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Original illustrated tasks with photos of regional plants for botany knowledge control and consolidation

Mikhail Klimenko[1], Nataliya Tarasovskaya[2], Sholpan Hamzina[3], Bulat Zhumadilov[4], Bibigul Zhumabekova[5]
[1]Higher School of Natural Sciences, Alkey Margulan Pavlodar Pedagogical University, Pavlodar, Kazakhstan
[2]Biology Education program, Higher School of Natural Sciences, Alkey Margulan Pavlodar Pedagogical University, Pavlodar, Kazakhstan
[3]Higher School of Pedagogy, Alkey Margulan Pavlodar Pedagogical University, Pavlodar, Kazakhstan
[4]Chair of Ecology, Faculty of Forestry, Wildlife and Environment, Saken Seifullin Kazakh Agro Technical University, Astana, Kazakhstan
[5]Scientific Centre for Biocenology and Ecological Research, Alkey Margulan Pavlodar Pedagogical University, Pavlodar, Kazakhstan

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ABSTRACT

This article addresses one of the current issues in education: the use of resources in biological disciplines classes that are required for students to develop meta-subject competencies. The incorporation of natural objects into educational content can create a favorable environment for teaching biology classes and assist students in developing necessary knowledge about regional flora. The authors created a set of integrated plant tasks that require knowledge of ecology, plant physiology, and evolution. The main goal of tasks is to learn about regional plant species and to control what students have learned. Certain activities are specifically created for hands-on engagement with nearby natural entities to determine their taxonomic classification, morphological characteristics, and adaptations. This approach, according to the authors, ensures productivity in biology teaching.

Corresponding Author:

Mikhail Klimenko
Higher School of Natural Sciences, Alkey Margulan Pavlodar Pedagogical University
Olzhabay Batyr Street, 60, Pavlodar, 140002, Republic of Kazakhstan
Email: klimenkomy@ppu.edu.kz

1. INTRODUCTION

In the contemporary era characterized by the pervasive presence of digital technology and screens in educational settings, the study of botany and plant life may seem disconnected or incongruous [1]. Academic Institutions worldwide are seeing several difficulties in sustaining student engagement in various disciplines of industrial science due to the widespread use of digital materials and online courses [2]. Researchers and educators are continually exploring new methods to evaluate and improve knowledge of plants, acknowledging the importance of developing a thorough understanding of local plant species.

Nevertheless, there are challenges in endeavoring to enhance the educational milieu for kids. Conventional teaching methods, which rely heavily on textual resources from textbooks and slide presentations, may not consistently inspire students with a strong desire to study botany [3]. This strategy may not consistently facilitate individuals' comprehension of the variety and distinctiveness of plant species thriving within their local area. In this study, we examined a novel approach to problem-solving in education, using creative illustrated activities with images of regional plants [4]. This pedagogical solution aims to provide students with a hands-on opportunity to investigate and acquire information about local plants, so facilitating a deeper understanding of the field of botany. This approach serves to both foster interest in the field of plant science and contribute to the preservation and promotion of diverse regional flora. Such efforts hold significant value in the contemporary world, which is actively seeking sustainable solutions in the realms of ecology and environmental management [5].

Authors consider that to manage and consolidate knowledge of taxonomy, illustrated activities with images of regional flora are an effective and entertaining learning tool. This enables students to learn visually, through image perception and analysis, in a more interesting and memorable way than merely reading text or listening to lectures [6], [7]. Students can learn in their own area while exercising their visual perception skills by employing illustrated tasks with images of regional plants. This aids their understanding and retention of facts about various plants and taxonomy [8]. Furthermore, utilising images of regional plants in assignments allows students to become acquainted with real plant specimens, which aids in the development of observation and analysis abilities [9]. They can research plant structure, appearance, and response to varied environmental situations [10], [11].

