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SECONDARY SCHOOL STUDENTS' PERSPECTIVES ON INCORPORATING BIOLOGY OLYMPIAD TASKS INTO BIOLOGY LESSONS

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Abstract: *Tasks used in the Biology Olympiad (BiO) appear to be promising alternatives to traditional teaching tasks in biology education, as they frequently incorporate inquiry-based elements. This makes them a valuable resource for increasing students' exposure to inquiry activities during classroom instruction. However, for teachers to effectively implement BiO tasks in their teaching practice, it is essential to identify and understand which aspects of these tasks pose the greatest difficulties for students. Therefore, tasks from the BiO (n = 5) were integrated into biology classes. Subsequently, a questionnaire revealed that students (n = 232) encountered the most significant challenges during the solution process with individual inquiry skills, such as inferring answers from comparisons, justifying claims, and drawing conclusions, compared with non-inquiry difficulties and practical biology skills. Furthermore, the research results showed that the majority of participants (77.2 %) positively perceived the inclusion of BiO tasks in biology lessons. Overall, if teachers consider the content difficulty of the tasks, incorporating BiO tasks into the teaching process could be a way to enhance students' inquiry skills during biology classes, and learning would be perceived as more attractive to the students.*

Keywords: *biology education, biology teaching tasks, inquiry-based science teaching and learning, Biology Olympiad, questionnaire-based research*

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Introduction

In recent years, biology didactics research has increasingly concentrated on identifying teaching approaches, styles, and methods that help students acquire knowledge and skills more efficiently, deepen their understanding of the subject matter, and engage more actively in the learning process (e.g., Dolan, 2015; Freeman et al., 2014). Much of the research on biology didactics has aligned with the concepts outlined in the work of Janík (2018), which emphasizes the importance of addressing the processes, tools, and methods of didactic transformation, particularly to suppress the transmissive delivery of content to students. Swarat et al. (2012) described how the curriculum is conveyed to students as one of the most important factors. They reported that students are more interested in practical activities involving scientific procedures and technology than in purely cognitive activities that do not require active student involvement. Therefore, it seems appropriate to use inquiry-based teaching in the educational process (Rocard et al., 2007; Dostál, 2015a), where students are not only passive listeners who accumulate information but are active designers of lessons (Gormally et al., 2009), in which they use thought processes and scientific procedures similar to those used in authentic scientific research (Constantinou et al., 2018; Riga et al., 2017). However, the extent to which students are involved in learning and to what extent they become active designers is influenced by the degree of inquiry that is achieved in learning (Buck et al., 2008). Therefore, if we want students to reach a higher cognitive level during the lesson, they have to work with tasks whose solution requires performing activities at a higher cognitive level (Stein et al., 2009).

The use of inquiry-based teaching methods has limitations (Papáček, 2010; Stuchlíková, 2010). One significant obstacle to incorporating inquiry-based science education (IBSE) into teaching is teachers' insufficient preparedness, as most have not been systematically trained in IBSE (Petr et al., 2015). Consequently, teachers do not understand the essence of IBSE or lack the

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necessary professional and didactic readiness (Dostál, 2015b; Radvanová et al., 2018). If inquiry-based teaching is to be used more in school practice, it is not sufficient to address future teachers, but it is necessary to address already working teachers in schools (Rundgren et al., 2017). However, according to Ratcliffe et al. (2006), they often do not have time to change the design of their lessons and, therefore, change only when they are provided with teaching material. For these reasons, the use of tasks from the Olympiads in science subjects in teaching seems to be an interesting alternative.

The potential of subject-based competition tasks for teaching can be illustrated using an example of the Biology Olympiad (BiO) tasks. BiO tasks were designed to provide participants with a comprehensive and challenging experience. Students engage in activities in which they identify "natural objects" and complete tests assessing general biological knowledge, drawing on a range of resources such as texts, illustrations, schematics, graphs, maps, examples, and photographs. The practical component involves laboratory-based tasks, while the national round also incorporates field-based assignments. Solving BiO tasks typically takes 45 to 60 minutes (Farkač & Božková, 2006; Petr, 2010). Each year, the competition is centered around a new theme, requiring the creation of entirely original tasks. These are developed by specialized working groups comprising university students, educators, and subject-matter experts. This approach ensures that the tasks align with the formal and content-related criteria of the various BiO categories (Petr et al., 2018). BiO tasks also demonstrate an interdisciplinary approach that integrates knowledge and skills from biology, science, technical, and mathematical education. This aligns with the goals of European science education, which emphasizes the need for an interdisciplinary concept of teaching (European Commission, 2015). Moreover, BiO tasks emphasize a strong connection between knowledge and skills, which is a fundamental principle in school biology (Švecová, 2002). These tasks also correspond to the concept of "teaching tasks," which promote active student engagement by serving as tools for learning and focusing attention on educational goals (Gropengießer, 2006; Janiš & Ondřejová, 2006; Vaculová et al., 2008).

