

## DEVELOPMENT OF TEACHING METHODOLOGIES IN THE FIELD OF BIOLOGY

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**Abstract.** *The article considers the some aspects of development of teaching methodologies in the field of biology. The article gives a brief analysis of the history of the first methodologies by teaching biology. A professor from the Daugavpils University, Leonīds Keirāns, was the first to write a book on the structure of teaching methodology. The main innovation in the Keirāns book was a precise analysis of the structure of various methodologies.*

**Key words:** *teaching methodologies, teaching biology, development of methodologies, natural science education.*

The first methodology for teaching the natural sciences was written between 1832 and 1851 by **August Lüben** (1804–1873)<sup>1</sup>, a teacher in Bremen, Germany, who, along with the prominent Czech educator **Komenski** (1592–1670), felt that in teaching the natural sciences, one must move from the simple to the complex, from the unknown to the known and from the concrete to the abstract. In other words, Lüben was a promoter of the inductive method.

Lüben's methodology mandates that special attention must be devoted to ascertaining that students learn about various plant of forms. Students must learn about plant life, about the substances and forces that specify the processes of life and the variety of plant forms. Lüben felt that the study of botany allows students to develop all of their senses, especially sight, to exercise their ability to think properly, to discover sensitivity toward the beauty of nature and beauty overall, "to awaken a yearning to conduct research and act independently."

"The natural sciences are based on comparison, in other words, we learn about this or that form of nature only by comparing it to other, similar forms."

Lüben recommended the following activities:

- Study of domestic and foreign plants which are interesting because of their form or their beauty;
- Study of naturally occurring groups of plants in order to help students discover the overall homogeneity of nature – an entity which Lüben considered to be a single, large system that includes both living and non-living nature;
- Study of the internal structure of plants in order to explain the physiological processes of plants;
- Study of the dependence of plant structure and existence on climate, as well as of the distribution of fauna across the globe.

Lüben proposed that all of this materials be covered in four courses to be held during the summer:

During the **first course**, students must learn about specific blooming plants, their morphology, etc.;

During the **second course**, students compare various blooming plants and learn about the units which underpin them – the phylum and the genus;

During the **third course**, students learn about the main species of plants and the systematics of the plant kingdom. During this course students also are introduced to spore plants;

During the **fourth course**, students learn about the anatomy and physiology of plants (Lüben recommended the use of a microscope for this purpose).

Lüben felt that all studies of the natural sciences must begin with botany because plants are simpler in terms of their construction than are animals. Students must first learn about blooming plants, and only then about spore plants (a regressive structuring of the study material). These views were expressed most clearly in a book which Lüben published in 1841.

We find similar thinking in the work of Komenski, although he expressed the same thoughts in more generalized terms. Lüben, by contrast, took overall principles and elaborated them in great detail, showing in his books the ways in which the various techniques could be used in science lessons. Lüben can be considered the true father of teaching methodology in the area of natural sciences.

Still, these very valuable methodical conclusions did not really correspond to the topic which was covered in Lüben's books. They contained only systematics with a very lengthy list of the morphological signs of various plants (he described 990 plants from 136 species). A similar list was provided in explaining zoology.

The shortcoming to Lüben's methodology is the fact that he overemphasized morphology and systematics. The fact is that describing and comparing plants on the basis of a single model is a dry and boring process. Still, Lüben was very influential among methodologists and textbook authors of his day; many people sought to emulate his methods in various ways.

The first book on the methodology of natural sciences in Russia was published in the early 20<sup>th</sup> century, when new schools were being established and society was engaged in a detailed consideration of school plans and programs. The process of school reform attracted the attention of students and educators in terms of problems associated with teaching the natural sciences. In December 1901, the 11<sup>th</sup> congress of Russian natural scientists and physicians was held in St. Petersburg, and botany professor **Valerian Polovcser** (1862–1919) spoke on the topic "The mission of teaching subjects in high schools". He asked: "Why should the natural sciences be taught?", answering that study of the natural sciences is of great importance in a student's upbringing. He listed:

- An understanding of the phenomena of the external world;
- An understanding of one's own organism;
- Development of the senses, because those are the most important factors in determining our psychic development;
- Expansion and creative development of thinking methods;
- Expansion of the volume of one's spiritual needs and, by extension, the moral personality of the student.

