the experimental site. The main practical actions of students on the site were plant breeding, control over their growth and development. Students learned to record, collect factual material, analyze the results on a quantitative and qualitative level, compare the collected material and present the results of research (Table 1).

<table>
<thead>
<tr>
<th>№</th>
<th>Ways to study</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recognition</td>
<td>Analysis of phenological changes in cultivated plants</td>
</tr>
<tr>
<td>2</td>
<td>Visual</td>
<td>Показатель состояния посева, пришкольных участков</td>
</tr>
<tr>
<td>3</td>
<td>Comparative</td>
<td>Statistical preparation: evaluation of indicators from control and experimental plots.</td>
</tr>
<tr>
<td>4</td>
<td>Observing</td>
<td>Overview of plant morphologies</td>
</tr>
<tr>
<td>5</td>
<td>Systematics and classification</td>
<td>Ranking indicators, plants</td>
</tr>
<tr>
<td>6</td>
<td>Photography</td>
<td>Pictures of plants</td>
</tr>
<tr>
<td>7</td>
<td>Literature review</td>
<td>Information about living objects, a description of its characteristic features</td>
</tr>
</tbody>
</table>
| 8 | Yield Accounting Method | Commercialization, use of own
Experimental sites of educational institutions should have experimental plots and departments of plant biology necessary for classes in accordance with the program in the environmental direction. Work on the experimental site has been conducted not only in spring and in autumn, but also in summer; otherwise, the experiments laid down in the spring hasn’t been conducted to the end and lose all pedagogical meaning. It is necessary to follow the methodology for conducting experiments, which allows you to find out the influence of the studied factors on the development of plants, properly analyze and summarize the results of each experiment. It is recommended that a pilot site be established in all schools. In large cities, where some schools do not have the opportunity to allocate land for an experimental site, it is necessary to build greenhouses, or provide practice on experimental sites. In the content of summer recreational and educational work with children in each school, it is necessary to provide for experimental work on school sites, classes in associations of young naturalists. When planning the territory, it is necessary to provide for the following requirements:

- the possibility of organizing the correct crop rotation
- device "green class" for interviews and briefings;
- provide a storage room for inventory, a source of water.

In the process of conducting practical classes, a system activity approach is carried out in accordance with the requirements of the standard rules of education. Practical exercises on experimental sites should implement the following tasks:

- systematization of knowledge about objects of animate and inanimate nature, their relationships
- development of cognitive interests, intellectual and creative abilities of students;
- formation of skills related to the implementation of practical and laboratory work;
- education of a responsible and careful attitude to the environment, the formation of environmental thinking.

Students are involved in research activities, which is a condition for acquiring solid knowledge. Students have been assigned to each department. Each site had the required number of tools; a diary of observations drawn up (Table 2).

Table 2. Form of the observe diary.

<table>
<thead>
<tr>
<th>Date</th>
<th>Experiment name</th>
<th>Experiment aim</th>
<th>Experiment scheme</th>
<th>Site’s size</th>
<th>Plant specificity</th>
<th>Plant crop characteristics</th>
<th>Experiment schedule</th>
<th>Name of work, how to do it, deadline</th>
<th>Plant observations</th>
<th>Job evaluation</th>
</tr>
</thead>
</table>

It is expedient to make wider use of developing, research, student-centered, project and group pedagogical technologies in teaching. Expedient implementation of regional modules, which, depending on the educational and upbringing priorities existing in the region, ensure the activities of students in studying and preserving the nature of their native land, protecting and strengthening their health, observing and assessing the state of the environment.
Practical exercises in the experimental sites include demonstrations, observations, laboratory and practical work. Before starting experiments on the school experimental site, students should familiarize themselves with the requirements for experimental work: each experiment is set up on two plots - experimental and control. The sites have a homogeneous soil, a flat surface, the same size and shape. On the experimental site, the plants are thinned out, fertilized, but they do not do this on the control site. In both sites, soil cultivation, plant care, harvesting, etc. are identical and carried out at the same time; they have been laid in two surfaces; the theme, purpose of each experiment is clearly formulated and a plan for its implementation is outlined. On the plots of the experimental site, signs are placed with inscriptions: the theme of experience, culture, experience, control.

Setting up experiments on growing plants requires schoolchildren to show activity, curiosity, the ability to record the results of observations and make the right experiments. Its success and practical significance largely depend on the choice of the object of experiment. An important place in experimental work occupied by the choice of subjects for experiments in the school educational and experimental area.

The topics of experiments for students can be systematized into the following sections:
1. Soil and climatic conditions of plant life
2. Agricultural practices for growing cultivated plants
3. The effect of organic, mineral fertilizers, microfertilizers on increasing yields and improving product quality
4. Plants containing phytoncides as a means of protecting plants from insect pests.

The practical work carried out on the experimental site during the lessons is primarily of educational and cognitive significance. Students in the experimental plot must learn to observe the life of plants, the effect of the studied factors on experimental plants, be able to analyze experimental data and draw correct conclusions from them. However, at the same time, experiments should have an ecological and economic orientation, and become the basis, under appropriate conditions, for scientific generalizations.