Breyfogle (2003) outlined the possibilities of using such tasks in undergraduate teacher training, whereas Petr et al. (2018) considered their potential implementation in primary and secondary school teaching. For teachers interested in adopting an inquiry-based approach to education, these tasks are a suitable option, as they often include elements of inquiry-based teaching. Furthermore, BiO tasks are not entirely unfamiliar to teachers, as they are encountered annually during competition. An advantage for teachers using BiO tasks is that each year, preparatory texts focusing on the BiO theme and author-provided solutions for individual tasks are available. The usage of tasks from BiO in teaching thus seems natural because the difference between tasks from BiO and ordinary teaching tasks is essentially "only" that while solving tasks from BiO, greater demands are placed on thinking, they are more complex and often contain information of an extracurricular character (Petr et al., 2018). However, Novák et al. (2021) have indicated that students should not have a problem working with them during the teaching process if teachers appropriately choose BiO tasks. In the Czech Republic, the selection of some suitable tasks for teaching at primary and secondary schools was addressed by Petr (2014a). The author thoroughly discusses potential limitations (such as time constraints, content complexity, higher demands on laboratory skills, and inappropriateness of certain tasks) and benefits (such as interdisciplinarity, increased cognitive demands on students, closer alignment with scientific inquiry, and linking theory with practice) of using BiO tasks in biology education.

Problem Statement

Although BiO tasks have the potential to enhance opportunities for inquiry-based learning and to foster scientific thinking, they are still rarely incorporated into regular biology lessons. A key reason for this is the lack of clarity regarding how students respond to these tasks in standard biology lessons. It remains uncertain whether students perceive them as engaging and educationally valuable, or whether their level of complexity constitutes a barrier to wider implementation. Teachers may also be reluctant to adopt such tasks without a clear understanding of their practical impact on student learning outcomes. This gap in knowledge limits the effective use of high-quality and often inquiry-oriented materials (BiO tasks) in everyday biology teaching. Therefore, it is essential to investigate students' perceptions, the challenges they experience, and the overall feasibility of implementing BiO tasks as part of regular biology education.

Research Focus

This study aimed to identify students' challenges when solving BiO tasks and their perceptions of using these tasks in biology lessons. It examined which elements of BiO tasks students find the most difficult and evaluated

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the feasibility and educational value of integrating such tasks into regular biology teaching. This study addressed the following two research questions (RQ).

RQ1: What do students find most challenging when solving tasks from the Biology Olympiad?
RQ2: How do students assess the use of tasks from the Biology Olympiads in biology lessons?

Research Methodology

General Background

Five tasks were selected from the regional rounds of the BiO in the Czech Republic, which contained elements of the IBSE and incorporated into lessons in secondary school classes ($n = 8$) from five different secondary schools. The lessons were conducted by one of the researchers, who was also a teacher at one of the participating schools (three classes), or by trained teachers (one of the researchers provided instructions to the teachers in person and performed the selected tasks with them). The teachers selected the tasks themselves and consulted with the researchers on their choices. Each task was used in three classes (except Task 3, which was used in four classes), and each class completed two tasks. When selecting tasks for individual lessons, the focus is on the curriculum being taught. Teachers incorporated the tasks into their lessons when the topics covered in the tasks aligned with the curriculum. The necessary materials and equipment required for completing the tasks (e.g., microscopes, magnifying glasses, tweezers) were available at all schools, and any required biological material was provided to the teachers by the researchers. Lessons incorporating the BiO tasks were conducted during regular class hours. The time allocation for task no. 3 and no. 4 exceeded the duration of a standard class period (45 minutes). Two consecutive lessons were arranged for this research. This arrangement also allowed the students to complete a pilot questionnaire after completing each task. The questionnaire focused on assessing the difficulty of individual task components and collecting additional supplementary information (see the Instruments and Procedures section). This study was conducted in schools between 13. 12. 2022 and 30. 4. 2023

Sample

The research sample consisted of students from secondary schools where one of the researchers taught and where four long-term cooperating teachers were active. These teachers selected classes that, according to their educational plans for the given school year, covered curriculum topics related to the selected BiO tasks. A total of seven teachers were initially approached, however, only four agreed to participate in the study. All students from the selected classes took part. In total, the sample comprised 232 secondary school students (120 girls and 112 boys) from five schools (eight classes) located in three different regions of the Czech Republic (urban and semi-urban areas). The students were enrolled in grades 1 to 4 (ISCED 3). Regarding age distribution, 61 students were aged 15–16 years, 60 were aged 16–17 years, 56 were aged 17–18 years, and 55 were aged 18–19 years. Forty-seven students had prior experience with the Biology Olympiad from primary or secondary school, participating at both the school and regional levels. Class sizes were almost evenly balanced, ranging from 27 to 32 students. In a few cases ($n = 8$), students were absent, slightly reducing the number of participants. Three classes were from a chemistry-oriented secondary school, whereas the remaining classes were from general grammar schools. All schools were catchment institutions, ranging in size from small to medium. Although the sample does not fully represent the national student population, it included a broad range of students in terms of socioeconomic background, educational focus, and experience with science competitions. The sample was selected using a purposive sampling strategy based on curriculum alignment and existing collaborations. None of the students were foreign nationals, and four had been diagnosed with specific learning disabilities; these students received support from their teachers during lessons following standard practices. The cooperating teachers were selected based on personal connections with one of the researchers. One teacher taught two classes independently for two years, whereas the remaining three teachers each taught one class during their first year at the respective schools. The researcher-teacher was responsible for three classes at the chemistry-oriented school, teaching one class for two years and two others during their first year.

