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A Concept of Developing Practical Skills in Teaching Biology in a Foreign Language

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ABSTRACT
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"One drop of experience is worth more than thousands of kilograms of theory."
John Dewey

Introduction

In the current era of rapid changes and globalization, education plays a pivotal role in preparing future citizens and professionals. To maintain and stimulate interest in science, educational institutions must adapt the way they present scientific information to meet the contemporary challenges and requirements of our changing world. Recognized European directives in education promote the active integration of foreign languages into the learning process and encourage the application of innovative teaching methods that support the development of language skills and abilities within the context of specific subjects. European regulations outlining modern trends in education contrast with the actual findings regarding its state in some aspects. Annual reports from the World Economic Forum note a concerning decline in the quality of the educational system in Bulgaria. According to the latest results of the Programme for International Student Assessment (PISA) study, Bulgarian students face significant deficits in applying their knowledge in real situations, particularly in the field of natural sciences. The focus on actively developing practical skills in students is crucial for their successful adaptation in the dynamic and competitive environment of the educational and professional sectors.

Another aspect of the issue is related to the volume of the educational material, which, until 2018, was studied in high schools over three academic years. Now, it is stipulated to be covered in two years, with the total hours of general education reduced by 54 hours. A significant challenge for teachers is the prevalence of theoretical knowledge and the decreasing application of biology knowledge in practice. When considering the requirement for language high schools to teach general education subjects in a foreign language, the obstacles become more serious. These findings pose a real challenge to the effectiveness of teaching, especially in conducting classes for the formation of practical skills. This may impact students' performance and motivation, as well as the quality of education provided in schools. The integration of real, applicable scenarios and exercises into education can improve student motivation, promote active participation, and enhance their understanding of scientific concepts.

In response to the identified challenges in teaching biology in a foreign language at the high school level, this dissertation focuses its efforts on attempting to optimize the educational process by developing a concept aimed at fostering practical skills in high school students. It can be perceived as a tool for improving the quality of education and enhancing student motivation in the specific context of learning biology in a foreign language. The dissertation aims to justify the need for innovations in education, with a focus on the development of practical skills as an integral part of the educational process, to ensure better and more effective preparation of students for future challenges.

Chapter 1. Methodological Framework of the Study

1.1. Research Methodology

In the contemporary educational environment, a growing demand exists for more effective and innovative methods to research and enhance the learning process. This case poses an exciting challenge for scholars and educational practitioners alike. The methodology of scientific research represents a system of principles, rules, and procedures applied in the execution of a specific scientific study. In the following sections, the methodological framework of the educational research described in this work is presented.

1.1.1. Methodical Research Methodology

The methodology of methodical research provides a proper framework and guidelines for addressing research objectives. It is essential to define categories within the research field to ensure its effective progression. The choice of pedagogical research as a methodological tool for investigating this educational approach stems from the aim to comprehend the real impact of integrating practical tasks supported by electronic technologies into the teaching of biology in English. This allows for a systematic investigation, data collection, and analysis of the results.

Methodical research serves as a means for systematic analysis and improvement of educational practices. The preferred approach is didactic experimentation, which explores the effectiveness of the learning process by implementing various methods to achieve set goals. This involves individual work on practical tasks related to modeling, experimentation, creating crosswords, comics, presenting task outcomes through videos, photos, reports, etc. Ivanov (2006) defines action research as a family of research methodologies that simultaneously pursue action/change and inquiry/understanding. Within education, the primary goal of action research is to identify ways to enhance the children's learning process. The choice of action research in pedagogy is considered logical and scientifically justified, as it allows for tracking the results of applied methods and formulating objective conclusions about their effectiveness. Additionally, this process provides an opportunity for interaction between students and teachers in a real educational environment, which is crucial for a thorough understanding of the context and extracting relevant data. Thus, the research described here takes the form of a scientific text aimed at uncovering the possibilities and challenges associated with integrating practical activities and electronic technologies in biology education in the English language.

The methodology of methodical research necessitates the definition and construction of various criteria and aspects crucial for the research itself. These aspects include defining specific problems, determining the object and subject of the research, formulating hypotheses, setting goals and tasks, examining and supporting theoretical concepts, as well as analyzing the significance of the research for both science and educational practice. This analysis and structured approach to research enable a better understanding of the essence of the study and the achievement of more concrete results in the scientific and educational domains. (Bizhkov & Kraevski, 2002). In accordance with the above-mentioned, the hypothesis, object, subject, goals, and tasks of the study have been formulated.

1.2. Object, Subject, Research Questions and Hypothesis

1.2.1. Object

The object of the methodological study presented in this work is the practical skills in biology of students from the 9th and 10th grades in the secondary education stage, studying the general educational subject of biology in both Bulgarian and English languages, in face-to-face and electronic formats, within a digital environment. The results are tracked both vertically and horizontally over a period of 4 years.

The target group of the study comprises high school students from the 9th and 10th grades at the Foreign Language School "Dimitar Dimov" in Pleven. The total number of participating high school students is 179.

In various learning environments, students are expected to have developed the following skills:

- To describe the morphology of various microscopic specimens using a digital microscope.
- To create models of biological objects based on given instructions in a digital environment.
- To compile crosswords with biological terms in English using digital tools.
- To construct comics on biological themes in both traditional and electronic environments.
- To conduct experiments at home following a predefined algorithm. To analyze and present the results of the conducted experiments.
- To develop skills in applying knowledge through working with questionnaires, linking images/schemes to their corresponding concepts, filling in blanks in text, etc., in a digital environment.

1.2.2. Research Subject

The subject of the study is the development of practical skills related to perceiving, understanding, recognizing, and applying biological concepts in the English language. The research focuses on how successfully students achieve specific learning goals and competencies in the field of biology when studied and applied through practical tasks in the English language. Knowledge, understanding, and skills acquired by students, as well as their ability to communicate in a foreign language in this context, can be measured. The study analyzes how the students' developing language skills (reading, writing, speaking, and listening in English) contribute to a better understanding of biological concepts, terms, and processes. It tracks how they handle specific biological terms and adapt to the use of English in this area. Student motivation for learning, as well as the extent to which the use of practical tasks enhances engagement in learning and stimulates their activity, has been observed and analyzed through a survey. Recommendations and practical guidelines for the optimal integration of English-language biology education into the learning process, through the inclusion of appropriate practical tasks supporting the achievement of learning goals, are provided.

1.2.3. Research Question and Research Objectives

A fundamental research question has been formulated: **How can practical skills in biology, taught in English, be developed in students at the first high school stage, with a focus on their scientific literacy?**

This question is decomposed into the following sub-questions:

1. **What didactic materials are appropriate for application to the educational content when studying biology in a foreign language at the high school level?**
2. **What types of tasks are suitable for building practical skills in biology education in a foreign language in a digital environment?**
3. **What attitudes and opinions do high school students have regarding the implementation of practical tasks in biology education in a foreign language in a digital environment?**

To provide answers to the main research question and its associated sub-questions, the following objectives have been formulated:

Theoretical Objectives:

- Analysis and interpretation of literary sources to define key concepts and their relationships in the context of the research subject.
- Analysis of documentation related to the implementation of studying general education subjects in a foreign language.
- Analysis of literary sources related to the use of Content and Language Integrated Learning (CLIL).
- Analysis of literary sources related to the use and application of electronic tools in education.
- Constructing the theoretical framework for developing a concept for the formation of practical skills in biology education in a foreign language.

Practical Objectives:

- Constructing various types of practical tasks in biology education at the high school level. Selecting and preparing didactic materials and tasks for independent work.
- Formation of practical skills through the application of variations of practical tasks in a digital environment.
- Development of a toolkit for investigating the effectiveness of biology education in a foreign language for high school students by increasing the implementation of practical tasks.
- Experimental validation of the effectiveness of applying variations of tasks to enhance practical skills in biology.
- Experimental verification of the students' attitudes in the studied group towards the use of various types of practical tasks in biology education in a foreign language.

Based on the questions presented above, the following hypothesis has been formulated:

1.2.4. Hypothesis

The formation of practical skills in biology education in a foreign language is effective when developing and implementing a heuristic methodological design that includes practical tasks, activating high school students to apply their knowledge and skills in real situations, stimulating their analytical and critical thinking, as well as developing their problem-solving skills and information retrieval abilities.

Existing tasks can be adapted for use in English-language biology education, as well as new ones developed to align with modern learning requirements, specifically in terms of curriculum content. Analysis of results from applied tasks will provide insights into the relationships between task types and the development of practical skills. It is anticipated that improvements will be observed in biology education in a foreign language. Increased interest in natural sciences is expected through the dynamism and diversity of activities applied in the learning process.

1.3. Stages of the Research

The stages of the research are based on well-established frameworks in pedagogical science, following the formulations of Bizhkov (1999) regarding empirical research: 1. Planning and organization of the research (development of a concept), 2. Conducting the research, 3. Presentation and analysis of the results, 4. Implementation in practice and integration into theory. In most pedagogical research organized and conducted by teachers, educational specialists, and managerial staff, three main stages are primarily outlined: preparatory stage, main stage, and concluding stage (Ganchev et al., 2014). Based on the theoretical description of the research stages, a schematic representation (Figure 1) has been constructed, graphically illustrating the key components in the sequence of conducting methodical research for the application and tracking of results from the developed concept for the formation of practical skills in English-language biology education.

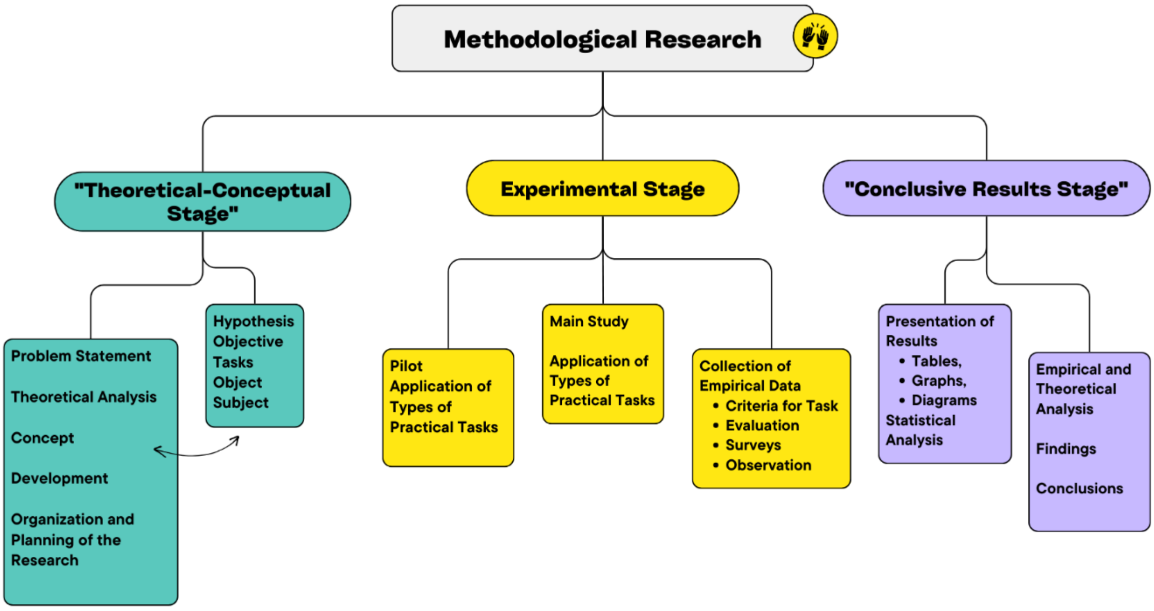

Figure 1: Stages of Methodological Research (according to Bizhkov, 1999)

The research described in the dissertation was conducted following the identification of weaknesses in the development of practical skills and competencies among high school students in the foreign language education of natural sciences. During the *theoretical-conceptual* stage, existing theoretical and applied aspects related to methodical research, skill formation, content and language integrated learning, approaches to competence attainment, successful pedagogical practices, and selected topics from the biology curriculum at the high school level were examined. Based on the literature review and problem analysis, a theoretical framework and hypothesis have been formulated to guide the research. A concept has been constructed by adapting a model for content and language integrated learning based on the competency approach. A design for practical tasks has been created to meet the established goals and hypotheses. The object and subject of the research have been defined, and a plan has been developed. The task design is built on the competency approach, integrating theory with practice to stimulate students towards independent exploration and experimentation. The *experimental stage* was initiated with the study of the first group of high school students in 2020 and continued for four years. During the first year, the results of the students' tasks, their reactions, and attitudes were monitored. Deficiencies in the concept and task design were identified. Over the next three academic years, six types of practical tasks and their variations were applied (described in Chapter 3 of the dissertation) to monitor their effectiveness in developing practical skills and achieving competencies. At the end of each academic year, data from assessments based on criteria (presented in Chapter 4 of the dissertation), academic success in the biology and health education discipline, as well as feedback from surveys and observations, were systematically compiled. In the concluding and *result-oriented* stage, a statistical analysis of the collected data was conducted to assess the effectiveness of the new concept. The results were interpreted in the context of the predetermined objectives.

The selection of research methods in pedagogical experiments is a crucial stage in conducting scientifically grounded research. These methods play a key role in gathering, analyzing, and interpreting data that serve to confirm or refute the research hypothesis.

1.4. Research Methods

To conduct the methodological research, aligned with its subject and object, and to achieve the theoretical and practical goals, the following methods have been applied:

1.4.1. Pedagogical Experiment

The effectiveness of applying the constructed concept for the development of practical skills through the design of practical tasks in English-language biology education has been monitored.

1.4.2. Theoretical Analysis and Synthesis

An analysis of the content and synthesis of information has been conducted regarding: the choice of the topic; approaches to integrated subject and language learning to shape the theoretical framework in developing the concept; the competency approach for constructing the design of practical tasks; the development of practical skills and attainment of competencies in biology and foreign language; characteristics of practical learning tasks; analysis of existing practices for implementing practical tasks; normative documents related to biology education at the high school level; electronic platforms used for distance and hybrid learning; electronic technologies for designing tasks in a digital environment; and the theory and methodology of planning and conducting pedagogical empirical research.

1.4.3. Survey

A standardized questionnaire with rating responses was utilized to assess the effectiveness of the practical tasks used in the pedagogical experiment. The questionnaire aimed to evaluate attitudes, difficulties, assimilation of scientific terminology, algorithmic work, and attitudes towards biology as a subject.

1.4.4. Observation

Observation by educational specialists was employed to monitor the correctness of task execution, identify any issues in following the task implementation algorithm, assess effectiveness, and gauge attitudes towards practical tasks as a method for acquiring and reinforcing knowledge. The observation aimed to overcome difficulties encountered in achieving theoretical and practical skills.

Chapter 2. Review of Existing Literature on Foreign Language Biology Education and Skill Formation

In accordance with the formulated theoretical goals of the research, scientific literature on the main aspects of creating a concept for skill formation was analyzed. Foreign language biology education is a component in the educational process that requires specific strategies and methods aimed at integrating language skills with the cognitive process. In planning the concept, emphasis was placed on studying scientific literature on content and language integrated learning (CLIL) concerning the study of general education subjects in a foreign language, the competency-based approach for educating individuals prepared not only with information but also with the skills to apply and generalize this knowledge in real situations, and skill formation related to the fundamental goals of the research.

2.1. Content and Language Integrated Learning

Content and Language Integrated Learning (CLIL), which has been in existence as an approach in foreign language education in European school systems for over 30 years, represents a concept in education that combines the communicative orientation of language learning with an interest in the content of general education disciplines. Learning a general education subject in a foreign language stimulates the cognitive development of students. They must apply language skills to understand new information, analyze texts, form reasoned opinions, and solve problems, thereby enhancing their critical thinking and analytical skills. The CLIL concept complements the competency-based approach by enriching the educational process and promoting the development of key competencies in students. The greatest significance of the CLIL direction lies in the fact that, when applied, skills and competencies are acquired simultaneously in two academic disciplines. Several conceptual models of CLIL have been described in scientific literature. These models serve as frameworks that systematize and summarize key principles, stages, and methods related to CLIL. They provide guidance and facilitate the understanding of important aspects of the educational process while offering directions for practical implementation. In 2002, a model seeking the interrelation between approach, design, and procedure was described (Richards & Rodgers, 2002). Other authors propose directing the outcomes of CLIL toward the 4C model: content, communication, cognition, and culture (Coyle et al., 2010). The content is directed towards the knowledge that students need to acquire from a given lesson, and communication can be related to language outcomes. These two dimensions are explicitly mentioned in the name of CLIL and are the primary goals of its implementation in most contexts. However, the 4C model requires education to go beyond content and language, also focusing on cognition and culture. Cognition involves higher-order thinking, such as the development of critical thinking skills, and culture "nurtures self-assessment and the potential to understand and appreciate others" (Ellison, 2018). In CLIL, it is crucial to ensure that language does not hinder the understanding of content while being cognitively demanding in itself. Meyer (2010) proposes the CLIL Pyramid model, based on Coyle's 4C model, which consists of several stages. It is important to note that all these stages can be applied within a module rather than in a single lesson. The stages include: theme/content (the base of the pyramid consists of broad themes from the curriculum rather than individual lesson units), selection of media for presenting content (educational materials providing multimodal formats and different presentation styles), task design (composing activities related to students' development and language competencies, designed in increasing difficulty), and CLIL implementation, the product of the process (Meyer, 2010). In the present study, Coyle's model serves as a foundation that has been revised and adapted to create a concept focused on the development of practical skills in biology education in a foreign language. The concept comprises three main components: (fig. 2)

- *Content* - the focus is on specific biological concepts that students need to learn, as well as their practical applicability.
- *Communication* - achieving language skills through reading and analyzing texts in a foreign language, as well as skills for effectively presenting and explaining scientific information. This component is considered as a tool for applying knowledge in practice.
- *Cognition* - forming skills and competencies that students acquire as a result of their education through the performance of practical activities.