Illustrated exercises also encourage students' active participation in the learning process [12]. They can autonomously analyse photos, highlight plant traits, identify them, and compare them to other species [13]. This enables individuals to improve their critical thinking, analytical, and comparative abilities [14], [15]. The use of illustrated assignments with photos might also be beneficial for consolidating taxonomic information [16]. Students can consolidate their knowledge and confidence in identifying and classifying different plant species by revisiting images of regional flora and completing homework based on them [17]. They can submit their answers and compare them to the samples provided, allowing them to evaluate their abilities and remedy errors [18].

The use of plant photos in assignments can help students acquire an aesthetic sensibility for and interest in nature [19]. They can learn about the diversity of their region's flora, its distinctive features, and the importance of protecting ecosystems [20]. This will motivate students to learn more about wildlife and its conservation [21].

When employing illustrated assignments with images of regional natural objects, however, it is vital to consider the variability of student training levels [22]. Because some students may have poor knowledge of taxonomy or local plants, tasks must be tailored to each level [23]. Students will be able to get the most out of this teaching style and broaden their understanding of plant taxonomy as a result [24].

2. METHOD

The authors created training assignments for the control and consolidation of knowledge in plant systematics in the form of tests, with the requirement to select or exclude an item (or objects) - in connection with belonging to a specific taxon [25]. The tests included original images of local plants acquired during field practice, as well as living and herbarium specimens of plant objects. After finishing the courses in plant morphology and taxonomy (offered at the Alkey Margulan Pedagogical University as part of the subject "Structure and functions of living organisms"), the compiled tasks were approved during field practice [26]. Students of Biology participated in two groups of 50 persons each, totally 100 responders. The mentioned quantity of participants is often regarded as the most suitable for the computation of statistical information [27]. The sample size also depended on the overall population of biology students within the research region.

In order to examine the potential impact of variables pertaining to students' individual resources and learning environments on score improvements, we gathered data on factors such as course organization (considering the occurrence or non-occurrence of deviations, the quantity of concurrent courses, and the instructors participating). The control activities followed a prescribed procedure in which students were required to identify and list as many different types of regional medicinal and beneficial plants as they could. The selection of students has not been conducted with any conscious criteria, particularly with regard to their place of residence, because the university admits students from many parts of the country. A second survey was done using identical methodologies to the previous iteration, subsequent to a series of virtual tours.

In the course of data processing, we allocated a set of named items to each participant and then calculated the appropriate quantitative score. Statistical techniques were used to analyze the quantitative outcomes of each group. Meanwhile, the mean and standard error were computed to facilitate data comparison via use of the student’s t-test.

The present research was conducted in accordance with the ethical norms delineated in the Ethics Codex for Education Researchers of Kazakhstan [28]. During a pre-research meeting held inside an educational organization, the authors properly apprised the parents and instructors of the students on the objectives and methodology of the impending study. The assurance of confidentiality and voluntary involvement was provided to students, parents, and instructors. Moreover, consent was acquired from both the pupils and their parents and instructors. Upon the conclusion of the endeavor, it was unanimously decided by all student groups to grant the researchers permission to retain their written works.

To create a psychologically safe and comfortable setting during knowledge control, it was proposed to do tasks individually and in groups, with the outcomes recorded in the observation log, but without lowering students' courses [29], [30]. Corrective actions were implemented using group approaches, such as the organization of trips and supplementary laboratory classes of business games, the content of which will be explained further [5]. At the same time, students expressed their impressions (reflection) with classmates and the teacher, both vocally and in writing, without assigning any assessment points [31], [32].

3. RESULTS AND DISCUSSION

3.1. Illustrated test task No. 1

Its essence is the requirement to eliminate one of the four plants that are not members of the named family. The task includes illustrations – photographs of these plants – that assist students in orienting themselves in morphology. Figure 1 shows the summary of the questions from this task (without illustrations to save space), as well as an analysis of the common mistakes students made in each task.

1. Which of the following plants does not belong to the *Scrophulariaceae*?

Linaria vulgaris

Gratiola officinalis

Verbascum uva-ursi

Stachys palustris

Explanation: *Stachys palustris*, a member of the *Lamiaceae* (with a tetrahedral stem), is not among the *Scrophulariaceae*.