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Description of the Tasks

For this study, three practical and two theoretical tasks were selected from the regional rounds of the Biology Olympiad in the Czech Republic, spanning the school years 2010/2011, 2011/2012, 2015/2016, and 2016/2017. The selected tasks incorporated elements of inquiry-based learning, with the aim of actively engaging students and promoting the development of higher-order thinking skills. The tasks required students to comprehend text, organize information, perform practical activities, conduct observations, make comparisons, evaluate findings, create biological drawings, analyze graphs, answer questions based on critical evaluation of texts or image comparisons, defend their findings, and draw conclusions. Tasks were chosen from older BiO competition years to ensure that students participating in the BiO had no prior exposure to them (none of the teachers had previously used these tasks in their lessons). The tasks were selected in consultation with the teachers, considering the topics they would be integrated into. Every task was divided into several sections. However, not all sections contained inquiry elements, as some required only basic cognitive operations. The tasks were used in their original form, almost without modifications or shortening. The only modification was that, in six sections, students were allowed to work in pairs while completing the tasks, and in one task, after submitting their answers, they could revise their responses during a teacher-led class discussion. Additionally, students were allowed to consult the teacher at any point. After completing the tasks, the students were given a questionnaire, and once they had filled it out, the teachers reviewed the tasks together with the students. For a detailed description of the tasks, see the Appendix.

Instrument and Procedures

Student data were collected using a pilot-tested questionnaire. The pilot testing of the questionnaire was conducted after teaching one class (29 students) with one task from the BiO, led by one of the researchers, in November 2022. A similarly structured questionnaire (focused on different tasks) was also utilized in another study (Novák, 2022). The questionnaire was validated by a member of the Department of Biology at the Faculty of Education, University of South Bohemia. The structure and content of the questionnaires were almost identical, they differed only in the sections related to the specific tasks. An example of the research instrument (the questionnaire for Task No. 5) is provided in the appendix. The questionnaire included a combination of closed and open-ended questions, as well as Likert-scale items rated on a scale from 1 to 5, where 1 indicated the highest rating and 5 the lowest. The questionnaires were distributed in paper form, and the responses were subsequently transcribed into an electronic format for analysis. Before completing the questionnaire, students read and signed an informed consent form explaining the purpose of the study and assuring the confidentiality of their responses. Data from secondary school students were anonymized and collected with the approval of the school principal, ensuring that the research design adhered to the ethical standards set by the Ethics Committee of the Faculty of Education, University of South Bohemia.

Data Analysis

Data from the questionnaires were transcribed into an electronic form using Excel from the Microsoft Office 2016 suite and subsequently sorted and categorized. The data were then transferred to Statistica 14.0 for analysis. An analysis of variance (one-way ANOVA) was conducted to determine whether significant differences existed in students' opinions across individual classes or regarding the use of specific BiO tasks. Tukey's multiple comparison test was used to identify significant differences between the classes and students' opinions. Yates' χ^2 test was used to analyze the differences between the expected and observed frequencies of students' responses - during the analysis, responses from the categories Nothing, Unspecified, and I don't know were excluded. The statistical significance level was set at $\alpha = .05$. Means, standard deviations (*SD*), medians (Q_2), and upper (Q_3) and lower (Q_1) quartiles were calculated to describe the data.

Research Results

When evaluating what students found most challenging when solving BiO tasks, their responses were categorized into three main categories: Non-inquiry, Inquiry, and Practical Biology Skills. These categories included 20 subcategories based on the student responses (see Table 1). Each task was evaluated individually, and Yates' χ^2 tests confirmed that the distribution of student responses across categories was not random (Task 1: Yates

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$\chi^2 = 7.105$, $df = 2$, $p = .03$; Task 2: Yates $\chi^2 = 36.022$, $df = 2$, $p < 1*10^{-6}$; Task 3: Yates $\chi^2 = 55.53$, $df = 2$, $p < 1*10^{-6}$; Task 4: Yates $\chi^2 = 9.063$, $df = 2$, $p = .01$; Task 5: Yates $\chi^2 = 29.222$, $df = 2$, $p < 1*10^{-6}$). These results indicate that difficulties in the Inquiry category were statistically more frequently reported in all tasks than those in the Non-inquiry and Practical Biology Skills categories.

Table 1
Students' Responses About What They Find Most Challenging When Solving Tasks from the Biology Olympiad

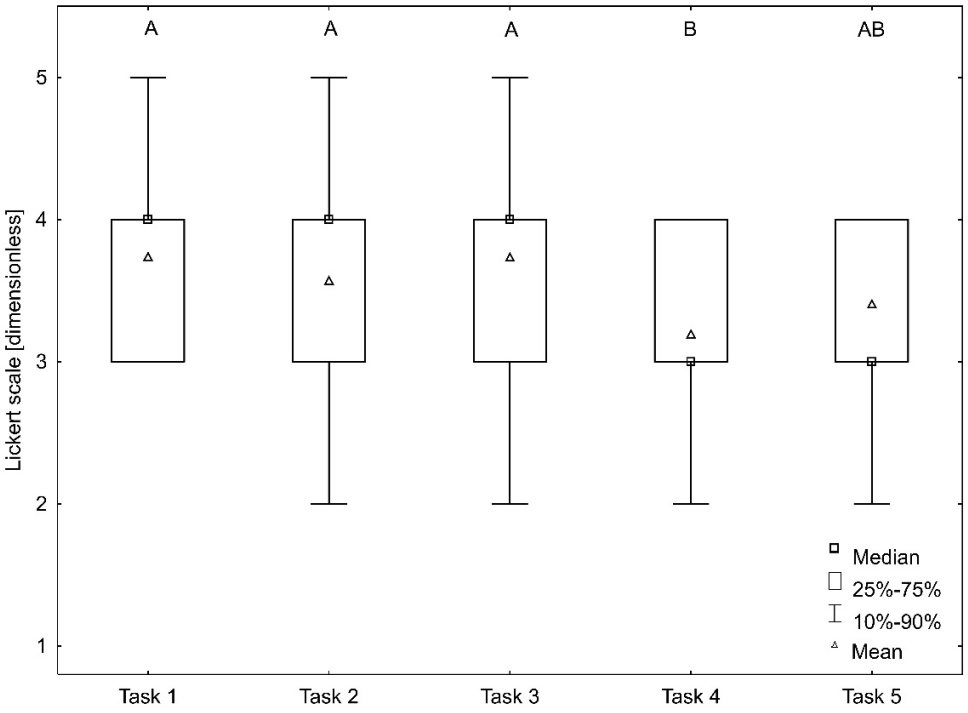
Difficulties perceived by students						
	Non-inquiry	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Task content difficulty	7	9	11	9	7
	Understanding the assignment	7	5	8	1	8
	Time demands	3	3	3	6	6
	Nothing	2	2		5	4
	Reflecting on the text	3	3	3		2
	Unspecified	3	4	1		
	I don't know	2	2	2	1	
	Inquiry	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Drawing answers by comparing pictures	16	23	4	24	
	Drawing answers from pictures/diagrams		22	23	3	16
	Justifying my claims	7	5	27		
	Drawing answers from the text	7	3	22	2	2
	Comparing information		5	9	2	13
	Experiment-derived answers				17	8
	Drawing conclusions					20
	Answers by comparing tables	15				
	Practical biology skills	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Preparing a sample	9			8	
	Creating a sketch				7	
	Conducting an experiment				3	3
	Description of microscopy sample	5				
	Microscopy	2				