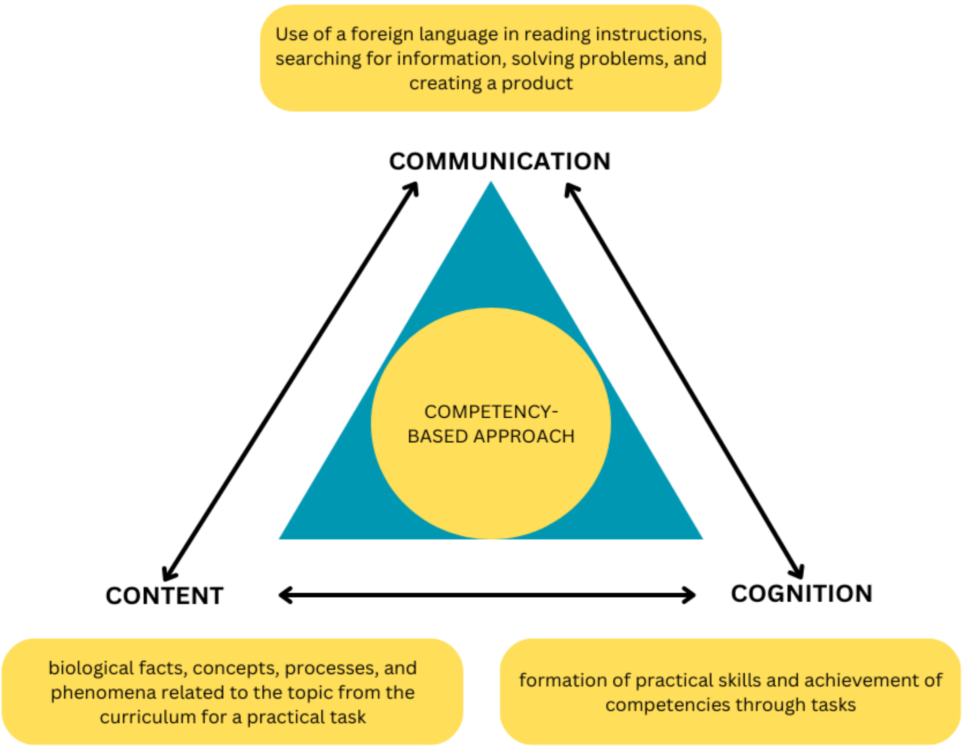

Figure 2. Adapted conceptual framework for developing practical skills in biology education in a foreign language (based on Coyle's 4C model for CLIL, 2010)

The adapted conceptual framework represents a modified version of the original theoretical model, altered to meet the specific requirements of the research. As depicted in Fig. 2, the scheme consists of three interconnected and interdependent components integrated into the theoretical framework of the concept. In light of the planned development of practical skills, changes have been made to better reflect the specifics of biology education and integrate the foreign language as effectively as possible for students. The competency-based approach is placed at the core of the scheme, serving as a unifying element for the three constructs—content, communication, and cognitive skills. The modified conceptual framework emphasizes the practical nature of education, focusing on competencies and integrating their development into every aspect of the CLIL model.

2.2. Competency-Based Approach

The competency-based approach is still predominantly declarative in educational documentation, and its application in teaching practice remains limited. The competency-based approach does not negate the importance of knowledge; rather, it incorporates them as an essential element within the structure of competencies. Instead of solely focusing on knowledge, the competency-based approach emphasizes skills and their contribution to real-life situations. This implies that students should not only memorize facts but also be capable of applying them in a real context to solve problem-based tasks. According to Gurov et al. (2017), when creating a concept for competency-based learning, attention should be paid to the methods, forms, and means of education to direct the process toward problem-based learning and creative application of educational goals. Implementing the competency-based approach in the biology and health education process aims to develop competencies that are specific to this educational area. This includes the development of subject-specific competencies related to the content of the subject, as well as interdisciplinary (key) competencies according to Hutorskoy (2003). Subject-specific competencies are developed and strengthened through the study of biology and health education content, demonstrating the correlation between content and knowledge within the concept. They encompass specific knowledge, skills, and the assimilation of information that are unique to the respective educational domain. On the other hand, key competencies are developed through the application of various teaching technologies and the creation of interdisciplinary connections between different educational domains. Implementing this approach is possible through the use of practical tasks, through which learners master and acquire various cognitive knowledge and social skills. Research has shown that interactive methods are necessary for the realization of the competency-based approach (Vasileva-Ivanova, 2014). It is important to emphasize that the use of practical tasks in biology education has numerous advantages and can be achieved through a competency-based approach that combines electronic tools, foreign language, biology, and various activities that support active learning and the development of relevant skills in students. Such an approach not only enhances understanding of biological concepts but also develops critical thinking, problem-solving, collaboration, and communication skills – skills that are crucial for successful functioning in contemporary society.

2.3. Skill Formation

One of the goals of biology education is the formation of skills appropriate to the students' age and the corresponding curriculum. Therefore, skills are a key component of competencies in biology and in a foreign language. This need is reflected in the educational requirements for organizing the learning process and the state educational standard for general education, Regulation No. 5 of the Ministry of Education and Science dated November 30, 2015. It emphasizes the necessity of acquiring skills and attitudes related to key competencies in natural sciences, as well as practical skills for observing and researching different levels of organization of living matter. The idea of including skills as a measure of students' achievements in the learning process, including in the field of biology, is an example of the fundamental concept of change in educational strategy. For Dewey (1986), skills are developed through activity and practice, encouraging students to actively analyze, interpret, and apply their knowledge in the context of specific situations. Piaget (2003) emphasizes that children learn and develop by acting on objects and issues in their environment and by encountering new situations and overcoming them. Structurally, each skill consists of two interconnected components: informational and practical-transformative, according to Tsanova and Raycheva (2012). The informational component represents knowledge about "something" and is specific and variable. It includes the necessary information and conceptual models required to perform the skill. The practical-transformative component refers to the sequence of operations carried out to analyze objects in a specific situation. It represents the stable part of the skill, the "tool" through which knowledge (the informational component) transforms into personal achievement developed through learning. Structurally, the practical-transformative component is the state that is acquired and improved to achieve the goals of the skill. Thus, the structural aspect of the skill shows that it includes an informational and a practical-transformative component, where knowledge and information are dynamic and flexible, allowing their integration into the skill to achieve various goals and tasks. In the context of this development, the structure of the skill is considered such that the informational component includes the students' knowledge regarding a topic from the biology curriculum, to which the task is structured, and the scientific text included in the instructions preceding the algorithm for execution. The practical-transformative component involves applying the informational component when performing the task, shaping, and presenting the final product. The ability to apply the skills is possible due to their generalized and integrative nature. This means that skills are developed as a whole, encompassing both practical and informational aspects. They are formed by the student, considering specified criteria and general principles.

The subject of study in this work is the skills developed by students in the process of solving practical tasks. The analysis of these skills will be conducted through a competency approach, focusing on specific competencies representing key components of students' development. Some of the studied competencies include:

- *scientific literacy* - this competence includes students' ability to understand, interpret, and evaluate scientific information, as well as their ability to use scientific terms and resources. The goal is to examine how high school students successfully apply scientific concepts in practical scenarios.
- *critical thinking,* which encompasses the ability to critically analyze information, evaluate different perspectives, and formulate well-founded opinions. The study will focus on how students demonstrate critical thinking when applying acquired knowledge to solve specific tasks.
- *experimental skills* - this includes the ability to conduct experiments, perform sequential actions according to an algorithm, the skill of measuring and recording data, etc. The research analyzes how students acquire and apply these skills in home conditions.
- *problem-solving* - which includes the identification and formulation of problems, creating strategies for solving them, and evaluating the effectiveness of the adopted solutions. The research tracks how students cope with challenges and solve problems that arise during their practical activities.
- *communication skills* - it includes the ability of high school students to present results clearly and effectively, as well as their ability to share and discuss scientific concepts. The focus is on how students successfully communicate and present their ideas and discoveries.
- *digital literacy* - it includes the ability of students to use modern technologies to accomplish tasks and analyze results. The research will focus on how high school students integrate technologies into their activities and the role they play in knowledge acquisition.

2.4. Theoretical Framework and Key Concepts Related to Biology Education and the Development of Practical Skills

2.4.1. Scientific Literacy and Practical Skills

The development of scientific literacy is becoming an increasingly important task for educational institutions and society as a whole. In the 1960s, the focus shifted from determining which scientific knowledge to include towards establishing standards measuring scientific literacy. One of the definitions of scientific literacy is: "the ability to use scientific knowledge to identify issues, to formulate evidence-based conclusions, to understand, and facilitate decision-making to address problems in the natural real world and the changes in it through human activity." (Gaydarova et al., 2015). The justification for the low results of PISA studies on the scientific literacy of Bulgarian students turns out to be not the weak theoretical preparation but the difficulties in solving specific problems, i.e., the practical applicative aspect of science. In recent decades, biology education has been largely theorized, while practical orientation has diminished. This is due to various factors, including outdated material bases, lack of suitable tools, and consumables. One of the main problems is related to the limitations of available material resources and tools in biological laboratories and educational environments. The lack of up-to-date and modern technical equipment often hinders the conduct of practical lessons and experiments that contribute to a better understanding and application of biological concepts. Instead of practical experience and direct contact with biological objects and nature, students are mainly taught through textbooks and theoretical lectures. This limits their ability to develop observational skills, experimental skills, and an understanding of the real world around them. The formation of practical skills in biology education is crucial for the development of students. They provide an opportunity to apply theoretical knowledge in a practical context, develop scientific thinking skills, and stimulate active participation and motivation among students. The development of task variations designed to develop different skills is an attempt to improve the effectiveness of the educational process regarding scientific literacy.

2.4.2. Educational Task

Scientific literacy, as a set of skills involving the understanding, analysis, and evaluation of scientific information, requires a systematic and structured approach. In this context, educational tasks can be used to activate scientific literacy by placing students in scenarios that require the application of scientific concepts and methods. For example, a task challenging students to investigate and explain changes in the natural environment can serve as a stimulus for the development of their cognitive and analytical skills. On the other hand, practical skills, including experimentation, modeling, and solving real-world problems, also find a suitable context in educational tasks. Raycheva and Tsanova (2012) define an educational task as a "sign model of a learning situation." These tasks aim to present general ways or principles of solving problems within the logic of the respective subject area or discipline. This means that students are challenged to use specific strategies and methods characteristic of the relevant field to solve problems or perform specific tasks. In the process of solving educational tasks, students must apply logical thinking and derive general principles or problem-solving approaches applicable in a broad context. This encourages learners to develop algorithmic thinking, which is an important competence in the educational process. To achieve the stated goals, the pedagogical experiment described in this dissertation and the analyzed theoretical classifications of tasks were applied as follows: according to Kulyutkin (1968), exercises-tasks providing instructions and algorithms for implementation, according to Lerner (1977), tasks of the 2nd level (for application in stereotypical situations) and the 3rd level (creative tasks). According to Trashliev (1989), traditional tasks encompass three components - given, sought, method, with the focus being on the sought. Based on Tsanova and Raycheva's classification, tasks are practical-analytical, practical-research, and practical-execution tasks, as described in Chapter 3 of the dissertation. The selected types of tasks were chosen due to the necessity of combining biology and a foreign language to develop practical skills.

In the dissertation, a design of six types of practical tasks is presented, comprising twelve variants. The types of tasks, considering the specificity of the activities performed in the pedagogical study, include modeling, experimenting at home, microscopy, crossword puzzle creation, comic/food web development, and tasks performed on an electronic platform. Each type of task aims to develop different practical skills, and through the activities performed to solve them, competencies are achieved. The conceptual design integrates elements from the Task-Based Learning (TBL) educational approach. The inclusion of TBL elements is justified by the desire to support active participation and application of the learning content in real situations. This approach emphasizes the use of tasks as a primary teaching methodology, fostering the development of practical skills and competencies. The incorporation of TBL into the conceptual framework encourages students to apply their knowledge in specific circumstances, which is a crucial aspect in the context of developing practical skills in biology education in a foreign language.

2.4.3. Remote learning, online education, blended learning, distance education in an electronic environment

The unforeseen situation arising from the COVID-19 pandemic provided a unique opportunity to track the effectiveness of the concept of practical skills formation in three different forms of education - remote, hybrid, and face-to-face. Various definitions of distance learning exist (Collis, 1993; Moore & Kearsley, 1996; Hill, 1997; Mielke, 1999; King et al., 2001; Jereb & Šmitek, 2006; Ellis et al., 2009; Sangrà et al, 2012; Keegan, 2013; Yotovska et al, 2020), which can be unified with that of Kremenska (2020): "Distance learning is when the learner and the educator are separated in time and/or space from each other." To ensure flexibility in the educational process, blended learning has emerged. The methodical research presented in the dissertation in the context of blended learning was conducted using a comprehensive rotation model (Tucker, 2012; Horn & Staker, 2017). In the comprehensive rotation model, the entire class moves between online and offline learning activities, creating conditions for connecting each learning activity with the most suitable educational environment, whether online or offline. During the first stage, the research was entirely conducted in a remote format, involving both synchronous and asynchronous learning. During the second stage and the first half of the third stage, hybrid learning was implemented using the comprehensive rotation model. In the second half of the third stage and throughout the fourth stage, high school students were engaged in traditional face-to-face learning. The execution of tasks for practical skills formation during the third and fourth periods of the experiment followed Henda's (2020) model for blended learning - face-to-face, with individual tasks in an electronic environment.

2.4.4. Electronic resource, electronic environment - technological aspect of DEEE.

With the increasing demands on students, a change in the way information is delivered and presented becomes necessary. The integration of electronic technologies into the educational process opens up new opportunities for the rapid transmission, presentation, and dissemination of information across various distances, in numerous locations, and at any time. To conduct distance and hybrid forms of learning, an electronic environment for information exchange and educational process realization is essential. During the research on the educational environment in the first year, Shkolo was used, through which tasks were assigned and results were accepted for activities. Throughout the remaining three years, the primary educational platform was Microsoft Teams. The latter offers more functionalities and capabilities for task assignment, result assessment, as well as easy and quick communication. The educational platforms employed for tasks in the digital environment include Wordwall, LearningApps, and Padlet.

2.5. Analysis of the pedagogical practice used in biology education in a foreign language.

Research has been conducted on distance learning through assigning homework tasks (Dean, 2004), the role of the scientific laboratory as an instructional environment in the CLIL methodology (Tibaldi, 2012), the application of electronic resources in combination with face-to-face and hybrid forms of learning (Kiboss & Tanui, 2013), the development of skills as a cognitive activity (Angelova, 2013), the combination of CLIL with electronic learning in biology (Mirón, 2016), the use of digital resources in biology education (Iancu, 2018), the creation of lessons, tasks, and worksheets covering a specific topic and integrating the English language into biology classes using the CLIL concept (Chocholatá & Gahurová, 2018), challenges associated with integrated content and language instruction (Nuranova, 2020), teaching biology through Content and Language Integrated Learning (CLIL) to high school students with the help of research (Tagnin & Ní Ríordáin, 2021), the creation of electronic resources to fill gaps for high school students (Rissanen & Castelo, 2023), and others. The literature analysis revealed that studies have been described regarding the combination of CLIL with biology, CLIL with electronic learning, but the combination of CLIL, biology, tasks, and an electronic environment was not found. Consequently, the research described in this work can provide information on the application of a CLIL-based model combined with a competency approach and implemented through practical activities related to the digital environment.

Chapter 3. Design for the Formation of Practical Skills through Practical Tasks in Biology in English

In the third chapter of the dissertation, a design for practical tasks is described, implemented in the methodical research conducted with 9th and 10th-grade students at "Dimitar Dimov" High School in Pleven, focusing on biology education in English during the period 2020-2023. The design of the tasks in the presented concept is based on the 4Cs model for CLIL (Content and Language Integrated Learning) and the competency approach, contributing to the effective formation of practical skills in biology in a foreign language. The first component - *content*, is integrated into the design by incorporating topics from the biology curriculum and scientific texts in the task instructions. This not only provides students with the opportunity to apply theoretical knowledge in a practical context but also encourages them to develop scientific literacy. The second component - *communication*, is integrated through instructions in a foreign language, requiring students to read, analyze, search for additional information, and use a foreign language in shaping the product. This approach supports the development of language skills and challenges students to communicate effectively in a foreign language in the context of biology. *Cognition*, the third element of the concept, is developed through the skills gained by students through task completion. Providing opportunities for the practical application of their knowledge leads to the formation of specific skills and competencies. The products presented at the end of the tasks serve as evidence of the assimilation of knowledge and its application in a real context, allowing students to demonstrate their practical skills and competencies. This integrated approach combines content, communication, and cognition, providing a comprehensive and holistic framework for the successful formation of practical skills in biology in a foreign language.