All this, said Polovcser, can be provided by the natural sciences, but only if one condition is met: the teacher must first learn all of the necessary skills, and thereafter the teacher must always remember why he or she is teaching and what goals he or she wants to achieve in the school.

Polovcser devoted particular attention to the development of a "biological method" that was based on three principles:

- Form must be studied in terms of its relation to function;
- Lifestyles must be studied in conjunction with the surrounding environment;
- The most important subject matter must be taught at school: "Of a very large number of organisms, one must look at those which offer a wealth of biological materials, i.e., ones which are good representatives of biological types".

At one time this principle was known as the "type method". In essence, the "biological method" and the "type method" are principles for choosing and explaining study materials, not methods for teaching. The biological approach to researching organisms, which was defended by Polovcser, was similar to the discussion of ecological matters in biology classes today. It should be added that Polovcser was to a certain extent influenced by the ideas of Friedrich Jung, and he rejected the idealistic approach to organic usefulness that was propagated by Otto Schmeil.

There is full justification in believing that Polovcser was the greatest specialist in the methodology of biology in the early 20<sup>th</sup> century, and his work greatly influenced the initial development of natural science methodologies in Latvia.

One hundred years after Lüben published his methodology, the first natural sciences methodology was published in Latvia<sup>3</sup>. Published in 1931, the book was authored by eight of the most prominent teachers of that time:

- **Jānis Ģirupnieks** (1887–1964) was an outstanding educator and regional researcher who in 1919 became the director of the Institute of Teaching Resources. From 1921–1929 he worked as a physics teacher at the Jelgava No. 2 high school. Then, until 1934, he worked at the Rīga city technicum and trade school. He also worked at the University of Latvia and elsewhere.
- **Jānis Grete** (1876–1951), a prominent educator, literature specialist and cultural activist. He worked as a teacher in Valmiera, Rīga, Jēkabpils and Jelgava. He was also an instructor at the State Central Pedagogical Institute in Jelgava, as well as an employee at the Institute of Geology and Geography of the Latvian Academy of Sciences.
- **Zelmars Lancmanis** (1883–1935), educator, regional researcher, geologist. He worked as a teacher in various schools in the Vidzeme region of Latvia, but in 1911 he opened a private school in Lejasciems, where he worked until 1915. Later he worked as an elementary school principal in Rīga and Strazdumuiža. Lancmanis was one of the first Latvian educators to attempt to bring regional research and studies of one's native land into the teaching curriculum. In 1921 he wrote a textbook on the methodology of studying one's region. He was also the author of other textbooks.

The other co-authors of the natural sciences methodology were also highly experienced teachers, and the book had the following subtitle: "Methodological instructions and materials for the teaching of natural sciences". Much of the book was a description of the teaching experience of the authors.

The authors wrote that a natural sciences course must be based on the biological principle of teaching the natural sciences, where the life and organic makeup of an individual is seen in close connection to the surroundings in which the individual exists. Furthermore, the construction of various body parts can be explained by understanding the functions which the respective part must fulfill.

The purpose of a school, said the authors, is to prepare students for life and work – students who not only recognize and understand their surroundings, but are also able to find their proper place in society so that their work is of the highest cultural value. The mission of a school is to raise harmonized people who can orient themselves in their surroundings, who can think and work logically and independently. Furthermore, they wrote, schools must have a free working environment.