Furthermore, we were interested in whether students in biology classes worked with tasks similar to those from BiO. Student responses showed that they almost did not work with similar tasks at all ($Q_1 = 3$, $Q_{2,3} = 4$). The results of the one-way ANOVA showed a significant difference in students' opinions among individual tasks ($F(4, 459) = 6.2282$; $p < 1*10^{-4}$) – see Figure 1. A post-hoc multiple comparison by Tukey's test was performed, and the results indicated a significant difference between the use of similar tasks to task 4 and similar tasks to tasks 1-3 in regular biology classes. Tasks similar to Task 4 were used more frequently than tasks similar to Task 1 ($p < 5*10^{-4}$), Task 2 ($p = .04$), and Task 3 ($p < 2*10^{-4}$). The results of the one-way ANOVA did not show a significant difference between the individual classes in the use of tasks similar to BiO tasks in regular biology classes ($F(7, 456) = 1.4404$, $p = .187$).

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Figure 1
Comparison of the Students' Answers on Whether They Work with Similar Teaching Tasks in Biology Lessons



Students were also asked to specify the types of tasks they worked on during the biology classes. Their responses were classified into seventeen categories. Students most frequently worked with worksheets (28.4 %) and filled out true/false statements based on a text (17.2 %). A total of 9.9 % indicated that they performed experiments accompanied by a worksheet, and 7.3 % stated that they conducted the experiments together. Completing puzzles or quizzes was reported by 7.3 % of students, while the use of various educational portals and applications was mentioned by 5.6 % of students. Additionally, students mentioned group work (4.3 %), conducting experiments - without specifying how (3.4 %), and completing fill-in-the-blank exercises (3.4 %). The remaining eight categories (e.g., watching videos, identification activities, microscopy, discussions, and searching for information on the Internet) accounted for only 13.2 % of the total responses, with none of these categories individually exceeding 3 % of the total responses.

In response to the additional question of whether students work with "natural objects" (plants, animals, rocks, etc.) in biology classes, students answered that they hardly work with them at all ($Q_1 = 3$, $Q_{2,3} = 4$). However, the result of the one-way ANOVA showed a significant difference in the use of "natural objects" among the classes ($F(7, 224) = 6.2272$; $p < 1*10^{-6}$). A post-hoc multiple comparison using Tukey's test was performed, which revealed that Class A uses "natural objects" in lessons more frequently compared to Classes D ($p = .002$), G ($p = .001$), and H ($p < 4*10^{-5}$). Furthermore, it was shown that Class E uses "natural objects" more frequently than Class H ($p = .006$) and Class F more than Class D ($p = .03$), G ($p = .02$), and H ($p < 5*10^{-5}$). However, only Class A had a median value ($Q_2 = 3$), which was different from the other classes ($Q_2 = 4$).

It follows from the measurement of students' attitudes that they believed their classmates would be able to work with similar tasks ($Q_{1,2} = 2$; $Q_3 = 3$). The results of the one-way ANOVA showed no statistically significant difference between students' opinions on individual tasks ($F(4, 459) = .24639$; $p = .912$). However, a significant difference was found when comparing the students' responses between classes ($F(7, 456) = 2.0741$; $p = .043$). Tukey's test revealed that students from Class A had a more positive attitude toward their classmates' work on similar tasks compared to students from Class G ($p = .02$).