3.1. Design of Tasks and Didactic Materials

According to the practical objectives set for the methodical research presented in this work, the following design goals have been decomposed:

- *Integration of biology knowledge and language skills:* The goal is to combine knowledge and skills in the field of biology with the development of language competencies in English. This supports students in applying biological concepts and terms in English in practical scenarios.
- *Development of practical skills for working with scientific information in English:* The tasks should encourage students to seek, analyze, and interpret scientific information in English.
- *Formation of critical thinking and analysis:* The design of tasks should stimulate students to analyze and evaluate scientific information, demonstrating critical thinking and understanding the interconnectedness between biological concepts and objects.
- *Learning through practical situations:* Tasks should be created to allow students to apply their knowledge in real-life situations.
- *Development of language confidence and communication skills:* Through the tasks, students are encouraged to develop confidence in using the English language in the context of biology, as well as communication skills necessary for effectively sharing knowledge, conclusions, and ideas.
- *Innovation and creativity:* The design of tasks should encourage students to be innovative and creative by challenging them to find new ways to apply scientific concepts.
- *Personalized learning:* The design should be flexible, allowing students to develop their practical skills according to their individual needs and interests.

In accordance with the described design concept, implemented through practical activities, the tasks applied in the study are presented in figure 3.

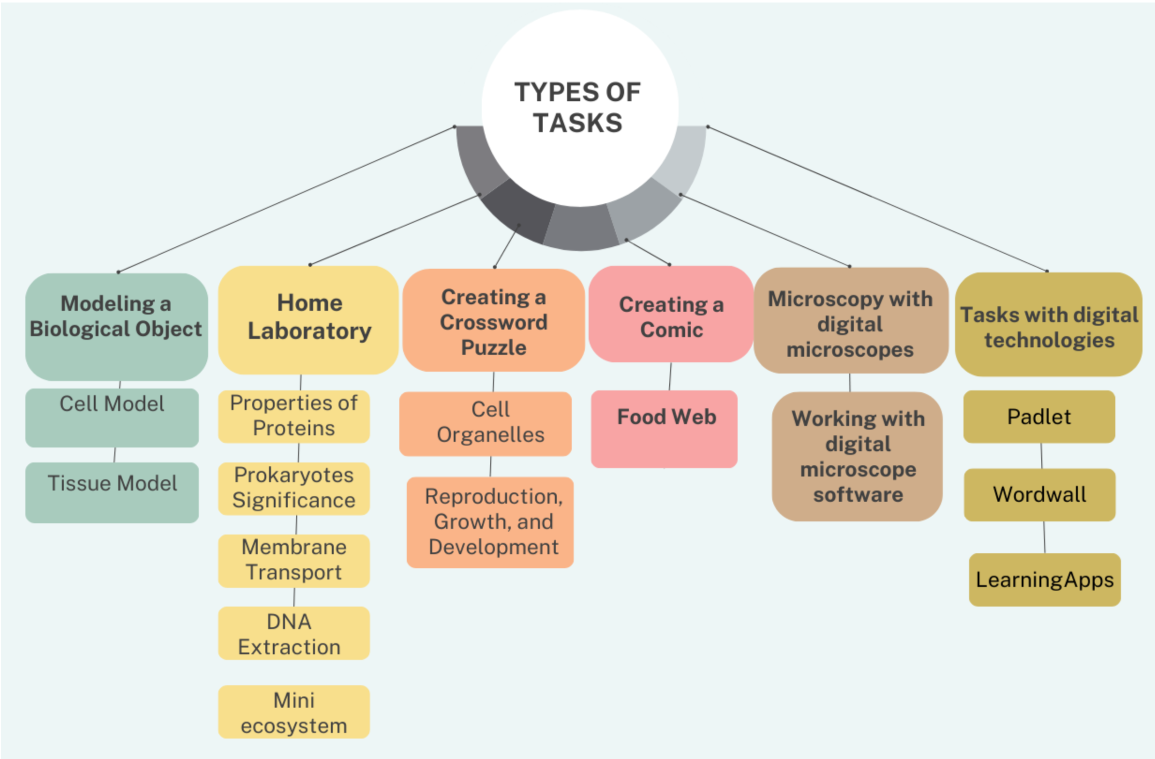

Figure 3. Types of educational tasks and methodological variations for their application in the study.

In accordance with the theoretical model and the defined goals of the methodical research, instructional materials were constructed. These materials include clear instructions and various types of tasks designed to support the formation of practical skills in biology in English.

3.2. Didactic Materials

3.2.1. Instructions for Carrying Out Practical Activities

The instructions provide a structured framework for conducting practical activities. They define the sequence of steps to be followed and offer precise guidance on the task's objectives and expected outcomes. It is crucial for the instructions to be clear and understandable, ensuring that both teachers and students have a clear understanding of what needs to be done. Instructions serve an informative and formative function. Their informational role is expressed in providing facts and concepts necessary for understanding the task and its connection to the curriculum. Simultaneously, their formative function directs students toward actively analyzing, researching, and problem-solving. This encourages the development of analytical skills, critical thinking, and the ability to independently tackle tasks. Each of the created instructions contains specific text, an algorithm, and criteria for different types of tasks. Guidelines for task variants differ in their informative component, related to the specific topic of the curriculum, and the algorithm regarding the sequence of activities in line with the task type.

The constructed instructions in the design consist of three main components:

- Introductory Information Text
- Algorithm for Task Execution
- Criteria for assessing the task by components - deadline adherence, adherence to the task execution algorithm, description of the work and conclusions in English, creative approach in implementation and presentation of the product, maximum number of points (described in Chapter 4).

An example of the structural elements of the instruction is provided for the task type "Home Laboratory," variant "Mini Ecosystem," assigned during stages 2, 3, and 4 of the study.

HOME LABORATORY

Practical task "Mini Ecosystem"

David Latimer has created a most unusual garden, one that seems to mimic the ecosystem of Earth – in a sealed bottle! On *Easter Sunday* in 1960, David placed compost in a large round bottle and used a wire to carefully lower a Spiderworts seedling into the mix. He then added a pint of water and sealed the bottle up tight with a plastic cork. He placed the bottle in a sunny corner and viola – the magic of photosynthesis did its thing. Through photosynthesis, the plant acquires energy by absorbing sunlight. The plant stores part of this energy which it needs to grow. Some of the energy is used to remove electrons from water in the soil that it absorbs through the plant's roots. This creates a chemical reaction that converts carbon dioxide into carbohydrates for the plant to use as food. But where does the carbon dioxide come from? Bacteria in the soil absorb oxygen (which the plant has released) and break down the plant's old, rotting leaves. During this process, the bacteria release carbon dioxide that the plant needs to grow. But wait Reeko, you said the plant removes electron from *water*. What happens when the water inside the bottle is all used up? At night, when the plant has no sunlight to drive the photosynthesis process, it use "cellular respiration" to keep itself alive. It does this by breaking down stored nutrients. As it does this, it releases water into the air. This water condenses at the top of the bottle and then rains back down, starting the cycle all over again.

INSTRUCTIONS

1. Read the instructions carefully!

2. Research the types of plants you have to arrange.

3. Choose a suitable container in which you will place the mini ecosystem - for example, a 3L glass jar or another glass container with a large enough opening through which you will put the soil and plants in the jar. Gather all the necessary materials.

4. When you have selected the plants and secured all the necessary components, take a photo before arranging the mini ecosystem, as well as at the stages of arranging it.

5. Every 3 days, PHOTOGRAPH the ecosystem in daylight and describe if there are any changes in it.

6. Arrange the photos in a video or document with the corresponding descriptions by day. Draw conclusions. Send via Teams - Assignments where the assignment was made.

7. Presenting the mini ecosystem at school in biology class and organizing an exhibition.

Figure 4. Instructions for the task type "Home Laboratory," variant "Mini Ecosystem"

The components of the text with introductory information and the algorithm for task execution in the instruction are shown in Figure 4.

<u>Text with introductory information:</u> The place of this element in the concept is within the content and communication components. One of the goals of the introductory text is to direct the student's attention to the specific task's topic and enrich their knowledge. In this particular case, it serves to discuss the knowledge about the cycles of matter in the ecosystem, stimulating action with the successful example of David Latimer, where the ecosystem survived without intervention for about forty years. Information is provided about a plant species for which additional information can be sought to understand its requirements for light, temperature, humidity, soil, etc., aiding in the selection of suitable plants for the successful completion of the task. Other objectives of the presented instructions are to build reading skills, comprehension of text, gathering and processing information in English; expressing and interpreting concepts and facts in preparation for task execution; analyzing and synthesizing

information; effective communication for clarifying details when setting the task; skills for working with various sources of information.

The second structural component of the instruction is *the algorithm for performing the task*. It illustrates the sequence of actions that students must follow to successfully conduct the experiment. It is necessary to document their actions in sequence, providing a basis for the evaluator to assess whether the algorithm has been followed. At the end, there is information on how to format the task's product, where and how to submit the results. This task variant includes an additional experiment clarification text. It outlines the step-by-step sequence of actions to solve the task, provides example images, links to videos demonstrating how to create the mini ecosystem, and examples of suitable plant types for cultivation.

How to make a terrarium, vivarium, or garden in a bottle

1. First, find a suitable sealed glass bottle or jar. A bottle with a wide mouth will be much easier to work with. Make sure the bottle has a lid or cork which can be sealed tightly.
2. Fill the bottom of the bottle with pebbles. You need at least enough pebbles to cover the bottom of the bottle but can add more if the bottle is taller. Try to fill about 1/5 of the bottle with pebbles. The pebbles will provide a space for water to collect in. Colorful, polished, pretty pebbles can be purchased at a pet store (they use them in fish aquariums).
3. Cover the pebbles with a thin layer of activated charcoal. You can usually find activated charcoal at a pet store. The charcoal will filter impurities out of the water and will serve to keep the terrarium clean.

4. Add a ½ inch layer of peat moss (a type of very nutritious soil) on top of the activated charcoal. The peat moss will hold water and nutrients that the plant needs to grow.
5. Add a ½ inch layer of potting soil on top of the peat moss. This is the dirt that our plant will stake its roots into.
6. Take a piece of moss, with some soil still covering its roots, and carefully place it on top of the soil in your bottle. If the mouth of the bottle is too small to reach into, use tweezers, chopsticks, a Popsicle stick, or some other means (Reeko uses a well-behaved, specially trained ant who is very good at following directions) to lower the plant down into the bottle. Spray a bit of water on it – by now it's probably pretty thirsty.You can collect moss from outside. Look for it in places that have just a little bit of sunlight shining on them. Dig up a small moss patch and place it inside a plastic bag or sealed plastic container so it does not dry out before you can plant it.
7. Before placing the lid/cork on the bottle, clean the inner glass so it's easy to see through. You can attach a cotton ball or small piece of cloth to a stick that you can reach down into the bottle to clean the bottle's sides.
8. Place the lid on the bottle and seal it up tight!

Finally, place the bottle in a fairly sunny spot. The moss will need sunlight to grow but not as much as some plants. If there is too much sunlight shining on your terrarium, it will tend to dry out. Not enough sunlight and the plant will not live. Somewhere around a window, but not directly in the sunlight, will work best.
If the inside of the bottle seems to be too wet, leave the lid off for a day or two to let it dry out. Similarly, if it seems to dry, remove the lid and add just a tiny amount of water to the terrarium.

Additional Information

The "gap of air" in the bottle should be about 2/3 of the available space. That means 1/3 of the height of the bottle should be filled with pebbles and soil and about 2/3 of the height of the bottle should be empty space for the plant to grow into. Sometimes moss and soil can have bugs or bug eggs in it which you might notice after the bottle is sealed. Be nice and let the little critters out.

Sample videos

https://www.youtube.com/watch?v=7Lg4tzkHgVo with bugs
https://www.youtube.com/watch?v=uOJrgr3jxRg only plants
https://www.youtube.com/watch?v=_h0LS9DJMfE top 5 plants for closed ecosystem

Evaluation criteria:

1. Compliance with an algorithm when performing tasks (maximum 6 points)
2. Clarity and precision of notation in English. (maximum 5 points)
3. Credible and correct presentation of results and information. (maximum 6 points)
4. Creative and original approach in presenting the results. (maximum 5 points)
5. Compliance with the deadline (maximum 3 points):

Total: 25 points.

Figure 5. Algorithm Components with Additional Information and Performance Evaluation Criteria from the "Mini Ecosystem" Task Instructions.

The goals of this structural element of the instruction are: reading, understanding, and processing information in English text; building skills in reading with comprehension, analytical thinking, analyzing and explaining biological facts; using various networks, software, and digital platforms; employing digital technologies when following instructions; and processing text and video files. Figure 5 displays additional information, performance criteria, and evaluation from the "Home Laboratory – Mini Ecosystem" task instruction.

The next component of the instructions is the *task evaluation criteria.* Task performers receive information about the criteria by which their products will be assessed. The maximum number of points, the type of criterion, and a brief clarification describing the criterion are presented. The goals of this final structural part of the instructions are to inform the task performers about how they will be evaluated and enable them to self-assess their work. The criteria for the tasks and their indicators are described in Chapter 4 of the dissertation. The instructions are delivered to the students through a Word document in an electronic environment at all stages of the research.

Instructions have been created for 12 tasks involving practical activities covering various topics in the 9th and 10th-grade curriculum. The instructional content for 9th grade includes Tissues, Proteins, Significance of prokaryotic organisms, Cellular organelles, Cell membrane, Membrane transport, Types of cells, Metabolism, and Cell division.

The instructional content for 10th grade encompasses Reproduction in animals and humans, Biocenosis, Ecosystem, and Anthropogenesis.

2.2.1. Online Platforms for Implementing Practical Activities

In the described methodical research, two platforms were utilized for delivering instructions to students and collecting task submissions. During the initial stage of the research (2020), Shkolo.bg was employed. Since 2017, this platform has been used as the electronic diary for the "Dimitar Dimov" Vocational High School in Pleven. Apart from its role as an electronic diary, it serves as a means of communication among teachers, students, parents, and the school administration. Throughout the remaining three stages (2021-2023), Microsoft Teams was utilized. Microsoft Teams provides a centralized workspace where students and teachers can collaborate, exchange information, and complete tasks. It integrates seamlessly with other applications such as Word, Excel, and PowerPoint, facilitating the creation and sharing of documents and presentations. Teachers can create and assign homework, as well as delegate tasks by sharing on other platforms or assigning tests through Microsoft Forms. Students can easily complete and submit these tasks. The integrated features in Assignments, such as task criteria, deadlines, and the option to assign to specific students, contribute to the convenience of the platform.

3.2.3. Platforms for Implementing Practical Tasks by Students

In the context of updating the educational process in line with modern learning requirements, various educational websites and platforms have been utilized, including Wordwall, LearningApps, Padlet, MakeBeliefsComix, Wisc-Online, ClassTools.net Crossword, Crosswordlabs, Kahoot, and others. These innovative resources provided diverse opportunities for creating tasks aimed at developing practical biology skills in the English language. Tasks developed using the tools of each of these platforms are directed towards stimulating critical thinking, developing communicative skills in a foreign language, and supporting the process of knowledge acquisition. Wordwall and LearningApps were used for creating interactive exercises that enhance language, digital skills, and knowledge in the field of biology. Padlet was applied for creating collaborative boards where students share information and results from their research, promoting interaction and knowledge exchange among students. MakeBeliefsComix was employed to stimulate a creative approach to learning by creating comics that explain biological concepts and processes. ClassTools.net Crossword and Crosswordlabs were utilized for creating electronic crosswords. The use of these educational platforms aimed at optimizing learning and increasing student motivation, while simultaneously meeting the modern requirements and preferences of youth in the digital era.

3.2.4. Tasks for Practical Activities

In response to the set practical objectives, tasks have been designed to cultivate various practical skills and achieve competencies. The process of solving these tasks involves complex mental operations such as analysis, comparison, analogy, and synthesis. The development and use of tasks with educational purposes provide an opportunity for accelerated experiential learning (Hadjiali et al., 2014). According to Raicheva and Tsanova (2012), tasks can be categorized based on the student's experience into standard tasks, where the solution method is known, and creative tasks, where creative thinking, innovation, and originality are required to develop a unique solution or product. The tasks described in this work are standard, featuring all three components - given, sought, and method - within the instructions. The same authors classify tasks as cognitive, affective, and psychomotor, based on the stages of world assimilation and personal spheres - cognitive, affective, and psychomotor (Tsanova & Raicheva, 2012). In the context of forming practical skills, practical tasks have been created wherein competencies are achieved through activities. Another characteristic for differentiating types of tasks as a pedagogical phenomenon, as described by Trashliev (1989), is executive, constructive, and analytical tasks. The following are the types of practical tasks created to develop practical skills and achieve competencies. The skills and competencies targeted by each type of task are detailed in Chapter 3 of the dissertation in tabular form.

3.2.4.1. Task Type: "Modeling a Biological Object"

The process of creating a cellular model involves making assumptions and simplifications to represent the complex biological system in a more manageable way. This requires creativity in deciding which aspects of the biological system to include, how to visualize them, and how to present the product in an original way. Students must use logic, analysis, synthesis, and innovative ideas to find solutions to problems. The task of modeling a biological object - a cell or tissue - is practical and executable because it requires specific actions and the application of theoretical knowledge in real conditions. It involves the use of real materials, tools, and techniques to create a physical or virtual replica of the cell or tissue. This requires students to apply their knowledge of the specific characteristics of prokaryotic and eukaryotic, plant or animal cells, or, in the case of tissues, the differentiating components of various tissues, using practical skills such as cutting, assembling, drawing, or utilizing various tools and software. Such tasks encourage students to develop skills in observation, experimentation, problem-solving, and creative thinking. The developed modeling task effectively integrates all components of Koil's theoretical model - content, communication, and knowledge/skills - providing a competency-based approach to education. The content is related to the biology curriculum on types of tissues and cells and their structure. The communication element is embedded in the task instructions and the modeling process itself. Participants must interpret and understand the provided foreign language directions to create the model, thereby developing bilingual communication skills, crucial for foreign language learning. In the context of the modeling task, knowledge is formed by integrating theoretical knowledge into the solution of a specific problem. Participants develop skills in recognizing and analyzing structural components of a biological object, selecting suitable materials for model creation, constructing a biological object on a different scale, applying techniques to distinguish components of the biological object, labeling structural elements of the model, visually representing the product, presenting the product in a digital environment, recognizing types of cells - prokaryotic, eukaryotic, plant, animal - recognizing and presenting cell organelles, recognizing different types of tissues - epithelial, connective, muscular, and nervous - identifying and describing differences between biological objects, using learned concepts in text composition, working with various sources of information, applying theoretical knowledge in a specific situation, analyzing and systematizing information. Knowledge, in the context of skills, becomes active when applied to a real biological object that is the subject of modeling.