Ģirupnieks set out the following requirements for leading laboratory projects:

1. Some of the course must be devoted to independent work by students;
2. In this part of the student's work, the teacher offers explanations only insofar as it is necessary for the student to understand the process sufficiently to be able to do independent work;
3. The work is organized and arranged by the teacher. As much as time and working conditions permit, students must be involved in working out the job plan; students must always feel to be active participants in the process;
4. In carrying out their assigned tasks, students conduct observations and experiments, drawing conclusions from the data which they collect;
5. The conclusions that are drawn by students are reviewed and discussed by the entire class under the leadership of the teacher; during this phase any inconsistencies or errors in the conclusions are discovered, and the obtained knowledge is analyzed; control observations and experiments are done if warranted;
6. Students add to their knowledge by reading assigned literature;
7. Students are taught to reproduce (drawing, sculpture, etc.) and to apply scientific materials to practical life; this helps them firm up their knowledge;
8. Each project concludes with an evaluation of the students' knowledge;

9. Other parts of the lesson plan must be presented so that in-class activities encourage students to seek out and research things on their own [p. 77].

A large section of the first chapter of the methodology, authored by Ģirupnieks, was devoted to an explanation of the Dalton plan, the Howard plan and the individual Winnetka technique.

An entire sub-chapter was devoted to a discussion of working experience:

- **Aleksandrs Karlivāns**. “My experience in using elements of the Dalton plan in elementary schools”
- **Jānis Grete**. “Presentations by students”
- **Jānis Mežsēts**. “Evaluation of accomplishments in the natural sciences”

The author of a second methodology, *Dabas mācības un lauksaimniecības metodika* (Methodology for natural sciences and agriculture, Rīga (1936), re-issued in 1944)<sup>4</sup>, was an inspector and natural sciences teacher at the Jelgava State Teachers Institute, **Paulis Kupčs** (1891–1977). In the introduction he wrote:

“At teachers institutes there is a palpable lack of appropriate textbooks about the methodology of teaching the natural sciences and agriculture. The textbook *Methodology for the natural sciences*, edited by Jānis Ģirupnieks, does not meet the needs of teaching institutes either in terms of content or in terms of volume, even though it is valuable with its practical suggestions. Natural sciences methodologies in German, Russian and other foreign languages are not appropriate for our elementary schools, and students have difficulty in accessing these because of insufficient language skills. It is impossible to dictate all of the content to students, because there are relatively few hours devoted to methodology.”

Kupčs’ book had a clearly evident methodical structure. The first chapter was devoted to issues of the development of the natural sciences: the distribution of the sciences (separating spiritual sciences from natural sciences) and the history of the natural sciences (prehistory; ancient times; the Middle Ages; the later era; the newest era).

Chapter two concerned the teaching of the natural sciences in school and their importance at school and in life. The second section of the chapter reflected the way in which the topic was taught in various eras (in Medieval monastery schools, during the Reformation, in 18<sup>th</sup>-century Germany and France, etc.). The chapter also covered the teaching of natural sciences in Latvian schools and the latest ideas about the teaching process.

The third chapter covered the principles governing teaching work in elementary schools, while the fourth chapter was about the main principles for teaching biology in natural science and agricultural courses.

A separate chapter was devoted to the technical aspects of teaching (ease of understanding, teaching resources, drawing, observation and experimentation).

The work methods which Kupčs listed were questions by the teacher and answers from students; laboratory work; methods of conducting a discussion; sample field trips; plans for lesson analysis, etc.

The author noted that in teaching any subject, one needs not only theoretical knowledge and practical success, but also certain Godgiven characteristics. He felt that the personality of the teacher had much to do with the success of students in the various topics. Kupčs wrote that any teacher can become an average instructor of the natural sciences and agriculture, but only people who have the characteristics needed to teach these topics can become truly good teachers of the subjects.

The author listed the main characteristics needed by natural sciences teachers: “... The teacher must be physically and spiritually aware ... he must be a person with a “practical touch” ... he must be familiar with nature in his country ... he must be interested in his subject and must always be learning more about it ... The teacher who loves his topic, who trains and educates his students directly and indirectly, awakening within them a deep love for their fatherland without any loud shouting” (p. 122).