3 Results and discussion

With a zero control, the quality of knowledge of students in the classes of each parallel, selected as experimental and control was equally low. The main reasons for poor knowledge are the lack of a relationship between theory and practice, the lack of a regional component in training according to the standard program, the lack of contact with nature, and often - insufficient participation in everyday service work. Based on the results of conversations with parents and the students themselves, we found that even in rural areas more than half of adolescents do not have any household chores, almost all cases are entrusted to parents, and often grandmothers, who take part in the upbringing of their grandchildren. Not everyone has a garden at home, and most students do not have a personal farm with livestock or poultry at home (for the reason that parents considered it unprofitable to keep a small number of animals, and many products can be bought inexpensively both in the city and in the village). As a result, there is no consolidation of natural science material in practice (both at home and at school).

Initially, work on the school site caused difficulties for many: many teenagers did not have elementary labor skills in caring for plants; they did not know how to use simple agricultural implements. Gradually, the students got involved in the work, became interested in growing plants, asking questions to classmates and teachers. Work on the school site acquired an emotionally positive connotation for everyone, and took it on with pleasure.
Based on the results of completing test tasks after a cycle of classes at the school site, it became obvious that the students of the experimental groups showed a higher quality of knowledge (Table 3).

Table 3. The results of the performance of individual work (test tasks) by students of experimental and control groups

<table>
<thead>
<tr>
<th>parallel</th>
<th>Students quantity</th>
<th>Students’ answers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Experiment</td>
</tr>
<tr>
<td></td>
<td>Students quantity</td>
<td>Students quantity</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>Correct</td>
<td>Incorrect</td>
</tr>
<tr>
<td>5 grade</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>34.8%</td>
<td>65.2%</td>
</tr>
<tr>
<td>6 grade</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>25.6%</td>
<td>81.3%</td>
</tr>
<tr>
<td>7 grade</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>21.5%</td>
<td>79.3%</td>
</tr>
</tbody>
</table>

Table 4. Comparative analysis of oral and written responses of students in control and experimental groups (by combined samples)

<table>
<thead>
<tr>
<th>Classes (combined groups)</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of works</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criteria for evaluating answers (in % of all received):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>completeness:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness, reasoning:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effectiveness, functional literacy:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Judging by the data in Table 4, the proportion of complete and reasoned answers to all the questions posed prevailed among the students of the experimental groups who were involved in work on the school site (Table 4).

The high level of functional literacy of the students of the experimental groups have been expressed in the fact that they knew well the requirements of each cultivated plant for moisture and fertilizers, were able to carry out plant care procedures, and knew the timing of flowering and fruiting, the main types of weeds, distinguished poisonous and harmless plants.

 Adolescents from the control groups knew only widely known crops, could not correctly name even common weeds, and did not distinguish poisonous plants from safe ones. Only a few students named Hyoscyamus niger and Datura stramonium among the poisonous plants (which were found in the village, but were absent at the school site).

In addition, teenagers from the experimental classes could correctly use the simplest meteorological instruments available on the site (weather vane, pluviometer (rain gauge), thermometer, barometer, and hygrometer).

Students from the control classes did not know how to handle these devices (although they should have learned about them in physics lessons).

When planning and organizing experiments, we proceeded from the real possibilities of the school district. The content of experimental work at school follows from the curriculum and supplemented depending on the interests of students, the tasks set by the organizers, on
The conditions of the soil, climatic zone and the characteristics of the local economy determine the possibilities of the school for choosing topics for experimental work. The volume of research work is great, and it can be done in a rural school only with the participation of each student. Most of these assignments are done outside school hours and considered as extracurricular activities.

An important task is to familiarize schoolchildren with cultivated plants and agricultural processes. To do this, collections of various cultivated plants grown on the site and experiments to increase productivity, to identify optimal growing conditions. In addition, when working on the experimental site, natural objects in combination with artistic illustration prevailed (Fig. 1).

Fig. 1. Practical work at the experimental site.

Due to age characteristics, students perceived material with bright visual objects much more effectively, there were positive changes in the minds of children and adolescents, and the level of the general culture of children increased; the experience of joint work on the preparation and action of a possible useful work on their own has been formed.

The lessons conducted on the experimental site have their own characteristics and reflect a certain relationship of live visibility for practical work. The experimental site should have, first, cognitive and educational value. Therefore, the entire teaching and student staff of the rural school should be involved in the organization of the site and the formulation of work on it. Careful consideration is necessary to know how to use the site, how much space is needed for each of its plot and each culture in the plot, where are located training and support facilities. A thematic plan for experimental work on the site is drawn up, placement of experimental plots for work in classes and for a circle of
young naturalists, a work schedule for students in the summer, the need for inventory, seeds and planting material, and fertilizers.

At the experimental site, rural schools conduct lessons and excursions in the natural sciences. In addition, extracurricular activities, youth, environmental and experimental work carried out here.

The results of the experiments and growing a collection of plants during the autumn, spring and summer used to prepare demonstration and handout materials for lessons, laboratory work and circles of young naturalists.

School-wide extra-curricular activities, exhibitions, and excursions organized at the site.