Typical mistakes: 54% of students figured out the *Verbascum uva-ursi* because its flowers are actinomorphic rather than zygomorphic. Around 40% of students focused on the tetrahedral stem, which is typical of *Lamiaceae*.

Figure 1. Determination of *Scrophulariaceae*

3.2. Illustrated test task No. 2

With their photographic images, students are given the names of several plants. The trainees' task is to determine whether all of the plants depicted belong to the named systematic or ecological-morphological group. This task forbids the mechanical exclusion of a certain number of extra objects. Although all of the named plants may belong to the same family, one, two, or even three plants may be unnecessary. In this case, you must justify your choice by providing appropriate explanations on the task form. We provide brief summaries of the expected correct answers, as well as an examination of common errors made by students while completing the task, as seen in Figure 2.

3.3. Illustrated test task No. 3

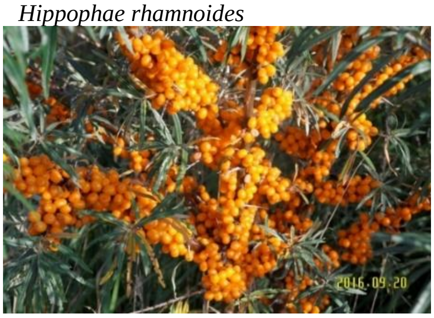
In this section, the students must name the family to which the plants belong based on their names and images. In this case, all named plants belong to the same family. Therefore, we have obtained further findings as seen in Figure 3.

2. *Rosaceae*?

Rubus caesias

Lonicera tatarica

Hippophae rhamnoides



Amygdalus nana

Cerasus vulgaris

Padus racemose

Explanation: *Lonicera tatarica (Caprifoliaceae)* and *Hippophae rhamnoides (Elaeagnaceae)* are not members of the *Rosaceae*.

Typical mistakes: Up to 30% excluded burnet, which has a dense capitate inflorescence, which is unusual for Rosaceae. 8% excluded blackberries, 14% excluded almonds (mistaking a fruiting willow for a flowering willow). At the same time, 43% of respondents did not rule out honeysuckle and sea buckthorn as *Rosaceae* relatives.

Figure 2. Determination of *Rosaceae*

1. *Betulaceae?*

Alnus glutinosa

Betula pendula

Family	*Betulaceae*

Typical mistakes: 6% of respondents did not identify the family at all, and 4% identified these plants as belonging to *Salicaceae*.

Figure 3. Determination of *Betulaceae*

3.4. Examination of the application of the original illustrated tasks

The first phase of the investigation included examining the questionnaires completed by the students. The findings revealed that a significant proportion of students lacked practical knowledge about the utilization of plants. A comparative analysis of all completed plant systematics tasks using regional illustrated and natural material revealed the following major gaps in students' knowledge. The test tasks revealed a lack of knowledge of background species of regional plants found in everyday life. The students recognized plants found in school and University textbooks, popular scientific literature, and medicinal plant literature (*Taraxacum officinale*, *Capsella*, *Plantago*, *Glycyrrhiza*, *Tussilago, Humulus, Cannabis, Urtica*). Common trees and shrubs (*Betula, Acer, Populus nigra, Populus tremula, Ulmus parvifolia, Syringa, Rosa*) were fairly well identified, as were some weeds (*Atriplex, Chenopodium, Cyclachaena*) and poisonous (*Hyoscyamus, Datura, Convallaria*) plants. Plenty of individuals were aware of the economic significance of these plants [33], [34]. Nonetheless, students of Natural Sciences faculty were unable to identify dozens of species of regional plants found in the city and region.

It was also discovered that while the students were aware of the plant's name (from educational and popular science literature), they attributed it to a completely different species [34], [35]. Often, determining the species status of a plant using dubious electronic sources resulted in an incorrect determination and, as a result, the storage of false information in the memory. Inadequate knowledge of the generative organs of various plant taxa, such as the typical structure of a flower and the characteristics of fruits and seeds, was also revealed. As a result of certain external similarities, the students mistook completely taxonomically distant plants for related forms. The majority of plant morphology and taxonomy students had a superficial understanding of the characteristics of vegetative organs and structures unique to certain families, orders, and classes [36], [37]. This made identifying plants even more difficult and corrected incorrect results of independent work in memory.