3.2.4.2. Task Type: "Home Laboratory"

Experimental work, including in online learning, stimulates various modes of thinking and creative expression. It requires learners to apply their knowledge and skills in new contexts and situations, contributing to the development of innovative and divergent thinking. This type of learning activity challenges creative initiative and positively influences motivation by engaging learners in an active and involved learning process (Yotovska & Necheva, 2021). Five task variants have been constructed from this type, four from the 9th-grade curriculum (Properties of Proteins, Prokaryotic Cell Application, Membrane Transport, DNA Extraction), and one from the 10th-grade curriculum (Mini Ecosystem). The tasks are designed as experiments conducted in home conditions following a predefined algorithm. They are creative, practical-constructive, and analytical. Applying a creative approach and solving non-standard or trivial problems defines them as creative. Working with real materials, designing and performing activities according to an algorithm encourages the development of skills and experience in applying theoretical knowledge in practical scenarios. Solving these tasks requires analysis of information, evaluation of various possibilities, and making informed decisions. This process develops learners as analysts and helps them understand the connections between different concepts and factors. The main goal of tasks of this type is to provide students with an opportunity to acquire scientific knowledge and understand the principles and laws in the scientific field of biology. The practical task "Home Laboratory" fits into Koil's theoretical model by integrating content, communication, knowledge/skills, and a competency-based approach to the educational process. Within the experimentation in home conditions, the content represents biological concepts and processes that students need to study and apply. This includes topics from the corresponding curriculum, as indicated in tabular form (Appendix 35 of the dissertation). This component is complemented by the scientific text in the task instructions. The communication element in the task is broken down into different aspects - on one hand, instructions in a foreign language that students must understand and follow, and on the other hand, feedback with the teacher when shaping and presenting the product. The process of exchanging information takes place in an electronic environment. The third component - knowledge, involves the development of practical skills through conducting experiments in home conditions. Students apply theoretical knowledge from biology in a real context, using technical skills for measurement, observation, and analysis. The skills and competencies aimed to be achieved by this type of task are presented in Table 5 of the dissertation.

3.2.4.3.Task Type: "Comic"

The use of comics in education is based on the idea that they can create interest and motivation among students towards the educational content and the learning process as a whole (Asenova, 2018). Creating a comic is a creative and hands-on task that requires the specific application of knowledge and skills, as it involves the creation of a graphic and textual story that is both informative and educational. The goals of the task are for students to learn while having fun, to present the processes of cellular metabolism and cell division by creating a comic, using either paper medium or an online comic tool. Practical assignments for creating comics are creative, requiring the integration of imagination and scientific facts. To create a comic, a detailed understanding of the topic being presented through it is necessary. In the case of creating a comic for metabolic processes, high school students must not only understand the essence of metabolic processes but also demonstrate their communication and creativity skills through visual images and text. In this type of task, the correlation of all elements of the adapted conceptual framework—content, communication, knowledge/skills through a competency-based approach—is realized. A biology topic, scientific text in the instructions, communication through the instructions, and presentation of the product form practical skills in reading comprehension, constructing stories through images, using grammatical structures, combining text with images effectively, selecting appropriate images, presenting biological concepts in an original and attractive way, expressing biological concepts and phenomena through images and illustrations, finding original ways to present information, analytical thinking, interpreting and creating visual informational materials, searching for additional information on a specific topic, recognizing and distinguishing between different animal groups, identifying and describing differences between biological objects, using learned concepts in composing text, differentiating types of metabolic processes, recognizing types of division, and the individual phases of cell division, among others (as presented in Table 6 of the dissertation).

3.2.4.4. Task Type "Crossword Puzzle"

The practical task involves creating a crossword puzzle with biological terms in English. The task is creative, involving the selection of terms, construction, and the choice of the medium – electronic or paper – on which it is created and presented. Creating a crossword puzzle with biological terms in a foreign language is a practical-analytical task. Students must be able to define and explain biological terms, improving their language skills and knowledge of the biological dictionary. The task aims to learn the concepts and their content. Working on crossword puzzles requires students to be attentive and concentrate on details and correct answers, promoting the development of self-regulation skills and information processing. In the conceptual aspect of a crossword puzzle creation task, the content represents a rich field of terms and facts from specific biological topics. Students choose and structure information in a way that reflects their knowledge and perception of the important aspects of the subject. This element serves as a basis for forming key cognitive abilities. Communication in this context is realized through creating the crossword puzzle and providing clear instructions for solving. Students actively search for and present information, formulating suitable definitions and clues that guide towards the correct answers. Knowledge expressed in this task comes from students' abilities to select appropriate terms and creatively present this material. The process of constructing the crossword puzzle requires active participation and transformation of individual knowledge into skills for creating an educational environment. Types of activities aimed at achieving competencies and developing skills are presented in a tabular form in the dissertation (Table 7).

3.2.4.5. Task Type "Microscopy with a Compact Digital Microscope"

The task "Microscopy with a Compact Digital Microscope" is a practical research assignment. It involves the investigation of objects or processes using a digital microscope, enabling the recording of images. Students can explore microscopic structures, biological objects, and then analyze and present the results of their observations. This process not only develops their microscopy skills but also familiarizes them with the use of visualization technologies in the biological sciences. Such practical research tasks stimulate students to be active participants in the scientific inquiry process and apply their theoretical knowledge in practical scenarios. This task is designed to present the results on the Padlet platform, where students showcase the outcome as an image and document its characteristics. The practical task

"Microscopy with a Compact Digital Microscope" integrates content, communication, knowledge, and a competency-based approach according to the created concept. The content is presented as knowledge about the structure and characteristics of different types of tissues, as well as the features of a compact digital microscope. The task encourages interaction and information exchange between students and the English language teacher applied in various aspects. Through modern communication technologies, students share their observations, discuss findings, and collaborate to enrich the educational process. Students acquire practical skills in working with a digital microscope and develop analytical and observational abilities. This process contributes to the formation of key competencies such as critical thinking and problem-solving. The task not only provides information but also encourages students to apply their knowledge in real situations. They develop competencies such as creative thinking, communication skills, and collaborative abilities, which are crucial in contemporary education and society. Thus, the practical task integrates all components, combining content, communication, knowledge, and competencies into a harmonious educational experience.

3.2.4.6. Task Type "Digital Activities," Variant "Anthropogenesis"

This type is constructed on the Wordwall platform in the form of four practical activities entirely in a digital environment - categorizing concepts, word searches in a grid, arranging words in a sentence. The task is practical, executable, and standard. The platforms allow the construction of diverse tasks that, through their modern design, contribute to the easier perception and application of information. Their use in the educational process represents an innovative way to engage students, facilitate the learning process, and develop their skills within the digital environment. Digital activities in Wordwall combine the components of the research concept, providing an educational experience that covers content through various learning activities constructed with concepts from the "Anthropogenesis" theme, biology content for the 10th grade. Communication is supported through the possibility of interaction and feedback between students and the teacher during the activities. Knowledge and skills are developed through cognitive exercises, including word recognition and information grouping. The competency approach is reflected in group work, critical thinking, and self-regulation in solving educational tasks.

As a result of achieving the set practical goal of the research – *constructing various types of practical tasks in high school biology education, selecting and preparing didactic materials and tasks for independent work*, a design has been constructed for six types of practical tasks and their variations. By implementing them in practice and analyzing the results described in Chapter 4 of the dissertation, it will be possible to address the research questions regarding the appropriateness of didactic materials, the types of tasks suitable for building practical skills, and whether the application of these tasks affects high school students' attitudes toward biology. This design represents a holistic approach to education, aiming to simultaneously integrate content, develop communication skills, and acquire competencies.

Chapter 4. Analysis and Interpretation of the Results

In the dissertation presented in this chapter, the focus is on the analysis of the results from the methodical research conducted to assess the effectiveness of implementing practical tasks in biology education in a foreign language. The practical goals set in Chapter 1 have been achieved through the experimental verification of the effectiveness of applying variations of tasks to enhance practical skills in biology. Additionally, the study involved experimentally assessing students' attitudes toward using variations of practical tasks in biology education in a foreign language. Furthermore, the development of tools for investigating the effectiveness of biology education in a foreign language for high school students through increased application of practical tasks was undertaken.

The verification of the conducted methodical research was carried out using both quantitative and qualitative methods. The quantitative methods employed include:

- **Average values** of the points obtained for each practical task from two evaluators - the one conducting the research, a colleague teacher in natural sciences, and the self-assessment of the student who implemented the practical task.
- **Standard error of the arithmetic mean value**
- **Standard deviation** in the number of points given by the assessors and the self-evaluator, as well as the overall standard deviation.
- **Pearson's correlation coefficient** between the two evaluators, as well as between each evaluator and the self-assessment.
- **Graphical representation** of the obtained results.
- **Surveys** with closed-ended Likert-scale rating questions.
- **T-test** for comparing students' ratings before and after the experiment to track whether students' interest in biology as a subject increases.

Qualitative methods have also been applied, including **direct observation** to track accuracy in task execution, problem-solving during the implementation of specific task algorithms, assessing effectiveness, and gauging attitudes toward practical tasks as a means of acquiring and reinforcing knowledge. Additionally, qualitative methods were used to address challenges arising in the development of theoretical and practical skills.

4.1. Analysis of Parameters Tracking Results Based on Criteria for the Formation of Practical Skills

To track the effectiveness of the applied practical tasks, an analysis of assessments was conducted by three evaluators: the teacher and assignor of the task, a teacher not involved in instructing the participants but a specialist in the same scientific field, and the self-assessment of the task performer. Evaluation was carried out by assigning points based on predefined criteria in the task instructions. Depending on the degree of meeting the criteria, a certain number of points were assigned. The evaluation criteria served as a tool for measuring various aspects of task performance. For maximum objectivity, the achievement of goals for each type of task was distributed across five criteria. The use of a point system for different criteria contributes to a more detailed analysis of practical skills. Each point is an indicator of the degree of success or performance deficiency.

The analysis of the results was conducted using statistical methods such as the mean, standard deviation, standard error of the mean, and Pearson correlation, providing a quantitative perspective on the degree of agreement or difference in assessments.

As **input parameters**, the results of the participants' first practical task in the 9th grade were used for each participating cohort, aiming to track the development of practical skills with the application of subsequent tasks. The **output parameters** considered were the results from the last practical task completed by the participants during the second academic year in the 10th grade. The analysis of the results was conducted in both vertical and horizontal dimensions. In the ascending dimension, the process of forming practical skills was traced through the results of tasks solved over two academic years when the high school students were in the 9th and 10th grades. In the horizontal dimension, the results of three cohorts of students in the 9th grade were compared with three cohorts in the 10th grade.

The methodical research was conducted in four stages, beginning in the 2019/2020 academic year. Figure 6 presents the mean values of the input parameters from the first practical task, which 99 students completed in March 2020, precisely when education was entirely conducted remotely due to the COVID-19 pandemic.

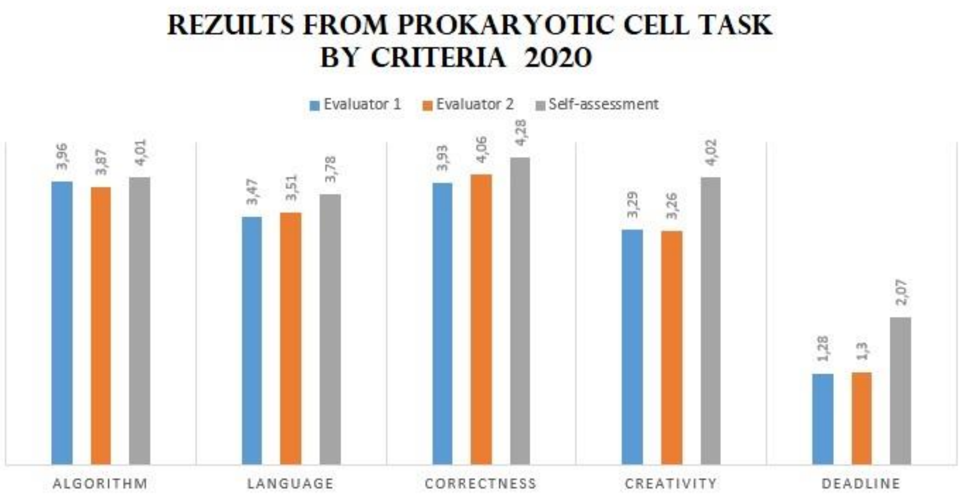

Figure 6. Input Parameters - Mean Values in Points per Criterion from the Practical Task "Prokaryotic Cell," Stage I

Analyzing the results shown in the graph, it is established that the mean values are above average but far from the maximum values for the respective criteria. The values of Assessor 1 and Assessor 2 are close, confirmed by the Pearson correlation, which has a value of 0.847, emphasizing a high degree of similarity in the assessments. Only the self-assessments of the participants have higher values, which could be interpreted as overestimation or a need for changes in the task instructions. Self-assessment allows students to focus on their strengths, examine their actions, and view the results from a different perspective.

In Stage II, the input parameters are the results from the first practical task "Microscopy" for the 9th-grade participants. The criteria for this task are again five, allowing a comparison in the number of points from the subsequent practical tasks and tracking changes in the formation of practical skills and the achievement of competencies. The following results were obtained (Figure 7).

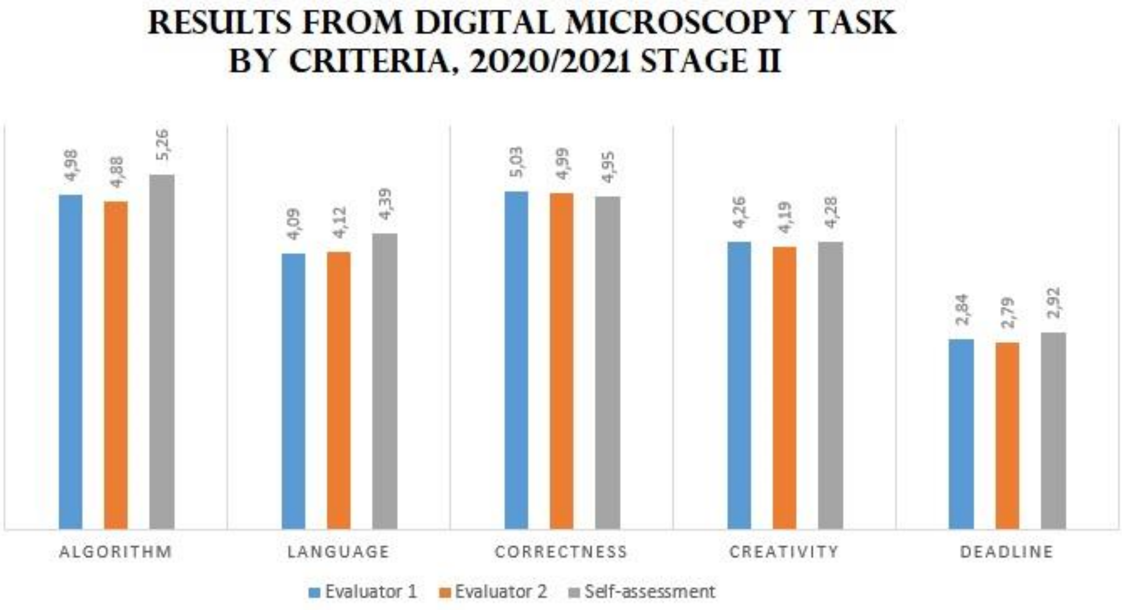

Figure 7. Mean scores in points per criterion from the practical task "Microscopy with Digital Microscopes," Stage II

Comparing the input parameters of the mean number of points per criterion from Stage I and Stage II reveals a difference in the results between the two cohorts. For the criteria, the values are as follows: Algorithm - Stage I: 3.95, compared to Stage II: 5.04; Language - Stage I: 3.69, compared to Stage II: 4.20; Correctness - Stage I: 4.09, compared to Stage II: 4.99; Creativity - Stage I: 3.52, compared to Stage II: 4.24; Deadline - Stage I: 1.55, compared to Stage II: 2.92. The second stage of the study starts with higher results, which is likely due to the personal characteristics and abilities of the new participants, as well as the smaller number of high school students investigated in this stage. It should be noted that this task is only performed in a face-to-face form of training, and high school students adhere to the deadline for completing the task because they are constrained by time from the schedule of school hours. The focus of the research described in this work is to determine whether there is a change in the results, which will be an indication of the development of skills after the conducted pedagogical experiment.

Figure 8 illustrates the trends in the mean number of points from the three assessors for all conducted practical tasks during Stage I of the pedagogical experiment.