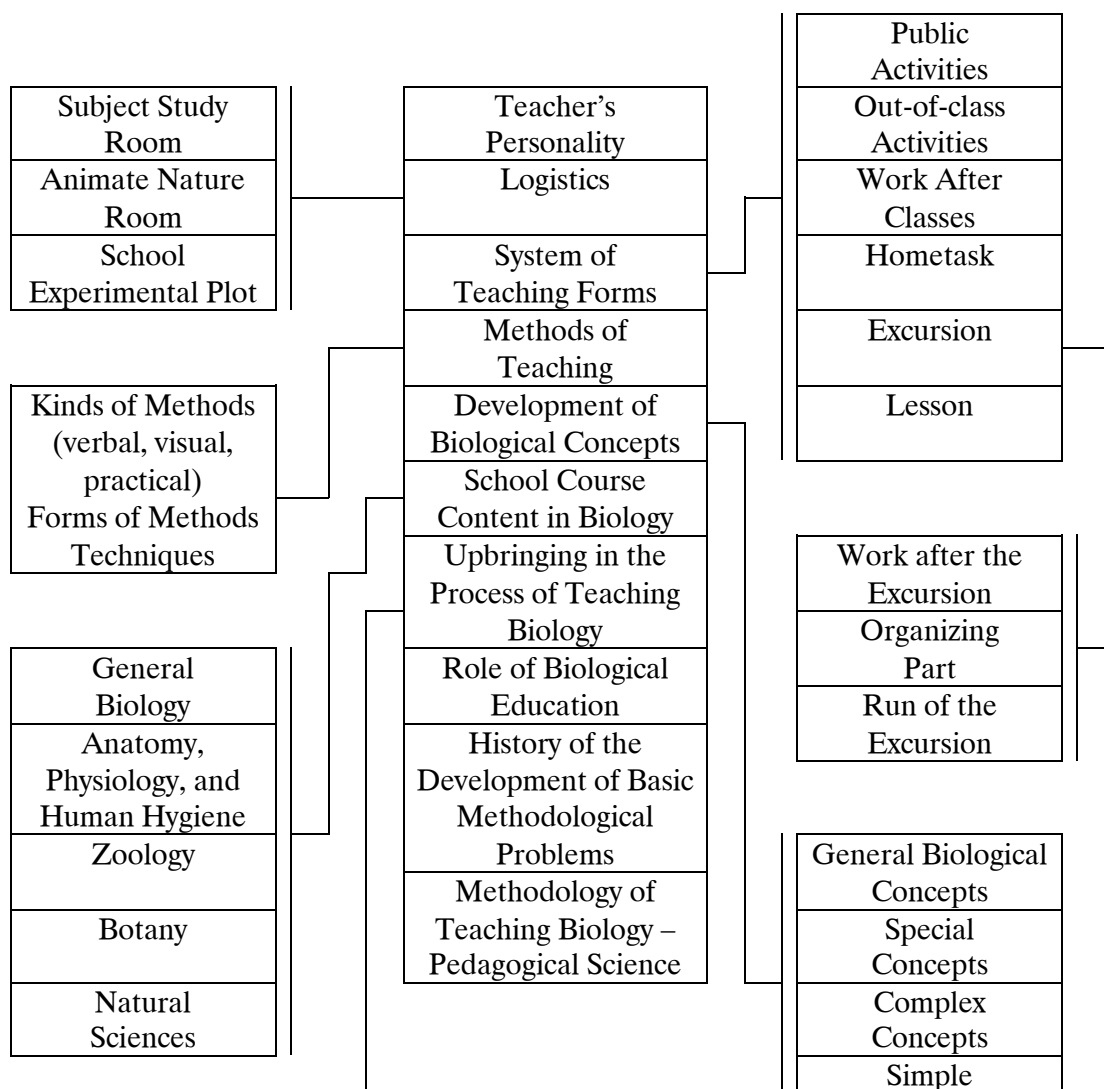
It was only in 1979 that the first general methodology for teaching biology to university students was published in Latvia<sup>5</sup>. The authors were St. Petersburg professors **Nikolai Verzilin** (1903–1984) and **Vera Korsunskaja** (1905–1995).