Many students' ignorance of the economic importance of plants reflected their low level of functional literacy and the relationship between theory and practice. Throughout the course of the semester, students engaged in the examination and analysis of regional flora, focusing on the fields of plant taxonomy and morphology. This was facilitated via the utilisation of various educational resources, such as illustrated atlases, workbooks, and manuals that were specifically designed and produced by the authors for this purpose [9], [38]. The students were instructed in the identification of indigenous plants, specifically in discerning their respective family and species. The authors believe that pictures play an active role in this phenomenon, since visual teaching materials enhance information perception and aid in memory retention [6]. Following the conclusion of the task, students were requested to participate in a survey as part of the formative phase.

It is important to acknowledge that there was a marginal increase in the quantity of plant species that students noticed in their natural surroundings or in another natural setting subsequent to the formative phase of the experiment. Following their introduction to plant morphology via a virtual tour, the adolescents acquired the ability to visually identify plants, establish connections between their visual representations and corresponding names, and then endeavored to locate certain species within urban and rural environments. Nevertheless, it is important to acknowledge that not all pupils have access to dachas or the countryside. Additionally, in urban areas, particularly in certain micro districts, there is a restricted variety of plant species, mostly consisting of ruderal flora. Several students who had the privilege of travelling outside the Pavlodar area reported seeing several species of flora in other regions of Kazakhstan. The species that students have often encountered in theoretical contexts are typically wild plants that are not found in urban environments, but rather in steppe or floodplain habitats. Examples of such species are *Thymus vulgaris*, *Origanum vulgare*, and *Bidens tripartita*.

Within the category of tree and shrub plants, the students identified many species that were not encountered during their study. These species, including *Hippophae rhamnoides, Elaeagnus angustifolia, Tilia europaea, Prunus padus, Rubus* subgen, and *Crataegus oxyacantha*, are not known to thrive in urban environments. Nevertheless, inexplicably, the trees that students often misidentified as *Acer negundo* and *Ulmus parvifolia* were not really present in their surroundings. There are two potential factors contributing to this phenomenon: the disparate distribution of trees and bushes throughout several districts within the area, and the idiosyncrasies of students' attention, which tend to overlook simple and commonplace items. According to a well-recognized concept in the field of psychology, object perception involves the perceptual segregation of a picture into distinct components, namely an object and its corresponding backdrop [10]. It has been shown that students tend to see ordinary and common trees, often found in big clusters, as background elements rather than objects of focus.

Acer negundo is a prevalent tree species found in Pavlodar region. This species has a wide distribution and is capable of self-seeding and thriving in many environmental circumstances. For reasons that are not yet fully understood, students of all age groups have challenges while attempting to identify this particular type of plant. During field surveys conducted in urban and rural areas, several students misidentified *Acer negundo* as *Quercus robur*. The tree known as *Ulmus parvifolia*, referred to as "karagach" in Kazakh, derives its name from the Turkic term "black tree." While this nomenclature is widely recognized, it seems that not all people associate this term with the actual physical characteristics of the tree. The term "this plant" encompasses many species that are extensively used in the field of landscaping, serving purposes such as the establishment of forest belts and the delineation of borders. Frequently, within the Pavlodar region of Kazakhstan, people engage in the practice of pruning these plants, resulting in the formation of a crown. In some areas of the region, *Ulmus parvifolia* exhibits growth patterns like those of huge trees, attaining their inherent dimensions. The lack of clear distinction between natural and cut trees hindered the ability of students to identify the species of the tree, making it unrecognizable.