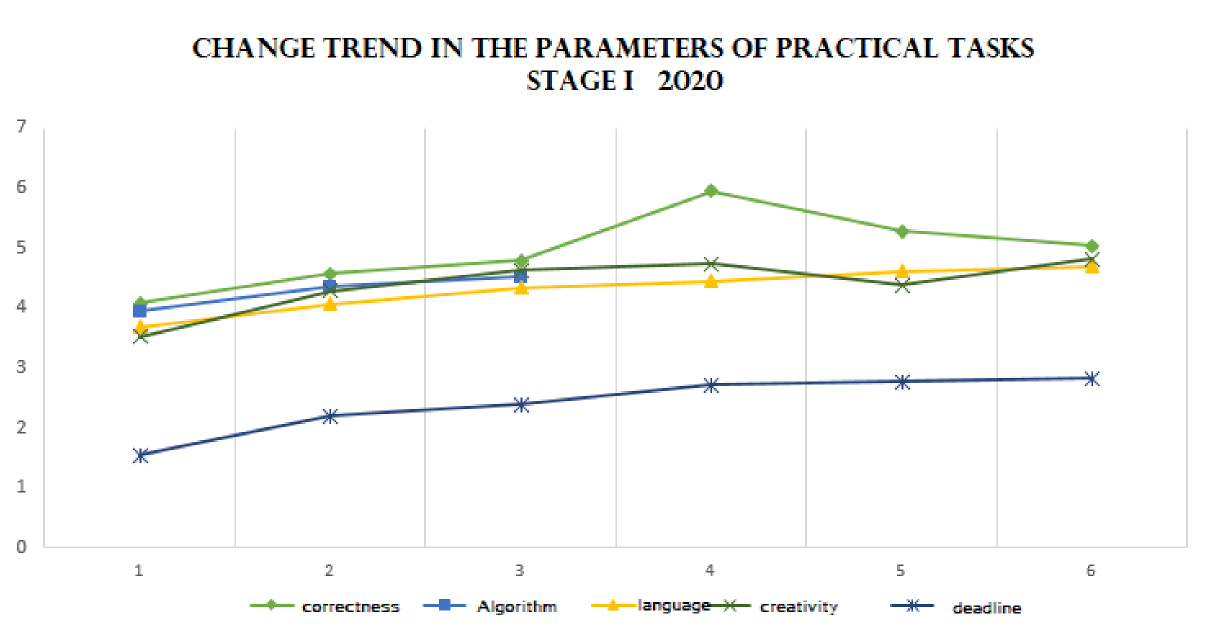

Figure 8. Trend in the change of mean arithmetic scores in points per criterion from practical tasks, Stage I

The graphically presented data shows that the number of points has increased for each criterion in each of the practical tasks. The Pearson correlation between the number of points for rater 1 and rater 2 is 0.837, between rater 1 and self-assessor is 0.809, and between rater 2 and self-assessor is 0.821. The data indicates high consistency in the results and a well-expressed linear dependence between the number of points assigned by the raters. Self-assessors give similar evaluations to their work, demonstrating skills for a realistic perception of what they can achieve and what their strengths are. The tendency for higher ratings in self-assessment is maintained throughout the entire first stage, with the difference becoming smaller with the number of completed tasks. This is explained by timely evaluation of the performed practical tasks and corrective comments from the teacher motivating the number of points for each criterion. The overall standard deviation is 0.093. The standard deviation values for Stage 1 are distributed as follows: rater 1 – 0.268, rater 2 – 0.282, self-assessor – 0.304. The results show a small variability in the assessments. Similarity in standard deviation emphasizes the objectivity in the assessments of the three raters. With identical assessment criteria, it contributes to the reliability and objectivity of the assessment process.

For a horizontal comparison of the results of high school students from Stage I with those from Stage II, Figure 9 shows the achievements in the number of points for the remaining three criteria - deadline, creativity, and language. From the graph data, it can be observed that the number of points for the presented criteria increases similarly to Stage I. For the deadline criterion, a small difference is noticed from the incoming parameter - 2.857, and the number of points from the last practical task of the academic year for the participants from 9th grade is 2.977. For the second task, the number of points for the deadline criterion is smaller - 2.263. This is explained by the fact that the first practical task was carried out entirely in a face-to-face form of training, and the activities were conducted in the classroom. From the illustration

(Figure 9), it becomes clear that the average number of points increases gradually for the three criteria presented in the figure.

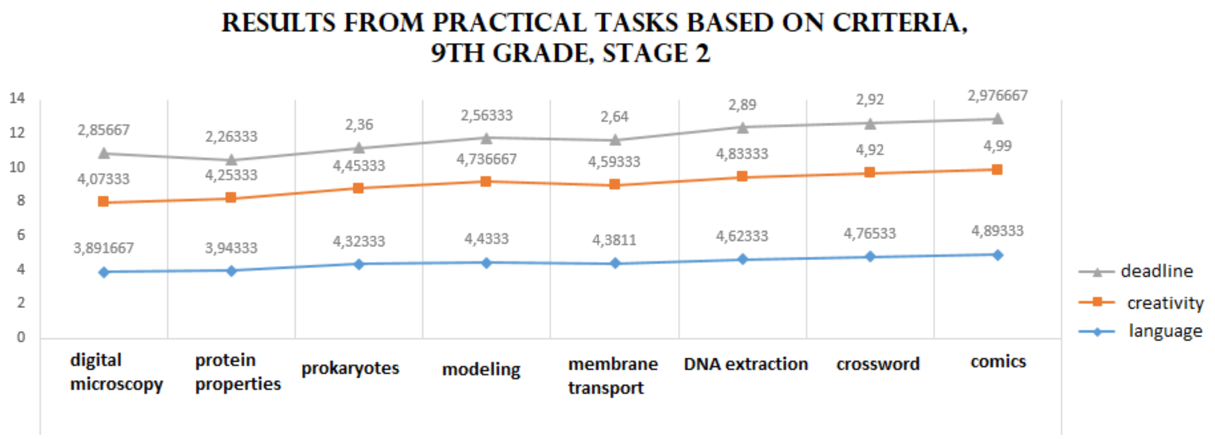

Figure 9. Average scores in points by criteria - deadline, creativity, and language from practical tasks for 9th grade, Stage II

With an increasing number of completed tasks, the number of points increases by the criteria, as seen in the participants from the 9th grade in Stage I. This leads to the conclusion that the more practical tasks students complete, the better results they achieve. Therefore, they successfully accomplish the goals of the tasks, namely the formation of various practical skills. It is essential to note that participants in Stage II were trained in a hybrid form of education, but this did not affect the formation of practical skills. The likely explanation for this fact is that almost all tasks, except "Microscopy," are designed to be carried out in both in-person and remote forms of education, utilizing resources accessible to students in the online environment.

The results from Stage III for the 9th-grade students are presented in Figure 10.

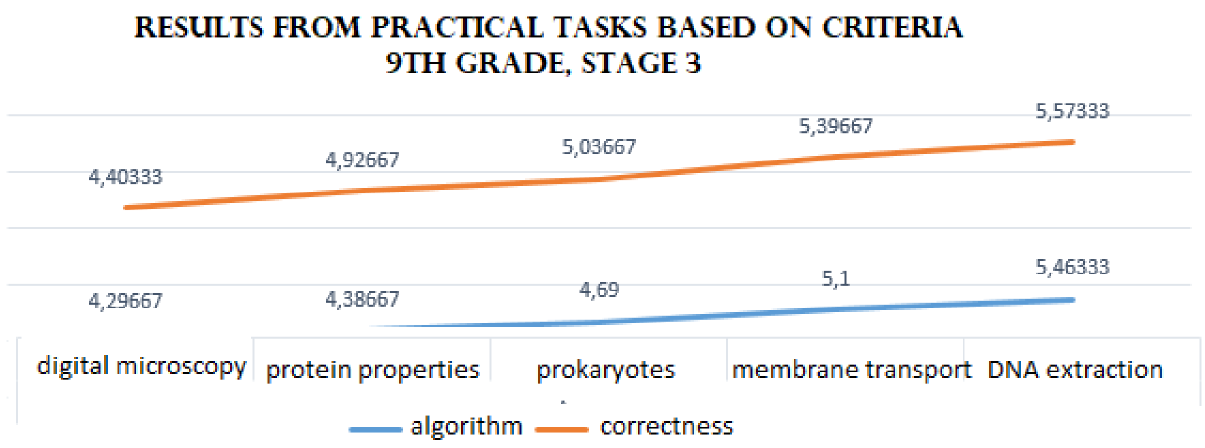

Figure 10. Average scores in points by algorithm and correctness criteria for practical tasks for 9th grade, Stage III

According to the data, the values for the algorithm criterion demonstrate an increase from the first task to the last, indicating a continuous improvement in students' use of a systematic and effective method when solving problems. This growth in algorithm values is associated with improvement in logical thinking and the ability to structure activities. Tracking the correctness criterion shows the same trend of gradually increasing values, as students solidify their ability to present accurate and correct results when completing tasks. This aspect reflects a demonstrative development of students in enhancing their analytical skills and adopting a critical approach when solving problems.

When tracking the results of the participants in the study in a vertical plan, a positive trend of increasing points based on criteria related to practical tasks is observed. This growth provides objective evidence for the development and formation of the studied skills in the students. Results from three practical tasks of students from stage II, who participated in stage I, are shown in Figure 11, presented in the order in which they were carried out.

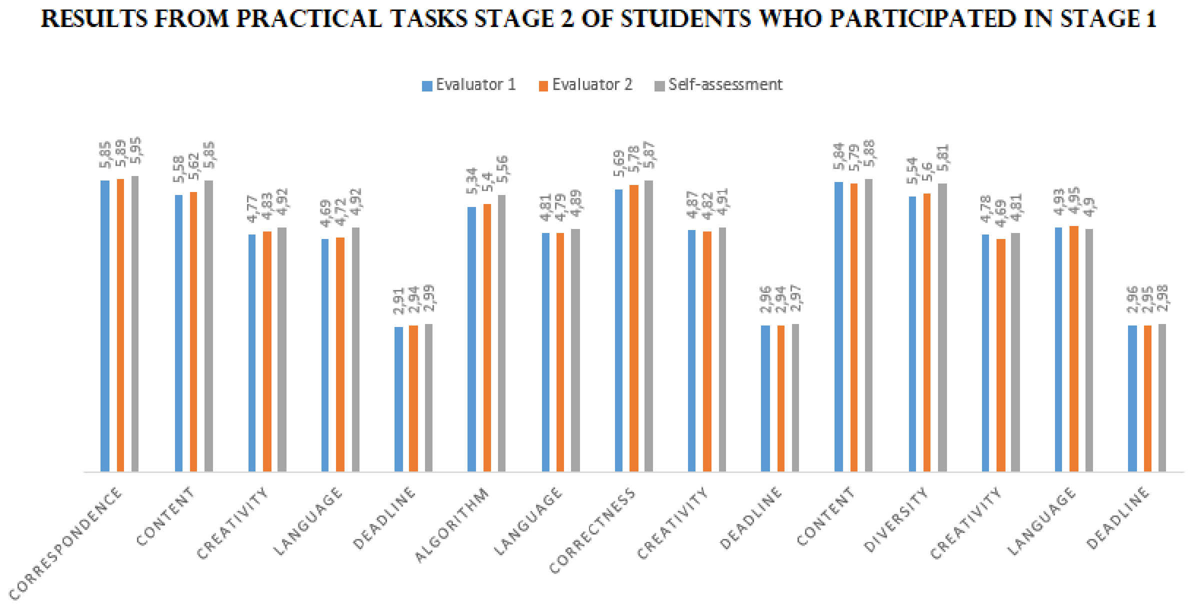

Figure 11. Average scores in points per criterion from practical tasks "Crossword Puzzle," "Mini Ecosystem," and "Food Chain," Stage II.

From the data on the graph, it can be observed that the mean values of the evaluators are very close, and this is also valid for the self-assessments. When comparing the points based on the criteria, it is noticed that almost maximum results, 5.90, are achieved for the correctness criterion. This indicates improvement in the students' skills regarding the analysis and explanation of biological facts, connecting concepts with precise definitions, organizing information, analytical thinking, creating visual informational materials, etc. The algorithm criterion has a mean value of 5.43, showing an increase compared to the previous stage's maximum of 4.69. Comparing it with the input parameter from 2020 - 3.95, it can be concluded that the students have developed algorithmic work skills. When comparing the results of Stage II criteria (language, creativity, deadline) with those of Stage I, there is a trend towards approaching the maximum points for each criterion. Both the tenth-grade students from Stage II and those from Stage III were evaluated by two assessors and conducted self-assessment after completing the tasks. The mean values by criteria for the tasks conducted in this stage are shown in Figure 12.

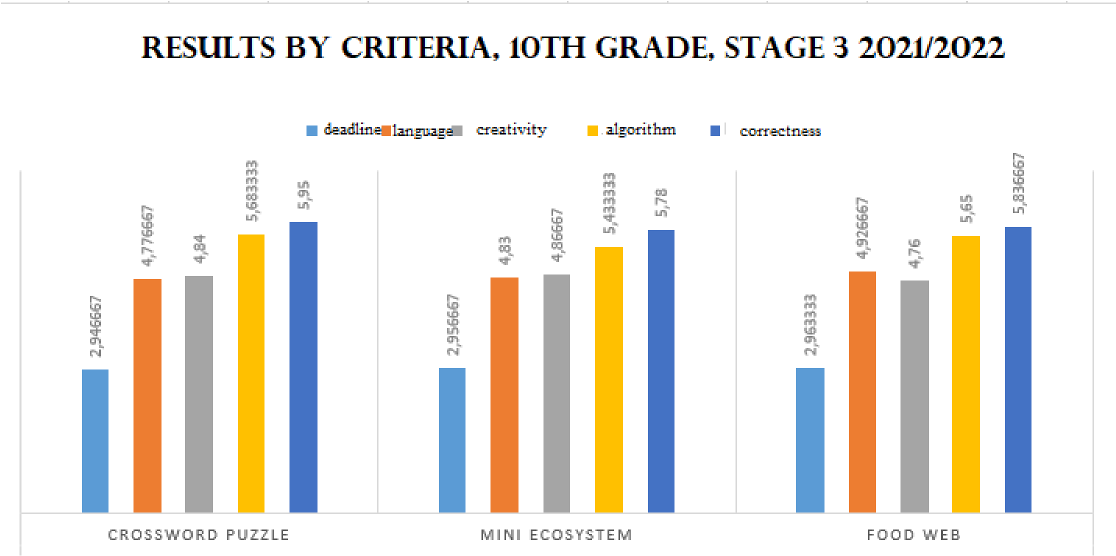

Figure 12. Mean Scores in Points by Criteria from Practical Tasks for 10th Grade, Stage III.

From the graph (Figure 12), it can be observed that, in terms of the deadline criterion, the results have maintained the values from the last completed task in the 9th grade. The values are very close to the maximum three points. A definite conclusion can be drawn that, after twelve implemented practical tasks, students have acquired the skill to complete practical assignments while adhering to specified deadlines. Regarding the language criterion, similar results are observed for the tenth-grade participants in the pedagogical study. The high school students have successfully presented descriptions, analyses, conclusions, and products in a foreign language, enhancing their skills in reading, comprehension, and writing in English. The trend of achieving scores close to the maximum continues for this criterion. For the algorithm criterion, values above 5.5 out of a maximum of 6 have been achieved, indicating a stable trend.

The participants in the final stage of the study are fifty-four high school students who completed four practical tasks. The achieved results, distributed across individual criteria, are presented in Figure 13.

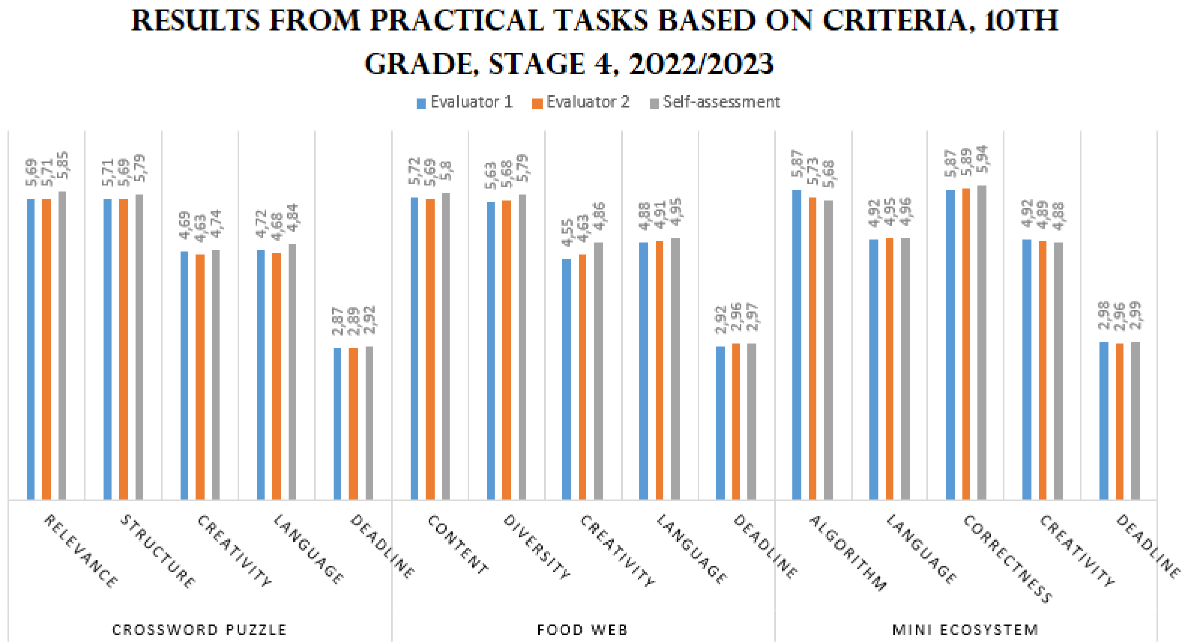

Figure 13. Average scores in points by criteria from practical tasks for 10th grade, IV stage

Based on the data shown in Figure 13, it can be concluded that the average values of the evaluators and self-assessments are extremely close and overall high. Analyzing the results by individual criteria, it is found that the correctness criterion achieves scores close to the maximum - 5.78, compared to the initial values of 4.40. This significant improvement of 1.38 points indicates an enhancement in the students' skills in analyzing and explaining biological facts, combining concepts with clear definitions, organizing information, analytical thinking, and creating visual materials. The algorithm criterion also shows improvement, with an average score of 5.75, which is higher than the maximum value from the previous stage - 5.46. Comparing it with the initial parameter in 2021 of 4.30 emphasizes the successful development of students' skills in following instructions. The analysis of the results from Stage IV for the criteria language, creativity, and deadline shows a trend towards approaching the maximum points for each criterion. This progress reflects not only an improvement in the students' specific skills but also the successful formation of practical skills within the conducted study. Their average values have changed as follows: language criterion - initial value - 3.75, at the end of Stage IV - 4.87; creativity criterion at the beginning - 4.04, at the end of Stage IV - 4.75; deadline criterion at the start - 2.77, at the end of Stage IV - 2.94.