To the question of whether students could imagine that teachers would regularly supplement biology lessons with tasks similar to BiO tasks, students responded that they could imagine it quite well ($Q_{1,2} = 2$; $Q_3 = 3$). There were

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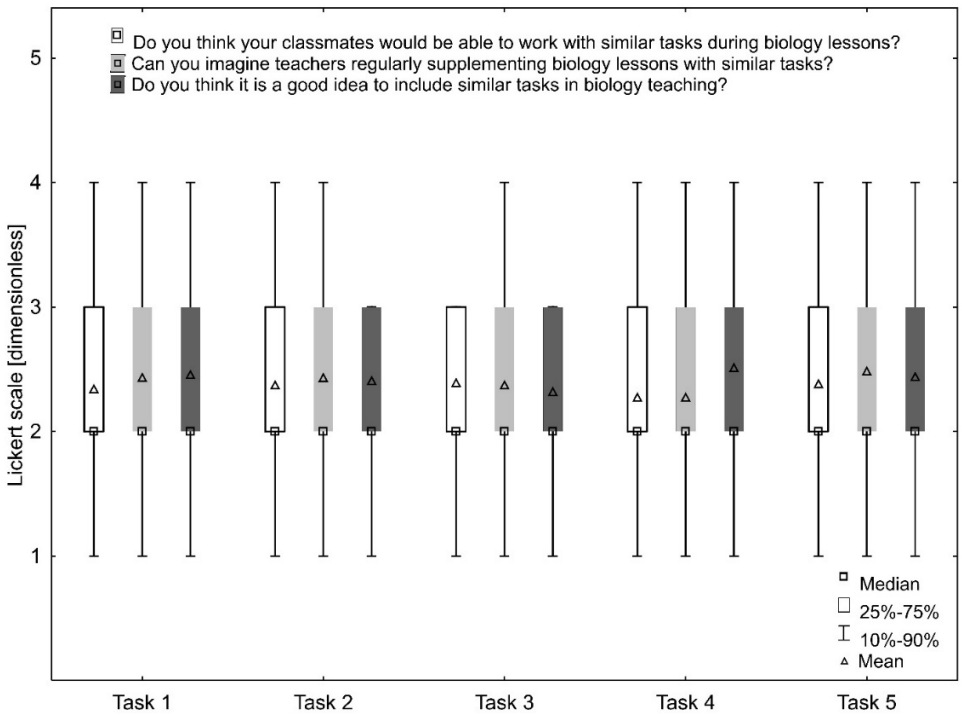
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also no significant differences between students' opinions on individual tasks ($F(4, 459) = .58649$; $p = .67$), nor were there any significant differences in responses among students from different classes ($F(7, 456) = .75677$; $p = .62$).

Furthermore, the students thought that the inclusion of teaching tasks similar to the ones they solved was quite a good idea ($Q_{1,2} = 2$; $Q_3 = 3$), and that there was no significant difference between students' opinions on individual tasks ($F(4, 459) = .52755$; $p = .72$). There were also no significant differences in the responses among students from different classes ($F(7, 456) = .99463$; $p = .43$). A summary graph comparing students' responses to the aforementioned questions across the solved tasks is shown in Figure 2.

Figure 2

Comparison of Students' Responses to Questions Regarding the Feasibility of Tasks for Classmates, Their Inclusion in Lessons, and Whether Such Inclusion Is a Good Idea Across Individual Tasks



Students did not evaluate whether including similar tasks in biology lessons is a good or bad idea solely using a Likert scale, they were also asked to choose "yes" or "no" and provide a written explanation for their reasoning. A total of 77.8 % of the students indicated that it was a good idea, while 22.2 % stated that it was not. These two categories (Positive and Negative) were further divided into 17 subcategories based on student responses (see Table 2). Student responses were analyzed for each task, and Yates' χ^2 tests confirmed that the distribution of responses across the categories was not random (Task 1: Yates $\chi^2 = 8.45$, $df = 1$, $p = .004$; Task 2: Yates $\chi^2 = 8.584$, $df = 1$, $p = .003$; Task 3: Yates $\chi^2 = 22.31$, $df = 1$, $p < 1*10^{-5}$; Task 4: Yates $\chi^2 = 16.458$, $df = 1$, $p < 1*10^{-4}$; Task 5: Yates $\chi^2 = 11.59$; $df = 1$, $p < 1*10^{-3}$). The results indicate that responses from the Positive category were statistically more frequent across all tasks compared to those from the Negative category.

To provide a descriptive overview, students were asked to assess their perceptions of the difficulty and popularity of biology as a school subject. The results showed that students rated the difficulty of biology as 2.94 ± .74 (mean ± *SD*) and its popularity as 2.69 ± .72.

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Table 2
Students' Responses Regarding Why Incorporating Tasks Similar to BiO Tasks into Lessons Is a Good or Bad Idea

Positive opinion	Task 1	Task 2	Task 3	Task 4	Task 5
More engaging and attractive learning	22	15	33	28	21
Practical activities connected to theory	10	7	3	7	7
We will learn more	6	8	5	5	7
Better understanding and retention of the subj. matter	5	6	8	3	9
More illustrative learning	8	9	4	8	2
More active involvement in learning	6	5	9	8	2
Enrichment of teaching	5	5	5	3	5
Unspecified	3	4	7	4	5
Information in context		3	4	2	8
We will think more about the subject matter		1	5	4	2
Expanding horizons			8		
Learning to work independently			2		
Negative opinion	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
The difficulty of the task content	6	14	6	5	8
It didn't interest me / It didn't suit me / I didn't like it	7	3	10	3	4
Difficult to understand	1	1	3	3	5
Not enough time to solve the tasks	4	3		3	1
I don't like dissections	4			2	
Unspecified		2	1		2
Too much text	1				1