According to several accounts, *Salix alba* was believed to be absent in natural environments among a subset of students. In the context of floodplain ecosystems and urban landscaping, it is worth noting that several forms of it serve as the fundamental components. In the context of students, the experimental phase included activities of diverse levels of difficulty. The activities associated with the second and third levels of difficulty included the examination of herbaceous and tree-shrub plants, which are very uncommon in the region and are mostly identifiable by field specialists. As expected, the students demonstrated little knowledge of most of these plants, only based on their own experiences, and were unable to make any cognitive associations with the pictures supplied. We would like to emphasize the significance of the university location in acquainting students with indigenous natural entities, such as flora. For instance, the students at the university site saw several woody, ornamental, and weed plants that were widely recognized, as indicated in the questionnaires.

The research revealed a favorable impact of the instructional approach recommended on academic achievement, regardless of the varied degrees of implementation of field excursions. Photo excursions may be seen as educational settings that provide experiential learning opportunities [12], [15], [31]. Here, the student has the chance to gain firsthand experiences under guidance, namely by observing a plant species and its variety within the same species in its natural environment.

The results increases were greatly influenced by the learning environment characteristics. The primary factor that positively influenced score improvement was the inclusion of field visits as part of the course curriculum. Students who participated in courses that included field trips achieved higher scores, while students in classes without field trips had lower levels of achievement. The study curriculum and the course teacher both have substantial impact on the students' performance. The size of the research group also had an impact on the outcomes. We observed a detrimental correlation between group size and learning performance, indicating that smaller groups exhibited superior learning outcomes.

An instructional benefit of photo excursions encounters throughout the learning process is that learners possess diverse methods of seeing and assimilating novel information. Instructors may include students in the examination of plants and taxonomy by showcasing how this information is practically used in conventional activities and socioeconomic circumstances [1], [30]. Gaining a more profound understanding of a species' biology, including its interactions with other species, its method of pollination, or its geographical distribution, might assist in assembling broken fragments of knowledge. Furthermore, the acquisition of learning strategies enhances students' understanding of the significance of the subject matter and their level of personal engagement, such as in comprehending biodiversity concerns and assuming responsibility for conservation endeavors. Engaging in photo excursions and outdoor projects has much promise for enhancing student learning outcomes [2].

However, in the future, when studying at a university, other potential elements might affect students' learning outcomes. One factor is the quantity of groupings. Frequently, one might see the presence of large assemblages consisting of 20-30 individuals, whereby it may prove challenging to provide individualized attention to each learner. This may impede comprehension of the information and result in a decline in the educational standard [39]. We propose the implementation of smaller learning cohorts to provide frequent feedback and validation from the instructor of the course. This method facilitates the early detection of misconceptions, allowing learners to internalize the right concepts more efficiently. In order to enrich the education of professionals, institutions should augment the study program curriculum by including diverse courses on advanced subjects. This will enhance students' engagement in species identification and mastery. A further constraining element is the quality of the instructional content. While several publications provide a broad overview and examine biological entities from various regions worldwide, they fail to emphasize the regional aspect [5], [27]. In order to improve the education of professionals, universities should augment the study programs by including supplementary courses on advanced topics. This will enhance students' engagement in species identification and proficiency. Students may enhance their comprehension and proficiency in plant identification via independent study. Implementing a teaching method that integrates self-study assignments, such as the obligatory production of an herbarium for evaluation, would enhance student engagement and comprehension of the subject matter. To enhance these phases of independent learning, it is possible to provide students with suggestions and comments from instructors who possess at least a moderate degree of identification abilities [3], [4].

Regular educational activities will serve as a catalyst for students to actively engage and retain their information. Furthermore, guided excursions provide pupils with a multitude of firsthand encounters. Having instructors in botany with significant knowledge and outstanding teaching abilities is crucial, just like in any other educational discipline, for effective identification sessions. Universities should aggressively promote and incentivize course instructors who possess deep expertise in botany and exceptional teaching abilities [40]. By using alternate pedagogical approaches, such as arranging supplementary field trips for botanical identification lessons, educators may enhance the efficacy of their instruction and broaden the scope of students' acquired knowledge. The next wave of biologists will only be able to determine species for ecology or preservation study, as well as categorize and characterize plants as novel scientific species, if this combination is provided.