Summarizing the investigation of parameters within the practical tasks across all stages, a clear trend of improvement in results throughout the entire research period can be observed. This progression is closely linked to an increase in scores by criteria, demonstrating a systematic enhancement in the effectiveness and quality of performance. The evaluation conducted by both assessors and self-assessment ensures the reliability and objectivity of the obtained results. This consistent progress not only affirms the commitment and diligence of the participants but also indicates the successful adaptation and development of necessary skills. The formulated conclusions underscore not only excellent performance but also a continuous readiness for improvement in the future. In conclusion, based on the summarized results by performance criteria from assessors and self-assessment, it can be asserted that the design of practical tasks is effective and achieves the conceptualized goals.

4.2. Analysis of Parameters Reflecting the Opinions, Attitudes, Difficulties, and Dispositions of the Investigated High School Students towards Practical Tasks

This analysis focuses on the study of high school students and their perception of various aspects of practical tasks. To assess the effectiveness of practical tasks, the respondents' attitudes toward biology as a science, the existence of difficulties in task execution, a standardized survey with rating questions was created. Closed-ended questions were used to allow students to express their opinions quickly and easily after completing practical activities. The survey was conducted at the end of each academic year, following the completion of the last practical task for the respective period. The questions reached students through a link on the Shkolo platform via a message. The SurveyMonkey platform was used for constructing and conducting the survey. The data were summarized and presented collectively for all stages of the survey. The survey used in the study included ten closed-ended questions aimed at providing a clear picture of students' perceptions of the proposed practical tasks. In this context, the analysis covers various aspects of their reactions, capturing trends and common attitudes that may influence the learning process.

Figure 14 presents the responses to statement Q1 ("Practical tasks in biology are interesting.").

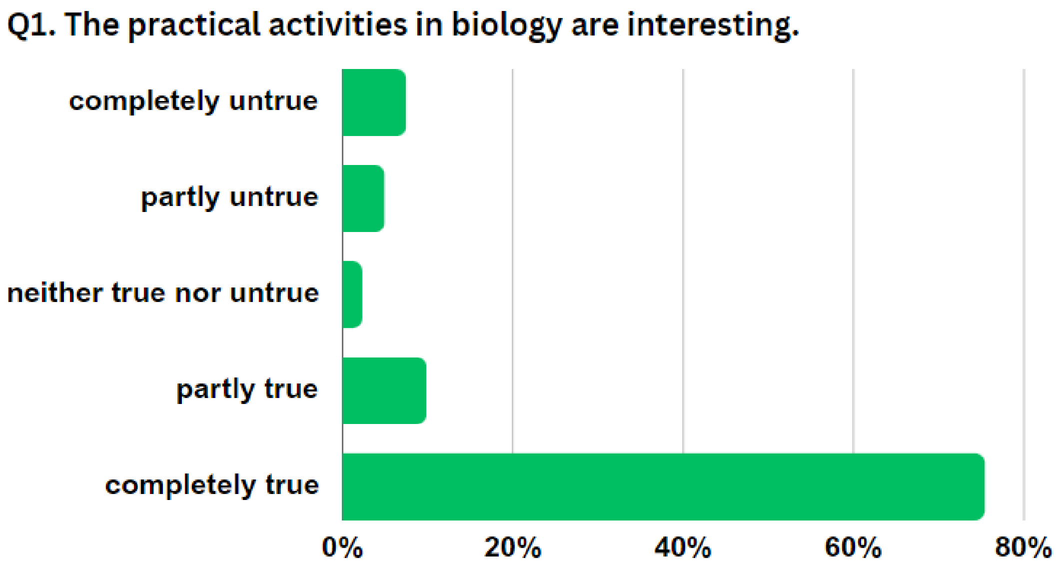

Figure 14. Results from the responses of students participating in the survey for statement Q1.

A large group of participants (75.43%) consider the statement to be 'completely true,' indicating that a significant portion of high school students express a high level of interest in practical tasks in the field of biology. Only 9.84% responded 'almost true,' which may be interpreted as a fluctuation in the degree of interest. However, even these participants express a positive attitude towards practical biology tasks. A relatively small percentage of participants (2.29% for 'neither true nor false' and 4.96% for 'almost false') express a negative or neutral opinion regarding the statement. The results from the first statement emphasize the widespread positive attitude of high school students towards practical tasks in the field of biology. This aspect can be used to stimulate educational initiatives that highlight the practical side of the learning process and increase students' engagement with the subject. Statement Q3 aims to explore the students' belief in the benefits of solving practical tasks for a more successful understanding and learning of biology content.

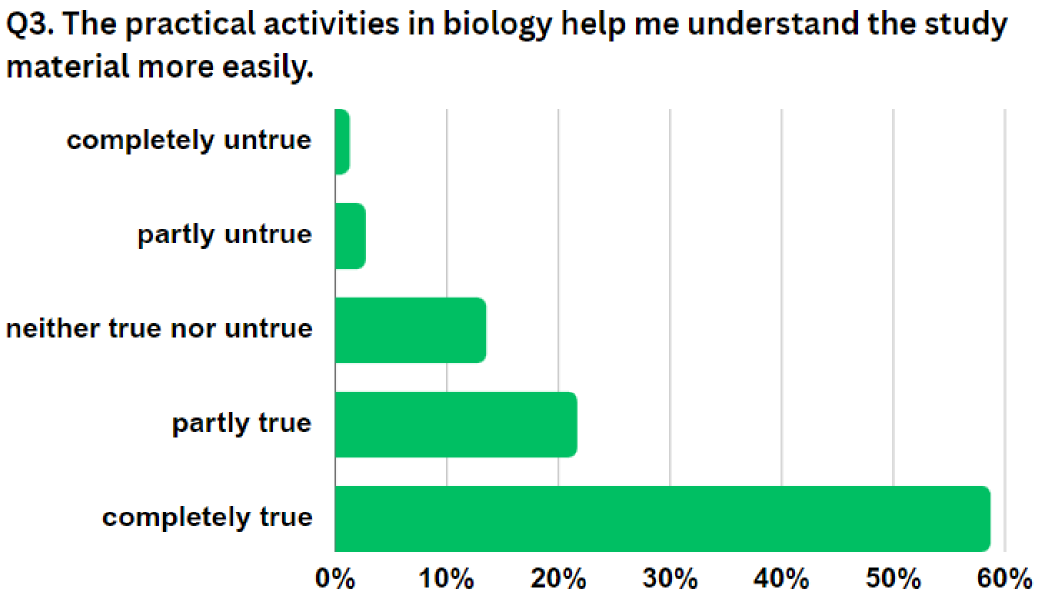

Figure 15. Results of responses from students participating in the survey for statement Q3.

Interpreting the responses of participants to the statement 'Practical activities in biology help me understand the study material more easily,' as shown in Figure 15, leads to the following conclusions: A large majority of high school students (58.76%) consider the statement to be 'completely true.' This result is significant and indicates that practical activities assist in the acquisition of biology knowledge for more than half of the students. A considerable number of participants (21.69%) responded 'almost true,' which can also be interpreted as an expression of a positive attitude towards the benefits of practical activities. A small percentage of participants (1.28% for 'completely false' and 2.73% for 'almost false') express a negative opinion regarding the impact of practical activities on understanding the study material. Statement Q5, 'Solving practical tasks in an electronic environment helps me acquire biological terminology in English,' aims to track the respondents' attitude towards their work in an electronic environment, concerning the tools used for studying and reinforcing biological concepts in English.

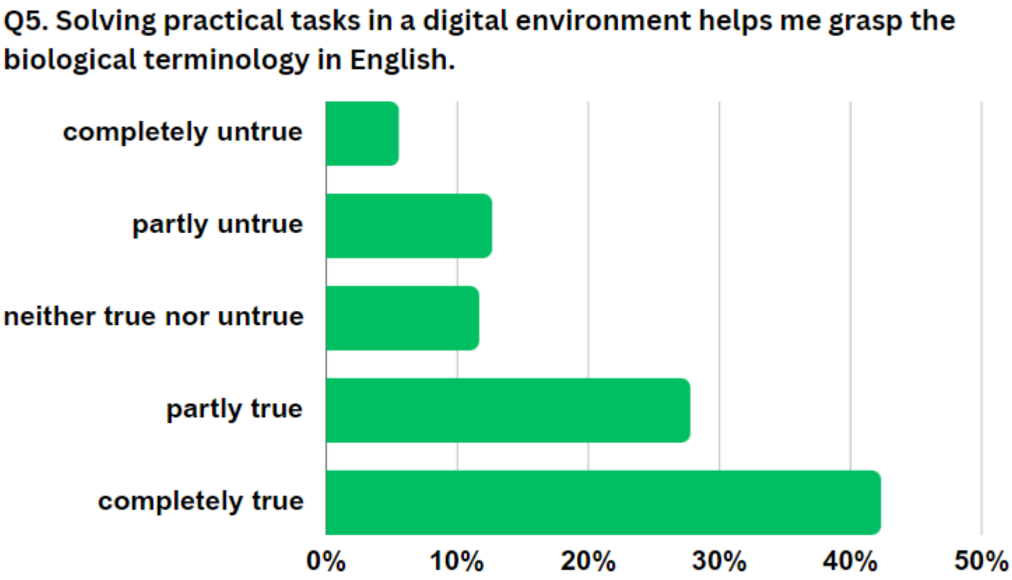

Figure 16. Results of responses from students participating in the survey for statement Q5

The results of the fifth statement (Fig. 16) indicate that a significant percentage of participants (70.11%) perceive solving practical tasks in an electronic environment as having a positive impact when learning biology concepts in English. Of the respondents, 42.33% stated "completely true," and 27.78% stated "partly true." A small portion (11.67% for "neither true nor false" and 12.66% for "almost false") do not consider the execution of activities in electronic platforms effective for improving their knowledge of English in the field of biological science.

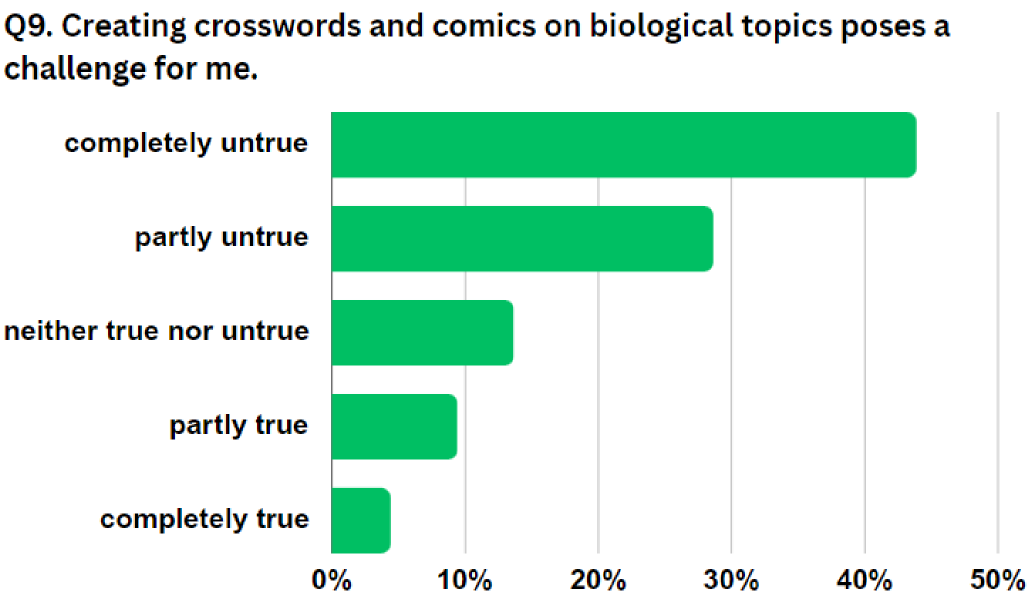

Figure 17. Results of responses from students participating in the survey for statement Q9

The penultimate statement from the survey explores the attitudes of respondents regarding constructing crosswords and creating comics on topics they study in biology. The sorting of responses is shown in Figure 17. The analysis of answers to Q9, "Creating crosswords and comics on biological topics is challenging for me," shows that a significant portion of participants (72.52%) do not encounter difficulties when creating crosswords and comics on biological themes. This emphasizes that these creative methods for studying biology are accessible and convenient for most students. However, 13.66% of participants express neutrality, neither confirming nor denying difficulties. This element of uncertainty may be associated with individual differences in the adoption of these methods, where some students may feel more comfortable than others. Additionally, a small percentage (9.42% "partly true" and 4.40% "completely true") of participants express that creating crosswords and comics on biological topics is challenging for them. This aspect highlights that there is a group of students who may experience difficulties or discomfort in applying these creative methods. In summary, the results show variability in students' responses and emphasize the importance of diversity in teaching methods. This analysis suggests that educational practices can be directed towards a more flexible and individualized approach that takes into account differences in students' preferences and abilities. As for the final question, participants were asked about their feelings and attitudes toward satisfaction and pleasant emotions accompanying practical-oriented activities. The data obtained from high school students are summarized in Figure 18. Analyzing responses from the survey regarding statement Q10, "Practical tasks in biology are fun, and I perform them with pleasure," it is noted that 69.87% of high school students express a categorically positive view that performing practical tasks in biology brings them enjoyment and satisfaction. This aspect is distinctive and reflects the strong positive reaction of a large percentage of students.

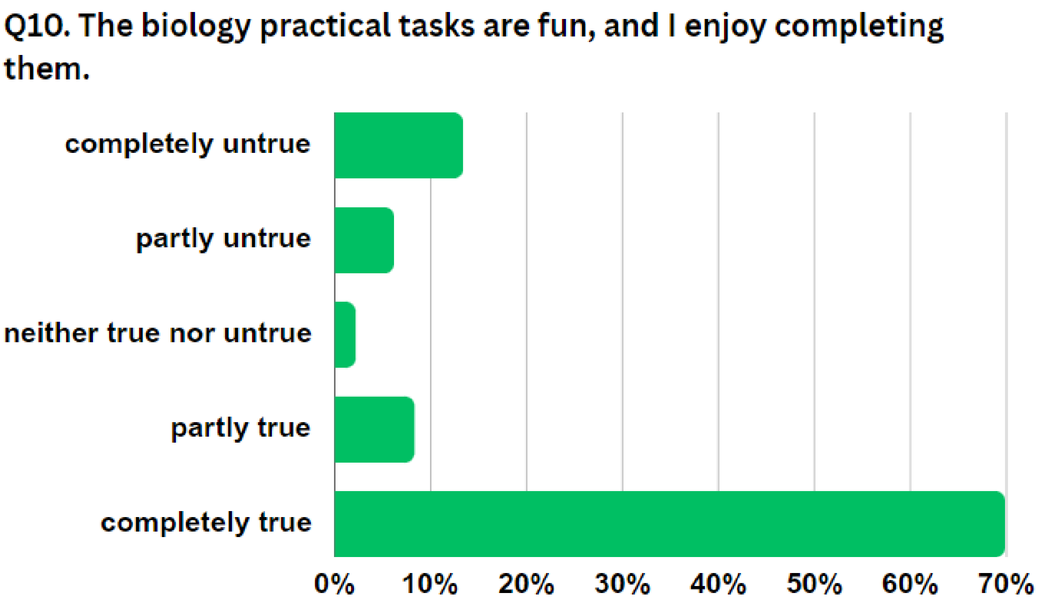

Figure 18. Results of responses from students participating in the survey for statement Q10

In the final analysis, 8.34% choose "partly true," emphasizing that there is a smaller group of participants who, while not as enthusiastic, still experience a certain level of satisfaction from performing the tasks. A relatively small percentage (21.79% - 13.40% "completely untrue," 6.21% "almost untrue," and 2.18% "neither true nor untrue") express a more neutral or negative opinion about this statement. This may be interpreted as the presence of a group of participants who do not feel as strong enthusiasm or satisfaction when performing practical tasks in biology. From the obtained data, it appears that the majority of participants enjoy practical tasks in biology, but there are also some who express a more reserved or negative attitude. The conclusions derived from the comprehensive analysis of the survey results among 179 students from the 9th and 10th grades at the "Dimitar Dimov" High School in Pleven, conducted over the four stages of the study, reveal a consistent and positive trend in participants' attitudes toward practical tasks. There is a positive disposition towards the completion of assigned activities, satisfaction with the impact of the implemented activities on mastering the study material, lively interest, and enjoyment in completing the tasks. High percentages of responses emphasize the importance of interacting with the material and applying theoretical knowledge in practical scenarios. The attitudes of the students presented in the survey highlight interest and a willingness to learn, indicating the significance participants attribute to the practical aspects of education. A small percentage of high school students state that performing practical tasks is challenging for them. Such responses allow the development of strategies to support these participants in overcoming difficulties. An interesting trend is that the challenges are primarily related to the complexity of the tasks and the need for a better understanding of the instructions. This aspect opens opportunities for optimizing communication and ensuring clarity in the provided guidelines for task completion. Results from responses related to specific types of tasks indicate that students handle modeling, solving problems in electronic platforms, creating comics and crosswords, and experimenting at home with ease. A positive attitude is a prerequisite for successfully developing practical skills through the execution of various activities related to the application of biological knowledge in practice, combined with performing these tasks in the English language.