Discussion

When analyzing students' responses to RQ1 regarding the most challenging aspects of solving BiO tasks, it became evident that students found inquiry activities more demanding than non-inquiry activities and practical biology skills. This is in line with the findings of Novák (2022), who suggested that inquiry activities during the resolution of the BiO task are one of the most challenging aspects for students. One possible explanation, as suggested by Vácha and Ditrich (2016), is that if students do not engage in inquiry-based activities during their education, they may perceive such activities as abstract, complex, and challenging to grasp. Furthermore, Edelson et al. (1999) described that some students may feel confused during inquiry activities and may experience cognitive overload. In the context of our study results, these explanations seem particularly relevant, as the surveyed students reported minimal exposure to similar tasks in their biology classes ($Q_1 = 3$, $Q_{2,3} = 4$). Overall, inquiry-based tasks are not extensively utilized within the Czech educational environment. Although their use in teaching has become slightly more frequent than in the past, Czech teachers' most commonly used approach is the interpretation supplemented by conversation or discussion (Radvanová et al., 2018). Since the way a teacher conducts a lesson strongly influences students (Organization for Economic Cooperation and Development, 2018), if students are not taught in a way that develops their inquiry skills, this practice is likely to lead them to perceive inquiry components in tasks as particularly challenging. If some students were experiencing inquiry elements for the first time, it is possible that they rated these activities as the most difficult for this reason. This aligns with the context

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of studies by Mohamed (2008) and Rajan and Marcus (2009), which suggest that students feel unequipped to perform tasks with inquiry during their initial exposure to them. Baldock and Pesl-Murphrey (2020) also noted that some students may find inquiry-based learning more challenging than a teacher-guided approach, particularly if they have limited prior experience with inquiry. Furthermore, Radvanová et al. (2019) indicate that when students engage in inquiry activities, they are often at a lower level of inquiry. Consequently, students may perceive parts of the BiO tasks that require higher-order inquiry skills as more challenging because of their lack of inquiry ability. This lack of inquiry skills was identified by students in the study by Shin and Kim (2010) as one of the significant difficulties in conducting open science inquiry activities.

In cases where students identified non-inquiry activities as the most challenging in solving tasks, the most frequently mentioned difficulties were related to the content complexity of the tasks, the understanding of the assignment, and the time demands. The content difficulty of the tasks was expected, given that these are competitive tasks designed for highly gifted students (Farkač & Božková, 2006). Even participants in BiO face challenges with the content complexity of these tasks because they often lack sufficient biological knowledge (Petr et al., 2014). Therefore, the perceived difficulty of the content of the task is partly the teachers' responsibility. However, teachers generally have a good ability to predict the difficulty level of tasks, as evidenced by the study conducted by Hebel et al. (2019), who used tasks with inquiry elements from the PISA assessment as an example.

Concerning the issue of poor comprehension of assignments, it can be linked to the average reading literacy of Czech students (Blažek et al., 2019). A similar problem with understanding written texts has also been reported among BiO participants (Petr et al., 2014). The length of the text may influence comprehension, as it directly increases the difficulty of individual tasks (Hebel et al., 2019). For effective text comprehension, the quality of reading assignments is crucial, since reading and problem-solving cannot be separated and directly affect the task-solving process (Bergqvist & Österholm, 2010). Neri et al. (2021) also noted that students with weaker reading skills encounter difficulties in understanding and solving science problems, even when their science knowledge is otherwise adequate. Therefore, if students did not possess strong reading literacy, it could have been one of the factors contributing to their perception of task comprehension as problematic.

The selected BiO tasks consisted of a large number of parts, and although the time allocated for solving them was 45 – 60 minutes, it is not surprising that students frequently cited time demand as a common difficulty. This was likely further exacerbated by including inquiry elements in the tasks, as such tasks require more time to solve than more traditional approaches (Gutierez, 2015; Demaria et al., 2019).

The third category of perceived difficulties was practical biology skills, which the students mentioned in tasks involving experiments. Kranz et al. (2023) reported that difficulties associated with conducting experiments are prevalent across all levels of education and manifest at the conceptual, procedural, and epistemic levels. Students often encounter challenges in formulating research questions, designing experiments, and interpreting data. Nevertheless, students in this study most frequently identified sample preparation and drawing as the most challenging aspects of conducting experiments. Großmann and Wilde (2019) stated that more frequent use of experiments in teaching improves students' skills necessary for conducting experiments, but students with low prior knowledge may struggle with understanding and performing experiments. In the case of Czech students, the most significant difficulties in using experiments in lessons are described as being related to their evaluations (Blažek & Příhodová, 2016).

The results showed that students most frequently worked with worksheets (28.4 %), conducted experiments accompanied by a worksheet with their classmates, or without any specific details on how they proceeded which represents the sum of three categories involving conducting experiments (20.5 %), or filling out true/false statements based on a text (17.2 %). We did not further investigate what types of worksheets students use or what specific experiments they conducted. However, we view the representation of experiments in teaching quite positively, as according to Radvanová et al. (2018), when students engage in inquiry activities in lessons, it is primarily through experiments. The results also showed that students worked with tasks similar to Task 4 statistically more often in lessons ($F(4, 459) = 6.2282$; $p < 1*10^{-4}$). This was a typical laboratory task, but it included elements of inquiry. Surprisingly, Task 1, which was structurally very similar to Task 4, was perceived as a type of task with which students did not work as often in lessons. However, this perception was not caused by students from different classes working with such tasks differently, as this was not proven ($F(7, 456) = 1.4404$, $p = .187$).

The use of experiments in teaching is also important in terms of utilizing "natural objects", which are often a part of them. "Natural objects" demonstrate both specific and general characteristics of living organisms, and they

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not only illustrate the curriculum but also enable the classification, concretization, and generalization of scientific knowledge. They are important not only to fulfil the principle of visual representation but also because they can serve as objects of students' inquiry activities, fostering the development of competencies typical of scientific research (Petr, 2014b). Although the results of this study show a statistically significant difference between individual classes in the use of "natural objects" during biology lessons ($F(7, 224) = 6.2272$; $p < 1*10^{-6}$), it can be said overall that students do not work with "natural objects" very often ($Q_1 = 3$, $Q_{2,3} = 4$).