4. CONCLUSION

We concluded the following from the study. Fieldwork is best for controlling and consolidating botany plant systematics knowledge. For plant systematics tests, illustrated botany exams problems with object selection and spoken explanations are excellent. Implementation reveals the depth and quality of knowledge (the structure of each family's generative and vegetative organs), geographic objects, and functional literacy (plants' ecological and economic importance). Additional practical activities and iterative learning techniques under a skilled course facilitator will improve the learned information to achieve accurate and reliable plant identification. Small study groups may allow for more frequent feedback and tighter course instructor scrutiny. The early discovery of misunderstandings in these cohorts will also improve students' comprehension. Universities should provide a variety of advanced courses to improve professional education. This campaign encourages kids to identify and study species.

Students may improve their plant identification abilities via self-directed learning. An instructional strategy that includes self-directed learning tasks, such as completing an herbarium before assessment, may increase students' intrinsic motivation to study more deeply. Instructors that are skilled in identification may guide and provide feedback throughout self-learning periods. Regular instructional field excursions may boost student engagement and retention. Field trips also provide students’ hands-on experience. Universities should apply the suggested method to monitor and consolidate botany and related knowledge. It is believed that this strategy may improve learning outcomes and increase knowledge intake. The next generation of scientists and biology educators will be able to classify and describe botanical creatures and identify species for ecological or conservation research.

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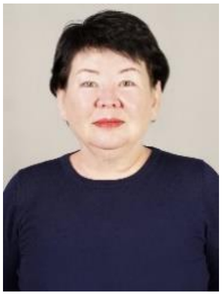
BIOGRAPHIES OF AUTHORS

Mikhail Klimenko is PhD student at Higher School of Natural Sciences, Alkey Margulan Pavlodar Pedagogical University, Republic of Kazakhstan, Pavlodar. His research focuses on biology, biology education, STEM education, botany, plants physiology, evolution and ecology. He can be contacted at email: klimenkomy@ppu.edu.kz.

Nataliya Tarasovskaya is Doctor of Biological Sciences, Professor, Higher School of Natural Sciences at Alkey Margulan Pavlodar Pedagogical University, Republic of Kazakhstan, Pavlodar. Her research focuses on biology, biology education, STEM education, genetics, evolution of biosphere, life sciences, Earth sciences. She can be contacted at email: tarasovskaja_n_e@ppu.edu.kz.



Sholpan Hamzina is Candidate of Pedagogical Sciences, Professor of the Higher School of Pedagogy at Alkey Margulan Pavlodar Pedagogical University. She is author of more than 120 scientific and methodological publications. She is a member of the Dissertation Council 8B015 for awarding the degree of Doctor of PhD in the direction 6 D011300 Biology "Teacher training in natural science disciplines" of the Korkyt Ata Kyzylorda State University. Research interests - environmental education, ecology, nature management, environmental protection. She can be contacted at email: khamzinashsh@pspu.kz.

Bulat Zhumadilov is professor candidate of biological sciences at Department of Ecology, Faculty of Forestry, Wildlife and Environment, Saken Seifullin Kazakh Agrarian University, Republic of Kazakhstan, Astana. His research focuses on biology, biology education, forestry, forest ecology. He can be contacted at email: zb.zhumadilov@kazatu.edu.kz.

Bibigul Zhumabekova is Doctor of Biological Sciences, Professor of the Higher School of Natural Sciences at Alkey Margulan Pavlodar Pedagogical University. She is author of more than 100 publications in the educational and methodological areas. She is editor-in-chief of the scientific journal "Biological Sciences of Kazakhstan". She is also chairman of the dissertation council at the Alkey Margulan Pavlodar Pedagogical University in the specialty - Training of teachers in natural sciences: Biology. The area of scientific interests is the methodology of teaching biological disciplines, multilingual education, environmental education. She can be contacted at email: zhumabekovabk@pspu.kz.