4.3. Analysis of Parameters Tracing Participants' Attitudes toward the Academic Discipline of Biology and Health Education

The high school participants in the pedagogical study underwent an entrance examination in the academic disciplines correlated with the study - biology and health education, as well as English language. These grades were utilized as input parameters for the pedagogical study. Official data from the Shkolo platform, where all student grades for the study period are stored, were used. Since the aim was to track the change in the attitudes of the same students before and after the pedagogical experiment, a t-test was employed to establish statistically significant differences in student grades before and after the pedagogical experiment. These initial grades were employed to monitor the participants' attitudes towards the biological discipline and their increased interest in it when applying practical tasks. The outgoing parameters included the participants' annual grades in the academic disciplines of biology and health education and English language.

The following formula is applied:

$$t = \frac{\overline{X_1} + \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$, where:

$\overline{X_1}$ и $\overline{X_2}$ are the average values of success before and after the experiment,

S_1 и S_2 are the standard deviations of success before and after the experiment,

n_1 и n_2 are the number of students at the beginning and at the end of each stage of the experiment.

The null hypothesis (H0) has been formulated: There is no statistically significant difference in students' success before and after the experiment. It is countered by the alternative hypothesis (H1): There is a statistically significant difference in students' success before and after the experiment, indicating an increase in students' interest in the academic disciplines of biology and health education in English.

A standard level of significance (α) has been chosen, representing the probability of rejecting the null hypothesis when it is true. This parameter is selected by the researcher due to its reliable and common use in statistical calculations, where a standard level of significance of 0.05 or 5% is typically employed. It determines how small the probability of error must be to reject the null hypothesis. Based on the results of the t-test, used to compare the students' performance before and after the experiment, the p-value has been calculated (the probability of obtaining the observed results or more extreme if the null hypothesis is true). The formula for the relationship between the p-value and the level of significance (α) is:

$$p \leq \alpha$$

This means that if the p-value calculated from the t-test is less than or equal to α, then we have grounds to reject the null hypothesis. On the other hand, if the p-value is greater than α, we do not have sufficient grounds to reject the null hypothesis. In the context of our study, with the adopted standard level of significance $\alpha = 0.05$, if the calculated p-value is less than or equal to 0.05, it would indicate statistically significant differences in students' performance before and after the experiment. Otherwise, if the p-value is greater than 0.05, we do not have sufficient grounds to reject the null hypothesis, and we can conclude that we have not found statistically significant differences.

To calculate the p-value, Microsoft Excel was chosen as the tool, where the students' results at the four stages of the study are entered in tabular form. The arithmetic means of the input ($\overline{X}_1$) and output parameters ($\overline{X}_2$) across academic years are presented in Table 1.

Table 1. Average values of success before and after the experiment by academic years

Stages of the research	Input parameters $\overline{X}_1$	Output parameters $\overline{X}_2$
2019/2020	4.305	4.568
2020/2021	4.491	4.778
2021/2022	4.471	4.735
2022/2023	4.372	4.845

After the calculations were performed, the following value was obtained: p = 0.029, which classifies the result as statistically significant.

$$p \leq \alpha$$
$$0.029 \leq 0.05$$

The obtained data suggest rejecting the null hypothesis and accepting the alternative. The results of the conducted t-test, including the obtained p-value of 0.029, represent a crucial moment in assessing the impact of the experiment on students' success and their attitude towards biology. The calculated p-value of 0.029, which is smaller than the traditional significance level α=0.05, provides statistically significant evidence for differences in students' success before and after the experiment. This result emphasizes that the introduced practical tasks have a positive impact on biology results. The attitude towards biology as a subject and science is of crucial importance, as students' success can be an important indicator of their interest. The observed correlation between the success of high school students and increased interest in biology highlights the success of the experiment. The introduction of a greater number of practical tasks proves to be a significant element in this context, creating a stimulating educational environment and encouraging active engagement with the study material. This scientifically grounded analysis of the results underscores the importance of practical tasks in the educational process and their impact on students' interest and achievements in biology. The obtained statistical data provide objective grounds for the conclusions drawn from the conducted experimental study and confirm the success of the applied methodology.

4.4. Qualitative Method Data Analysis - Direct Observation

Quantification of theoretical frameworks is achieved through the use of observation based on specific criteria. This approach provides a systematic and structured way of measuring and assessing theoretical aspects through clearly defined criteria. The results of this observation are presented through quantitative data, reflecting the degree of performance or characteristics of theoretical frameworks compared to predetermined criteria. This quantitative approach allows for a more objective investigation and analysis of theoretical aspects by providing a quantitative basis for evaluation and comparison within the scientific research process. In the presented study, conducted from March 2020 to June 2023, direct observation focused on various aspects of students and their interaction with practical tasks. The observed aspects include:

- *The students' attitude towards solving practical tasks.* Throughout the entire research period, the study tracked how students approach practical tasks and what emotions or motivations manifest during their execution.
- *Difficulties in understanding the instructions.* Analyzed were the difficulties students encounter in interpreting and following the instructions provided for each task.
- *Preferences towards some of the tasks were examined.* The study investigated whether students express preferences for specific types of tasks and how this influences their activity and engagement.
- *Differences based on the environment in which tasks are implemented have been examined.* It has been observed whether the environment in which practical tasks are performed influences students and their effectiveness.
- *The language of the instructions for the tasks.* The impact of the language used in the instructions for the tasks on their clarity and comprehensibility for the students has been investigated.
- *Adherence to an algorithm during problem-solving.* It has been observed to what extent high school students follow a specific algorithm or sequence of steps when solving tasks.
- *Formatting a product according to predefined criteria for a given task.* Observed how the products from practical tasks are formatted, adhering to specific criteria and standards.
- *Increasing interest in biology.* The object of observation was the effect of practical tasks on increasing students' interest in biology and science as a whole.

These aspects provide an opportunity for a holistic understanding of the impact of practical tasks in the educational process and contribute to formulating significant conclusions and recommendations for improving the learning environment. A system of indicators for eight observation criteria has been developed (Appendix 33 of the dissertation), integrating the essence of the practical skills formation concept, being clear and mutually exclusive. The observation results are reflected in protocols filled in during the execution of activities and their evaluation. To prevent errors, enhance objectivity, and reliability of the observation, as described by Bizhkov (1984), a "comparison of the results from one observer at different stages of the study" has been applied with those of another observer. Given that task results are assessed by criteria, the conducted observation aims to trace prominent trends, exceptions, and peculiarities in the above-mentioned aspects.

In connection with the extensive volume of data obtained during the observation in the four stages of the study, summarized results are presented. This information provides a comprehensive view of the key trends and outcomes derived from the observation. The figures below offer a visualization of the data focused on specific criteria validated in each stage.

Figure 19 illustrates the participants' preferences for the type of task they have completed during Stage I.

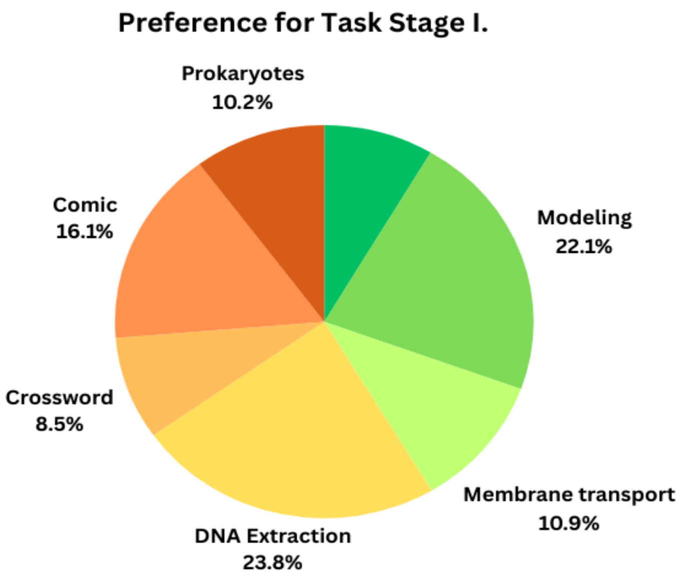

Figure 19. Observation results regarding preferences for the type of task. Stage I

When summarizing the data from the protocols, a significant interest in tasks involving experimentation in the "Home Laboratory" is observed. The tasks "Modeling," "DNA Extraction," and "Comics" had the highest preferences during this period. The products from these tasks are diverse and creatively approached, confirming the results from student comments. Based on these findings, for the next stage, the design of two additional tasks from the "Home Laboratory" category was developed - "Protein Properties" for 9th grade and "Mini Ecosystem" for 10th grade. In the later stages, the most preferred tasks continued to involve experimentation at home, with the highest percentage for "Mini Ecosystem." Figure 20 compares the results obtained from the observation regarding participants' attitudes towards solving practical tasks during stages II and III.

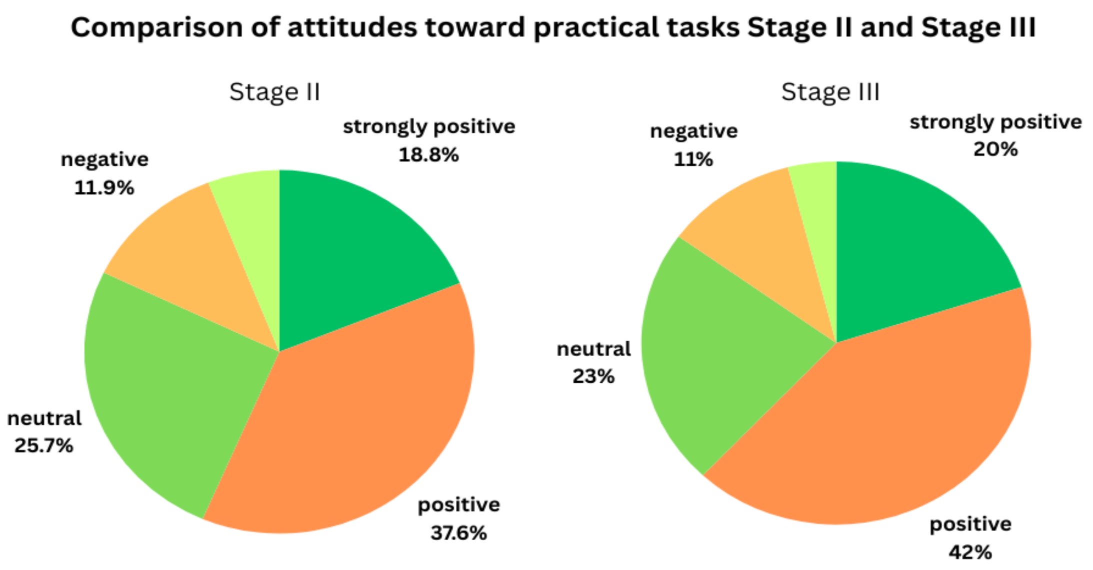

Figure 20. Comparison of observation results regarding the participants' attitudes towards practical tasks from Stage II and Stage III

The observation notes a similarity in the attitudes of students who participated in the previous stage and those who joined the experiment for the first time. The first group has developed a positive attitude and a desire for more practical activities. The second group shows curiosity but also uncertainty about handling the assigned tasks. The graph illustrates the change in attitude towards solving a greater number of practical tasks, with an increase in the proportion of positively inclined participants and a decrease in strongly negative attitudes.

Figure 21 compares the results of the observation based on the criterion of following the algorithm during stages II and III.

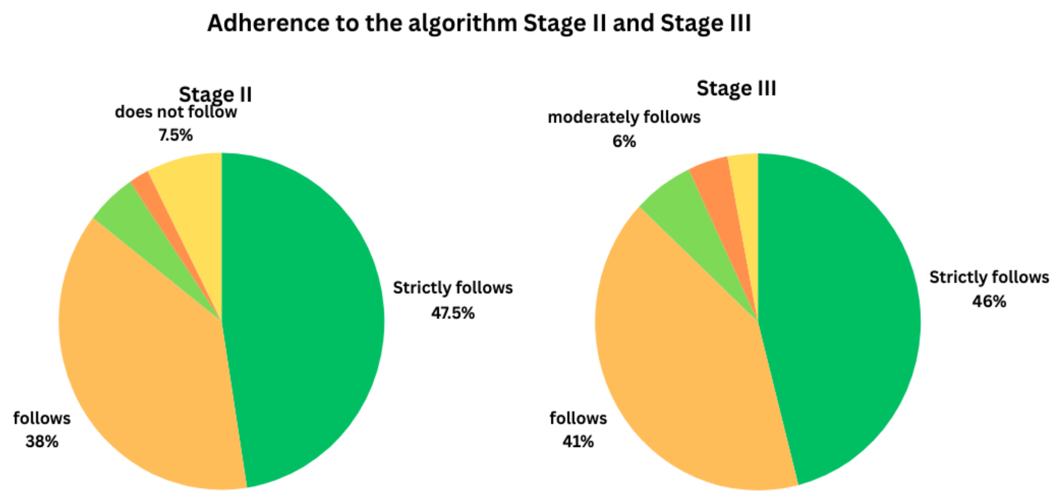

Figure 21. Comparison of observation results regarding adherence to the algorithm during the execution of practical tasks. Stage II and Stage III

The graphs show similarities in the results from both stages, confirming the stable development of skills in solving tasks while adhering to a sequence of actions, making appropriate material choices, and correctly using electronic platforms for task-solving or submitting finished products. When tracking the results based on the attitude criterion for solving practical tasks from Stage III and Stage IV, the following was observed (Figure 22). The presented data clearly demonstrate the positive attitude of students towards solving practical tasks in biology classes. When compared to previous stages, the percentage of high school students with a positive opinion increases at each stage.

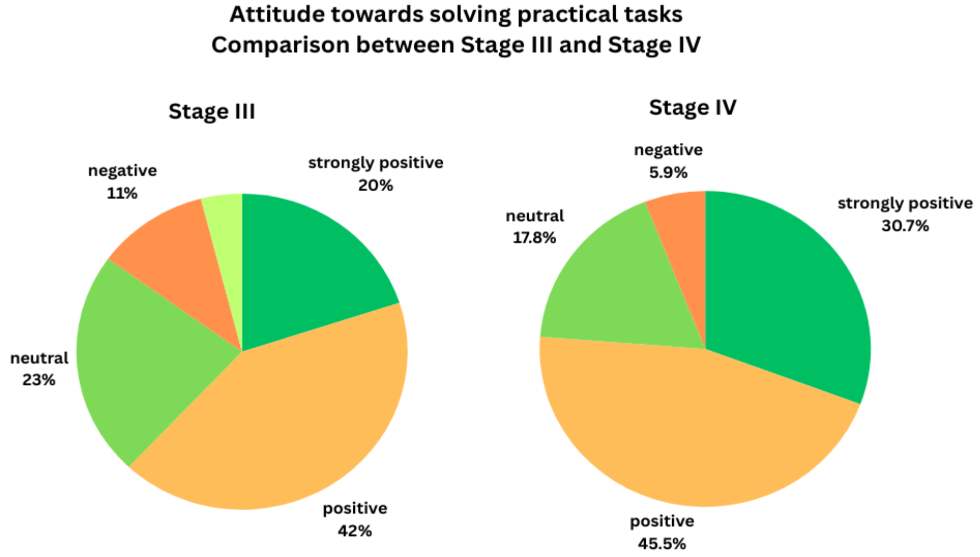

Figure 22. Comparison of results from observation regarding the willingness to perform practical tasks. Stage III and Stage IV

Upon analyzing the data obtained from the observation based on the criterion of interest in biology, the following trend was observed (Figure 23).