When analyzing students' responses to RQ2: *How do students assess the use of tasks from the Biology Olympiad in biology lessons?,* we inferred that students evaluated their use positively. Students expressed a positive view of their classmates' ability to work with tasks similar to BiO tasks ($Q_{1,2} = 2$; $Q_3 = 3$). This positive attitude among students is consistent with the findings of Dvořáková (2012) and Novák et al. (2021), who highlighted that high school students are capable of engaging meaningfully with tasks during lessons. Moreover, students believed that teachers could regularly supplement biology lessons with similar tasks ($Q_{1,2} = 2$; $Q_3 = 3$), and they considered incorporating teaching tasks similar to the ones they solved quite a good idea ($Q_{1,2} = 2$; $Q_3 = 3$). We assume that this preference stems primarily from the inclusion of hands-on activities, elements of inquiry, and processes that mimic scientific work. Teaching through such tasks is more engaging for students than purely cognitive tasks or those that lack active student participation (Swarat et al., 2012; Halim & Merah, 2016; Rohandi, 2017). This can also be inferred from students' responses, in which they explained why incorporating tasks similar to those from the Biology Olympiad was a good or bad idea. The most frequently mentioned positive responses (77.2 %) were more engaging/attractive learning, practical activities connected with theory, better understanding and retention of the subject matter, more illustrative learning, and more active involvement in learning. However, only 22.8 % of students stated that it was a bad idea, citing reasons such as the tasks being too challenging, a lack of enjoyment/interest, and difficulty in understanding the content. Overall, the students' responses suggest that they perceive the use of BiO tasks as supportive of their learning, which could account for their generally positive reception (Baldock & Pesl-Murphey, 2020).

The observed difficulties students encounter while solving BiO tasks, combined with the overall positive perception of their use in teaching, is one of the reasons that BiO tasks should be incorporated into regular biology lessons by teachers.

This study has several limitations that should be taken into account. First, the research findings may have been influenced by the selection of specific BiO tasks. If different BiO tasks were chosen, students might have expressed different opinions. Second, despite efforts to standardize the implementation of lessons during the research, individual teachers may have conducted the lessons differently, which could have affected students' experiences and opinions. Third, the relatively small number of participating schools and classes limits the potential to generalize the findings to the broader population of Czech secondary school students. Another limitation is that the research was conducted solely within the context of the Czech educational system, which means that differences in national curricula, teacher preparation, and classroom practices may limit the direct applicability of the findings to educational settings in other countries. Another limitation concerns the potential selection bias, as cooperating teachers were personally connected to the researchers and selected the participating classes themselves. Furthermore, no triangulation with classroom observations or interviews was conducted, which may have limited the depth of understanding of students' responses. Also, the study captured immediate student perceptions but did not examine the long-term impact of integrating BiO tasks on student learning outcomes. The final limitation concerns the use of a questionnaire survey, where differences in students' interpretations of the questions may have occurred. Future research could address these limitations by including a larger and more diverse sample of schools, exploring implementation in various educational contexts, and triangulating questionnaire data with classroom observations and interviews. Such an approach would enhance the generalizability and depth of insights regarding the feasibility of integrating BiO tasks into regular biology instruction.

Conclusions and Implications

This study revealed that the main challenges for students in solving BiO tasks were individual inquiry activities, such as drawing conclusions from comparing pictures, justifying claims, and analyzing information. Since students stated that they barely worked with similar tasks in regular biology lessons, we assume this is the primary reason why the inquiry elements of these tasks present the most significant difficulties for them. Students also reported challenges with non-inquiry elements of the tasks (e.g., task content difficulty, understanding the assignment)

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and practical biology skills (e.g., preparing a sample or creating a biological sketch), but these were mentioned less frequently than inquiry activities.

Clearly, students also expressed a positive view regarding their classmates' ability to work with tasks similar to BiO tasks and believed that teachers could regularly supplement biology lessons with similar tasks. Students considered incorporating tasks similar to the ones they solved into the teaching process a good idea, and their responses suggest that such learning would be perceived as more engaging for them.

It can be stated that the challenges students face when solving BiO tasks do not pose a significant barrier to their implementation in teaching. On the contrary, incorporating these tasks into lessons would provide students with opportunities to enhance their inquiry and practical biology skills while also making the lessons more engaging for them. Teachers are, therefore, offered the opportunity to use didactically appropriate tasks that help students develop essential 21st-century competencies, such as problem-solving, applying the scientific approach, and critical thinking.

Declaration of Interest

The authors declare no competing interest.

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Appendix

Description of the Selected BIO Tasks

Task 1 - part of the BiO in the school year 2016/2017 (Damaška & Mikát, 2016). This task comprises nine sections. The task commences with a text wherein students must select the correct answers from the options provided. In the second segment, students prepare a bee's eye, examining it through a binocular and a microscope. They are then required to represent their observations graphically. Subsequent sections involve completing a table based on provided data, answering sub-questions by inferring information from accompanying images, and justifying their responses. Additionally, sub-questions are presented in text form, often requiring students to defend their answers. According to Tollingerová (1970), this task could be categorized as tasks requiring demanding complex thought operations. This task exhibits a blend of closed elements, involving the selection of answers and open-ended components, encompassing sketching and providing concise responses. Inquiry elements inherent in the task include inferring, comparing, and defending their answers. The allotted time for completing this task is 45 minutes.