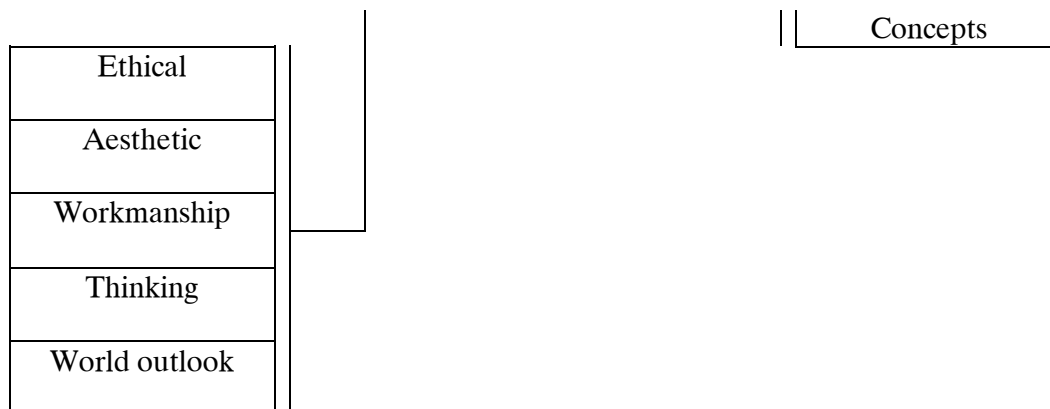
The main mission for students in preparing to become educators is to learn procedures for proper education, the basics of teaching biology, and the skill of conducting the process whereby students obtain knowledge. Young educators must be well familiar with teaching procedures, methods and methodical steps so as to be able to utilize these successfully in his or her work in various classes and under various conditions. When studying at university, students must not only become familiar with the theoretical foundations of methodology, but also with their practical applications. All of these conclusions were drawn in the Nikolai Verzilin and Vera Kursunskaja book.

A professor from the Daugavpils University, Leonīds Keirāns, was the first to write a book<sup>6</sup> on the structure of teaching methodology. Keirāns studied more than 400 different teaching methodologies from the humanities, the exact sciences, trade education, physical education and aesthetics. In his introduction to the book, professor Ivan Zverev noted that over the years there has been a great deal of literature about methodology, but there have been few attempts to offer an overall comparison of the various methodologies in order to learn similarities and differences.

The main innovation in the Keirāns book was a precise analysis of the structure of various methodologies. Tables, figures and graphics in the book contained a wealth of factual materials which describe the various methodological publications from different historical eras.

### Structure of the methodology of teaching biology





As a result of the research, the author offered the reader several noteworthy elements:

- An historical look that revealed the system by which school teaching methodologies were created;
- The content of each structural element as shown, and the level of its theoretical development was elaborated;
- General links were drawn between general and specialized methodological publications;
- The level of development of the various structural elements which was revealed can serve as one aspect of didactic analysis;
- The advantages and shortcomings of the various methodological publications were shown very convincingly.

As a specialist in the methodology of biology, the author wrote his book from the aspect of the specific methodology.

The process of differentiation helped to develop the structure of methodology, the functions of each element, or the no-option levels. The process of integration leads to changes in teaching subjects and to new relations among subjects.

The main idea behind teaching methodology is the teacher's widely developed personality.

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## Резюме

# РАЗВИТИЕ МЕТОДИК ОБУЧЕНИЯ БИОЛОГИИ

**Леонид Кейран**

В статье проанализированы некоторые аспекты развития методик обучения биологии. Автор раскрывает основные дидактические принципы первых методик естественнонаучного образования /ЕО/ - А. Любена (1804-1873) /Германия/, В. Половцева (1862-1919) /Россия/ и др. В 1931 г. в Латвии была издана первая книга по вопросам методики ЕО. Показаны главные аспекты деятельности ведущих латвийских дидактов прошлого столетия – Я. Гирупниекса, Я. Гресте, З. Ланцманиса и др.

В статье представлена структура методики обучения биологии разработанная на основе анализа более чем 400 разных методик обучения.

**Ключевые слова:** методика обучения, обучение биологии, развитие методик, естественнонаучное образование.

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