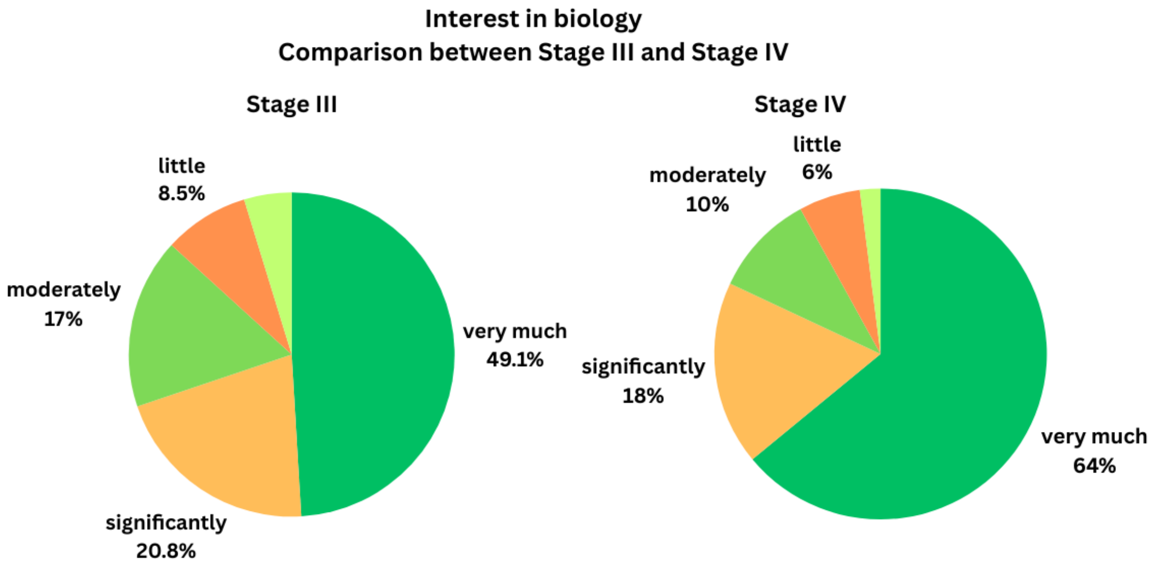

Figure 23. Comparison of observation results regarding the interest in biology when implementing a large number of practical tasks. Stage III and Stage IV

The presented data clearly demonstrates an increase in the interest of the surveyed students when comparing the results from the last two stages. By comparing the data from Stage I and Stage II, it can be seen that the group with a significant increase in interest has grown from 41% to 64%, confirming the study's hypothesis. Observing the participants' actions leads to the conclusion that the interest in biology classes has significantly increased.

The findings from the conducted observation underscore the successful implementation of the pedagogical experiment, focusing on the development of skills through assigning a greater number of practical tasks in biology education in English. The results indicate that students show significant interest in completing practical tasks. The observation recorded less than 15% of participants experiencing moderate to strong difficulties in understanding task instructions in English. In the final stage of the study, students with such difficulties were not registered. Preferences for the medium of delivering instructions to students and presenting the final products of tasks lean towards electronic means rather than traditional methods. The observation did not establish a correlation between the mode of educational delivery (distance, hybrid, or in-person) and the preference for the environment for assigning tasks and presenting task products. From the second stage of the study, task instructions are in English, and this did not raise objections from the students. Many students have developed skills in creatively creating documents, presentations, and videos to showcase the results of completed tasks. Evidence of this is the increased percentage of excellently and creatively presented task results. The observation also revealed that practical tasks in an electronic environment stimulate initiative, the search for additional information, and the enrichment of knowledge. Another important confirmation of the study's success is the increased interest in biology as a science. The execution of practical activities is crucial in studying natural sciences, serving as a source of real-world information on causal relationships between biological objects and phenomena.

As a result of the conducted methodical research and the analysis of its results, the hypothesis has been confirmed that the development of types and variations of existing practical tasks will lead to the formation and improvement of high school students' practical skills in biology education in a foreign language. The constructed concept, within the framework of the competency-based approach and the integration of the CLIL theoretical model, achieves its goals. The diverse types of tasks create conditions for the formation of various practical skills and the attainment of key competencies. Statistically significant differences have been observed in achieving results from activities aimed at developing practical skills and achieving competencies. A positive attitude towards increasing the number of practical tasks applied in education has been identified. Results in biology in English have improved. The interest of high school students in the biological science has increased.

Chapter 5. Conclusion - Findings, Summaries, and Contributions of the Dissertation

5.1. Summaries and Conclusions

The dissertation investigates the impact of implementing practical tasks in biology in English on the formation of practical skills, the attainment of competencies, and attitudes toward the biology discipline. In the latest PISA 2022 study, once again, the percentage of students covering Levels A and B is low. The overall participation result is below the average level - 500 points. The percentage of students covering Levels 4, 5, and 6 of the achievement scale is low. Despite significant achievements in global and international competitions and Olympiads in natural sciences, the average student possesses theoretical knowledge that they often struggle to apply in practice. The question "Why are we learning this?" is frequently heard in the classroom. There is a recognized issue regarding the need for a change in education towards the practical applicability of knowledge, as effective learning prepares young people for successful realization in life. The ability of students to apply their knowledge in practice is crucial in the educational process. It provides practical relevance to learning materials, making them more useful and stimulating. When students realize that what they are learning has specific applications in the real world, their functional literacy is enriched. Applying knowledge in real scenarios not only contributes to the acquisition of theoretical knowledge but also develops students' skills. They become more capable of analyzing and thinking critically, dealing with complex problems, and developing practical skills. The ability to apply acquired knowledge in real scenarios becomes a key factor in handling workplace tasks and successfully adapting to changes. Moreover, active participation in practical activities stimulates the long-term retention of information. Students who apply their knowledge in practice are more likely to retain this information for a longer period. A lack of didactic materials for practical exercises in the general educational discipline of biology in English adapted to the Bulgarian educational context has been identified. The current need led to the conduct of a pedagogical study on the formation of practical skills in biology in English through the design of variations of practical tasks.

As a result of the theoretical analysis regarding the achievement of the set objectives, a concept for developing practical skills in biology education in a foreign language has been constructed. For the purposes of the study, a model for content-language integrated learning has been adapted within the framework of the competency-based approach. Six types of practical tasks with variations for different educational content have been constructed. English language instructions containing scientific text and an execution algorithm have been created for these practical tasks. These tasks not only provide an opportunity for applying biological knowledge but also encourage the active use of a foreign language in the context of scientific research and experiments. The constructed concept is planned to cover various aspects of biology, ensuring diversity in content, activities, difficulty, and student requirements. The individual tasks are structured to support students in developing key skills such as observation, analysis, communication, and problem-solving while emphasizing the importance of learning biology in a foreign language. Criteria have been established according to which high school students self-manage their learning efforts, serving as an objective assessment by the pedagogical team. This model of interaction between students and the pedagogical team creates a more dynamic and adaptive educational environment, encouraging the achievement of optimal educational outcomes.

The created types of practical tasks were implemented in the education of high school students over four academic years, with the process, product, and students' attitudes towards the applied activities being tracked. The formation of skills and competencies was recorded through statistical analysis of grades based on criteria, a closed questionnaire, and direct observation. The change in students' attitudes towards the application of practical tasks and towards biology as an academic discipline and science was monitored. Based on the research, the following **conclusions** have been formulated:

- The research confirmed the working hypothesis that the development of variations of practical tasks would lead to the formation and improvement of practical skills among high school students in biology education in a foreign language.

- The developed variations of practical tasks are appropriate for implementation in the curriculum when studying biology in English during high school.
- Tasks involving conducting experiments at home; modeling a biological object; creating a crossword puzzle; making a comic; digital microscopy; answering questionnaires; connecting images/diagrams with their corresponding concepts; filling in blanks in a text on an electronic platform are suitable for building practical skills in the teaching of biology in a foreign language in a digital environment.
- The developed toolkit for studying the effectiveness of teaching biology in a foreign language to high school students through increased implementation of practical tasks is practical and effective.
- There is a significant approval for increasing the quantity of practical activities during the instructional hours.
- Tasks involving modeling, experimenting at home, and creating comics are the most preferred by high school students.
- Together with the practical skills, self-reflection has been achieved among the students performing the activities.
- The interest of high school students in biology has increased.

The research, conducted in all stages, confirmed the conclusions; therefore, it can be said that the implementation of more practical tasks in biology education in English forms practical skills, achieves competencies, and enhances students' positive attitude towards biology.

5.2. Contributions of the Dissertation

The main contributions of the dissertation work with theoretical-methodological and practical-applied significance are:

Theoretical-Methodological Contributions

- A conceptual framework for experimental learning has been established, effectively integrating the 4Cs model for CLIL into the educational context of the competency-based approach, with a focus on the development of practical skills.
- A design of practical activities for experimental biology teaching in a foreign language has been constructed for students in the first stage of secondary education to achieve competencies and enhance their scientific literacy.
- A research toolkit has been developed for tracking and evaluating the outcomes of implementing practical tasks in foreign language biology education.
- The theoretical analysis of the identified correlation between the task and the formation of practical skills in natural sciences within an electronic environment has been expanded.

Practical-applied contributions

- Twelve variations of six types of heuristic tasks have been developed to foster practical skills and achieve competencies in biology in English.
- Instructions for assigning tasks in an electronic environment, with options for other media, have been constructed.
- A set of criteria for assessment and self-assessment for each task has been developed.

- An assessment toolkit, including surveys and observation methods, has been developed to evaluate the acquisition of skills through the implementation of practical tasks.
- The effectiveness of the constructed concept for skills development has been experimentally tested three times, both horizontally and vertically.
- The effectiveness of the concept has been investigated and analyzed during training in three different forms - distance, hybrid, and traditional.
- The advantages of the applied concept have been systematized in a real situation following the analysis of the achieved results of the training effectiveness.

5.3. Conclusion

Conclusion

Based on the summaries and conclusions drawn, it can be asserted that the presented concept, implemented through the design of practical tasks, is intentionally structured to support various learning styles and student needs. The results described in the dissertation demonstrate the effectiveness of the concept and its application in a real educational environment. The combination of theoretical principles with specific practical scenarios provides a comprehensive toolkit for teachers and learners in the process of studying biology in a foreign language, emphasizing the importance of innovative and adaptive methods in education. This approach not only facilitates foreign language learning but also actively contributes to the development of students' biological knowledge and skills at the high school level. The application of knowledge to practice enriches functional literacy, provides practical value, and prepares students for successfully addressing the challenges that lie ahead in the future.

References

Ангелова, С. (2013). Възможности за формиране на умения в обучението по биология. *Химия, 22*(3).

Асенова, А. (2018). Приложение на софтуер за създаване на образователни комикси в професионалната подготовка на бъдещи учители по биология. *Годишник Телекомуникации*, (5), 37-44.

Бижков, Г. (1984). *Критерии за оценка на педагогическите изследвания*. София: Народна просвета.

Бижков, Г. Х. (1999). *Педагогическа диагностика*. София: Университетско издателство "Св. Климент Охридски".

Бижков, Г. Х., & Краевски, В. В. (2002). *Методология и методи на педагогическите изследвания*. София: Университетско издателство" Св. Климент Охридски".

Василева-Иванова, Р. (2014). Компетентностният подход в обучението по математика. *Научни трудове на Русенския университет*, *53*(6.2), 180-185.

Гайдарова, М., Манев, С., Петкова, Р., & Георгиев, Г. (2015). Анализ на националните стандарти и учебни програми по природни науки по отношение на компетентностния подход в PISA. *Стратегии на образователната и научната политика, 23(3).*

Ганчев, Г., Кожухарова, Г., & Делчев, М. (2014). Методика на педагогическите изследвания за студенти и учители. *Мултимедиен учебник.*

Гъров, К., Георгиева, С., Ковачева, Е., & Ангелов, А. (2017). Интегративни връзки в компетентностния подход в обучението по математика и информационни технологиии. *Чуждоезиково обучение*, *44*(5).

Иванов, И. (2006). *Педагогическа диагностика*. Шумен, Университетско издателство „Епископ Константин Преславски“.
Йотовска, К., Асенова, А., & Нечева, В. (2020). Качество на електронното дистанционно обучение в условията на пандемията от COVID-19 (Резултати от проучване мнението на учители). *Science & Technologies, 10(7), 14-21.*
Кременска, А. (2020). Избор на електронни среди за дистанционно обучение. *Сборник в чест на юбилея на проф. Галя Ангелова, 175-192*
Кулюткин, Ю. Н. (1968). Информационная характеристика эвристик. *Материалы III съезда общества психологов. Москва.*
Наредба № 5 на МОН от 30.11.2015 г за общообразователната подготовка. МОН.
Петров, П., & Лернер, И. (1977). *Познавателната самостоятелност на учениците*. София: Народна просвета.
Пиаже, Ж. (2003). *Психология интеллекта*. Москва: Питер.
Трашлиев, Р. (1989). *Задачата (психолого-педагогически проблеми)*. София: Печатна база към МНП.
Хаджиали, И., Райчева, Н., & Цанова, Н. (2014). Задачата в контекста на рефлексивна технология за обучение по биология. *Химия, Природните науки в образованието*, *23*(4), 535-547.
Хуторской, А. В. (2003). Ключевые компетенции как компонент личностно-ориентированной парадигмы образования. *Народное образование*, (2), 58-64.
Цанова, Н., & Райчева, Н. (2012). *Методика на обучението по биология–теория и практика.* София: Пенсофт.
Chocholatá, M. J., & Gahurová, B. E. (2018). Teaching Biology Using CLIL. *Doctoral dissertation, Ph. D. theis. Czechia: Masaryk university*.
Collis, B. (1993). Electronic links to enrich the life of the school. *Keynote paper prepared for the Councel of European Conference on School links, Stockholm*.
Coyle, D., Hood, P., & Marsh, D. (2010). *CLIL*. Cambridge University Press and Assessment.
Dean, D. M. (2004). *An evaluation of the use of web-enhanced homework assignments in high school biology classes*. The University of Alabama.
Dewey, J. (1986). Experience and education. *The Educational Forum, 50, 241-252*.
Ellis, R. A., Ginns, P., & Piggott, L. (2009). E-learning in higher education: some key aspects and their relationship to approaches to study. *Higher Education Research & Development*, *28*(3), 303-318.
Ellison, M. (2018). CLIL in the primary school context. *The Routledge handbook of teaching English to young learners*, 247-268
Henda, M. B. (2020). GUIDE for a blended learning system. *arXiv preprint arXiv:2007.04912*.
Hill, J. R. (1997). Distance learning environments via the World Wide Web. *Web-based instruction, Educational Technology Publications, Englewood Cliffs, New Jersey 75-80*.
Horn, M. B., & Staker, H. (2017). *Blended: Using disruptive innovation to improve schools*. John Wiley & Sons.
Iancu, M. (2018). The Assessment of Students' Competencies and Constructionism With Examples in Biological and Natural Sciences. *Learning Strategies and Constructionism in Modern Education Settings*, 223-249. IGI Global.
Jereb, E., & Šmitek, B. (2006). Applying multimedia instruction in e-learning. *Innovations in Education and Teaching International*, *43*(1), 15-27.
Keegan, D. (2013). *Foundations of distance education*. Routledge.
Kiboss, J. K., & Tanui, E. K. (2013). Effectiveness of e–Learning Investigation Model on Students' Understanding of Classification of Organisms in School Biology. *Journal of Education and Practice, 4(7)*
King, F. B., Young, M. F., Drivere-Richmond, K., & Schrader, P. G. (2001). Defining distance learning and distance education. *AACE Review (Formerly AACE Journal)*, *9*(1), 1-14.
Meyer, O. (2010). Towards quality-CLIL: successful planning and teaching strategies. *Pulso*, 33, 11-29.
Mielke, D. (1999). *Effective Teaching in Distance Education. ERIC Digest.* ERIC Clearinghouse on Teaching and Teacher Education Washington DC.

Mirón, J. P. (2016). Designing of STEM Macro-Activities Based on Cooperative Learning Strategies:1st Matemathical Relay Race Based on Viaro Teams. A Case Study of STEM Learning at Viaro Global School. *EDULEARN16 Proceedings*, 7128-7133.

Moore, M. G., & Kearsley, G. (1996). *Distance education: A systems view.* New York, NY: Wadsworth

Nuranova, A. (2020). Teachers' Perceptions of Teaching in English Based on Their Experience of Implementing CLIL Practices for STEM Subjects. *Nazarbayev University Graduate School of Education.*

Richards, J., & Rodgers, T. (2002). Approaches and methods in language teaching. *Korea TESOL Journal*, *5*(1), 161-165.

Rissanen, A., & Costello, J. M. (2023). The effectiveness of interactive online tutorials in first-year large biology course. *Journal of Applied Research in Higher Education*, *15*(3), 632-649.

Sangrà, A., Vlachopoulos, D., & Cabrera, N. (2012). Building an inclusive definition of e-learning: An approach to the conceptual framework. *International Review of Research in Open and Distributed Learning*, *13*(2), 145-159.

Tagnin, L., & Ní Ríordáin, M. (2021). Building science through questions in Content and Language Integrated Learning (CLIL) classrooms. *International Journal of STEM Education*, *8*(1), 1-14.

Tibaldi, E. V. (2012). The scientific laboratory as a learning setting in CLIL. *Synergies Italie,* (8), 175-186.

Tucker, C. R. (2012). *Blended learning in grades 4–12: Leveraging the power of technology to create student-centered classrooms*. Corwin Press.

Yotovska, K., & Necheva, V. Project-Based Learning by the Use of Information and Communication Technologies in the Preparation of Students-Future Teachers of Biology. *Education, Science & Technologies, 9(7), 16-22*

Publications related to the dissertation topic

Людмила Бояджиева, **Практическите умения в обучението по биология като средство за повишаване на природонаучната грамотност на английски език**, Наука и образование в дигиталната ера, IX Международна научна конференция, Варна, 10-13 септември 2020, 2020, стр.:97-106, ISBN:978-619-221-283-4

Людмила Бояджиева, **Варианти на представяне на задачи при дистанционна форма на обучение по биология на английски език**, Електронното обучение във висшите училища Осма национална конференция, Велико Търново, 25-27 септември 2020, издателство: Университетско издателство "Св. Климент Охридски", София, 2020, стр.:193-199, ISBN:978-954-07-5028-6

Lyudmila Boyadzhieva, **Competence-based approach to practical tasks in teaching biology in English**, Scientifik conference "KLIMENT'S DAYS" 4th November 2021 Abstracts, 2022, pages:36-36, ISSN (online):1314–4960

Anelly Kremenska, Lyudmila Boyagzhieva, **The practice of distance, hybrid and blended learning: challenges and possible solutions (teacher-trainers'experience)**, ISSN (print):978-3-339-13130-0, ISBN:978-3-339-13130-0