Task 2 - part of the BiO in the school year 2010/2011 (Prach, 2010). This task focused on comparing photographs of a landscape taken 54 years apart. Students deduce the changes that have occurred in the landscape based on the comparison of the photographs and solve questions related to the ecology of plant and animal species. A more detailed description of the task can be found in the appendix of our previous study (Novák et al., 2021), where the task was part of the research.

Task 3 - part of the BiO in the school year 2011/2012 (Zemek et al., 2011), delves into ecological patterns concerning the shape, size, and lifestyles in various environments. This task is primarily theoretical. Students frequently encounter questions that necessitate deducing answers from pictures. In cases where a picture is absent, the sub-question prompts students to envision a real example and derive their response accordingly. The task is comprehensively defined, ensuring students possess all the requisite information to complete the assignment successfully. As per Tolinger's classification (1970), this task falls into the category of demanding complex thought operations. It encompasses a combination of closed tasks, such as selecting answers, and open-ended tasks, including completion and providing concise responses. Inquiry elements embedded in the task involve inferring and defending answers. The allocated time for completing this task is 45 minutes.

Task 4 - part of the BiO in the school year 2015/2016 (Vosolsobě & Matějů, 2015). This task focuses on vertebrate limbs. The task comprises four segments. In the initial section, students dissect a chicken wing. Based on their experimentation, they must deduce answers to accompanying questions. Additionally, they must create a sketch, selecting relevant terms from a provided menu. Furthermore, in some instances, students need to defend their chosen responses. The second part involves using diagrams to derive correct answers, and students must justify their choices. In the third part, students encounter a text where they must select the accurate answer from the choices presented. The fourth part incorporates a limb diagram. Here, students add their inferred answers based on the provided images. According to Tollingerová (1970), this task could be categorized as a task that encourages a creative thinking perspective on discovery-based tasks rooted in personal observations. This task combines closed tasks (such as matching and selecting answers) with open-ended tasks (such as completing, sketching, and filling short responses). Inquiry elements of the tasks: inferring, comparing, and defending their answers. The time allocated for solving the task is 45 minutes.

Task 5 - part of the BiO in the school year 2010/2011 (Zouhar, 2010) centers on the difficulties of small populations. The task commences with a text introducing the practical aspect—simulating the transmission of alleles during reproduction using colored papers, spanning up to the 5th generation. This simulation is initially executed with a larger number of alleles and subsequently with a smaller number. Following the practical component, there are questions posed, the answers to which must be deduced from the experiment's outcomes. Additional sub-questions pertain to concepts such as the bottleneck and founder effects, where responses must be inferred and illustrated with real-life examples. The task further involves deducing answers from a family tree, particularly regarding haemophilia within European royal dynasties. According to Tollingerová (1970), this task could be categorized as a task that encourages a creative thinking perspective on discovery-based tasks rooted in personal observations. This task combines closed tasks (selecting answers) with open-ended tasks (such as completing and filling short responses). Inquiry elements of the tasks: inferring and defending answers. The time allocated for solving the task is 50 minutes.

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Questionnaire for Task No. 5

Student Questionnaire Focused on Learning Tasks

By completing this questionnaire, you provide your consent for the anonymized data to be used for didactic research purposes related to the author's dissertation project.

Basic information – *please circle your answer*

1. Gender
   Male – Female – Prefer not to say

2. Do you sometimes work with similar types of tasks during biology lessons? (Working with graphs, tables, diagrams, and photographs; "word problems" introduced by a short or longer text; tasks where you conduct an experiment yourself and then draw conclusions from the results; tasks where you select correct or incorrect statements; "identification tasks," etc.)
   Very often - Often - Fairly regularly - Occasionally - Almost never

3. Provide examples of the types of tasks you work with most often (*e.g., in class we work with tasks where we underline incorrect statements in a text; in class we conduct experiments that the teacher first demonstrates and we then repeat, etc.).*

4. Can you recall what was the most difficult part of the "Difficulties of Small Populations" task for you? *(e.g., the most difficult part for me was understanding the instructions; the most difficult part was justifying the processes I observed; the task required a high level of subject knowledge, etc.)*

Follow-up Information – *please circle your answer*

5. Do you think your classmates would be able to work with similar tasks during biology lessons?
   Definitely yes – Probably yes – Maybe - Probably not – Definitely not

6. Can you imagine teachers regularly supplementing biology lessons with similar tasks?
   Definitely yes – Probably yes – Maybe - Probably not – Definitely not

7. Do you think it is a good idea to include similar tasks in biology lessons?
   Definitely yes – Probably yes – Maybe - Probably not – Definitely not

   Briefly comment on why yes or why not:

8. Do you sometimes work with "natural objects" during lessons? (e.g., identification tasks, etc.)
   Very often - Often - Fairly regularly - Occasionally - Almost never

9. Biology is my …… subject – *complete the sentence by circling your answer:*
   Most favorite – Favorite - Neither favorite nor unfavorite – Unfavorite – Least favorite

10. I find biology …… – *complete the sentence by circling your answer:*
    Very easy – Easy – Neither easy nor difficult – Difficult – Very difficult

11. Rank the following subjects in order of preference - *list your most favorite subject first and your least favorite subject last:* [**Mathematics**, **Biology**, **Physics**, **Chemistry**]

12. Have you ever participated in the Biology Olympiad in the past?

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