Such a multilateral use of the experimental plot requires an appropriate selection and location of plantings and plantings.

In this regard, sectors and plots, greenhouses and a greenhouse defined in the structure of the school site.

In the course of the work, interest was aimed now of creating concepts in the formation of environmental knowledge, skills and abilities of schoolchildren.

To do this, we have extracted methods and methodological systems that provide opportunities for the content of classes on the site and allow the development, disclosure and generalization of concepts.

When conducting classes at the experimental site, we used a complex of different teaching methods (conversation, explanation, demonstration of the experiment, natural observation, identification and identification of objects).

This is the formation of the foundations of knowledge about the modern natural-science picture of the world and methods, mastering the ability to apply the knowledge gained, the development of creative, intellectual abilities and critical thinking for research, the development of application skills in everyday life.

The given experimental data showed that the best ways to master ecological knowledge and practical skills when working with soil, sowing seeds, caring for plants and harvesting the resulting crop provided only by practical work on the school site.

From the work done, we see that the formation of environmental knowledge on the basis of a school experimental site proceeds more successfully with the introduction of a methodology that provides:

1) The use of natural objects of the experimental site, as well as the results of the experiments;
2) The use of a certain set of methods and techniques for the development of intellectual activity of students;
3) Application of the proposed methodology for the implementation of the school curriculum in the experimental site;
4) Application of acquired knowledge in practice, using the experimental site of the school.

On our site, we have not conducted large-scale experimental work yet. In 2020, an orchard planted, during the growing season of 2021 and 2022, Fragaria ananassa, as well as fruit and berry bushes, gave their first harvest. The apple trees (Malus) still they bear fruit because the time has not come yet.

In the vegetable plot, the first planting carried out in 2021, but, unfortunately, a significant part of the bushes died due to fertilization with uncomposted manure. Irises (Iris germanica), peonies (Paeonia officinalis), marigold (Calendula officinalis), and petunias (Petunia hybrida) has not required specific occur and growth well in the flower and decorative plot.

The lawn maintained in its original state by the presence of turf, which prevents the development of many weeds characteristic of plowed soil.

Proper organization of various activities in the experimental area of a rural school contributes to:
- improvement of environmental knowledge and skills for their application in practice;
- the formation of skills and abilities for growing cultivated plants;
- development of knowledge and skills in experimenting with plants and animals;

E3S Web of Conferences 413, 03036 (2023)
https://doi.org/10.1051/e3sconf/202341303036
INTERAGROMASH 2023
improving the ability to observe natural phenomena, establish phenological phases, describe them, record observations, compare experimental and control objects, formulate evidence-based conclusions; the formation and improvement of skills to use devices for fixing weather phenomena and the condition of plants.

When organizing experimental work, two conditions are most important: the work of students must be varied, interesting and feasible; schoolchildren must solve at the same time solve specific production problems. This will captivate students and give them the opportunity to convince in the significance of their activities, introduce them to the range of topical problems, and broaden their horizons. Doing what they love, our students have the opportunity to show great activity and independence, all experimental activities correspond to age characteristics.

The experimental activities aimed at creating a developing environment that promotes the growth of creative potential, the formation of readiness for social actions of the entire school staff. The development of the school team should base on the close interaction of students, teachers and parents in an open socio-cultural environment.

The formulated content of observations and experiments favors the development of ecological knowledge of students; the effectiveness of assimilation of the material improves when using the base of the experimental site. Among the research, we found out the practical and laboratory activities we should hold in two directions – abiotic and biotic factors learning and learning the definite changes. These activities in the experimental site help students to obtain accurate, informed environmental knowledge. It is necessary to apply practical work on the site in course with the assimilation of students' understanding of experience, as well as certain observations that open up opportunities for the successful formation of biological and environmental concepts and their use in practice.

4 Conclusion

Conducting classes at the school site and participating in experimental work showed that direct practical activity contributes to the improvement of subject knowledge, functional literacy, and the introduction of a regional component into the educational process. Among the students of the experimental groups, who were involved in work on the school site, the proportion of correct answers to questions from the school curriculum was 1.7-2 times higher than that of adolescents from the control groups. When analyzing oral and written answers to questions, students from the experimental groups noted the completeness, reasoning, validity of answers, knowledge of regional natural objects, and correct behavior in the natural environment.

Thus, because of the work done, we concluded that the use of the experimental site is one of the effective methods of environmental education. At the same time, there is an active and productive research activity of students throughout the entire period of implementation of the activity. It contributes to the formation of a new generation of skills in the communicative intellectual process in the student, forms a personality ready for joint creative activity, with self-learning experience. The motivation of students increases, they have the opportunity to control their own activities, there is an increase in learning motivation. All this contributes to the development of skills of individual, creative activity, creates conditions for the assimilation of the material, as a result, interest in the subject increases and remains.

5 Acknowledgements
References


10. Sh. S. Khamzina, M. S. Kadyrova, B. K. Zhumabekova, Neformal’noe ekologicheskoe obrazovaniye v Respublike Kazakhstan na puti k “zelenoy ekonomike”, Mezhdunarodny zhurnal experimental’nogo obrazovaniya, 3(2) (2016)