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SECONDARY SCHOOL STUDENTS' ABILITY TO WORK WITH THE TASKS DESIGNED FOR BIOLOGY OLYMPIAD

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Abstract. *For the possibility of using competitive tasks from the Biology Olympiad (BiO), either directly or after certain adaptations for everyday teaching tasks in the teaching process, it was aimed to determine if students could work meaningfully with them. The success of 2nd-year secondary school students (n = 113) in solutions of tasks (n = 5) designated for BiO was compared with the solutions by the regional round BiO´s participants. One-way analysis of variance and Tukey´s multiple comparison test were used for the statistical evaluation of the data. The research shows that secondary school students achieved an average success rate of 47.58 ± 12.51 % and BiO participants 62.69 ± 9.86 %. Within the results of all selected tasks, at least someone of the class of the secondary students achieved similar results in each of the tasks as BiO participants. That indicates that secondary school students were able to work meaningfully with BiO tasks which confirmed students' eligibility for work with these tasks.*

Keywords: *biology education, Biology Olympiad, difficulty of tasks, learning tasks, science education*

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Introduction

The main lines of research in recent years in the field of biology didactics are moving in the direction which can be described as a search for pathways, styles, forms, and teaching methods, whereby students more easily acquire knowledge and skills, understand more of the content of the curriculum, and become actively involved in the course of teaching. This applies both in the Czech Republic (e.g., Kroufek et al., 2020), as well as abroad (e.g., Dolan, 2015; Freeman et al., 2014). Most research into the didactics of biology corresponds to the ideas contained in the works of Škoda and Doulík (2009) and Janík (2018) which implies the need to address the process, means and methods of didactic transformation. The challenge for the professional community in the Czech Republic, which focuses on science education and education in general, is a change from today's, mostly transmissive, teaching concept. This, according to Ušáková and Višňovská (2005), places primarily emphasis on the simple memorization and reproduction of a large number of facts and does not place demands on thought operations. A parallel could be seen in the amount of theoretical knowledge that Czech students have, but thinking about science problems, making a hypothesis, designing experiments and interpreting found data is a challenge for them (Blažek & Příhodová, 2016; Papáček, 2010a). Another reflection of the current state of science education is the decreasing interest in science studies (Akram et al., 2017; Anderhag et al., 2016; Held, 2011): only 17 % of students want to study science after secondary school (Mandíkova, 2009), related to the persistently decreasing level of performance of Czech students in PISA surveys (Blažek et al., 2019). There are several proposals to change the execution of the teaching process, e.g., the use of problem tasks (Čížková, 2002) or inquiry-based science education (IBSE) (Rocard et al., 2007; Papáček, 2010a; Dostál 2015a), which, however, have their limits and barriers in their implementation (e.g., Papáček, 2010b; Stuchlíková, 2010). A significant obstacle for implementing IBSE into the educational process is the current teachers' lack of preparedness, as most teachers had not been systematically prepared for IBSE (Petr et al., 2015). The consequence is that teachers either do not understand the substance of the IBSE or do not possess

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a high level of professional and didactic preparedness required for this method of teaching, so teachers do not want to use it or are unable to do so (Papáček, 2010a; Dostál, 2015b; Čížková & Čtrnáctová, 2016; Radvanová et al., 2018). For using the IBSE or any other appropriate and effective method of transforming the subject matter successfully in the teaching lessons, the teacher's understanding of the curriculum content is necessary as well as the teachers´ capacity to handle its subsequent transformation to students on an understandable form (Kansanen, 2007; Shulman, 1987), while students' interest, gender, culture, or possible learning difficulties must be taken into account (Janík, 2007). This is described as pedagogical content knowledge created during the educational process of pre-service teachers (Janík, 2008). As a way out, the possibility of incorporating learning tasks into teaching lessons is offered. Tasks from the Biology Olympiad (BiO), often containing IBSE elements, are a source from which teachers may draw inspiration within selected teaching topics, or they might prepare their teaching materials or use it to expand on their didactic competences (Petr, 2010; Petr et al., 2018).

BiO´s tasks constitute the basis of the subject competition, which has been continuously running in the Czech Republic since 1964 (until 1993 in Czechoslovakia). BiO represents systematic extracurricular activity in which, students solve complex theoretical and practical tasks based on skills and knowledge acquired in biology lessons. During the competition, the participants determine the living things, solve the test of general biological knowledge by working with texts, illustrations, schematics, graphs, maps, examples or photographs, the practical part consists of laboratory tasks. The national round of BiO also involves field tasks. The time subsidy for solving tasks varies between 45-60 minutes. Each year the individual competition always focuses on a different theme. Therefore, new tasks are needed every year. Accordingly, there are a relatively wide range of tasks. The tasks are designed by authorized working groups consisting of university students, university teachers, and experts of the prepared themes. During the creating process of the tasks the formal and content requirements for the various BiO categories are reflected. Upon completing the tasks, authors´ solutions and study texts are created. These study texts are made freely available to students before the competition (Farkač & Božková, 2006; Petr 2010; Petr et al., 2018). Petr (2014) states that there also may be limits during the incorporation of BiO´s tasks. Petr (2014) has seen the problem primarily in the tasks' extracurricular character, whereby the information contained in the tasks exceeds the basic framework of the subject matter, the time-consuming solutions in the equipment requirements and the infrequently available biological materials. Further, solving non-standard laboratory tasks in which students have to prove a higher level of knowledge and skills, which students without a great interest in often do not have as well as choosing suitable tasks because some of the BiO´s tasks are similar to those commonly used in teaching and include, e.g., simple observations, crosswords or a plain description of the images. However, despite these limitations, in teaching can be employed incorporation of BiO tasks. If the elements of IBSE appearing in the BiO´s tasks and the possible extension of didactic competencies within the author's solutions are omitted, they mainly fulfil the three attributes below. (1) In the BiO´s tasks, as in the school biology subject as described by Švecová (2002), there is a close connection between knowledge and skills. (2) Students use knowledge and skills that are a part of science as well as technical and mathematical education while solving BiO´s tasks, thus reflecting the requirement of one of the six objectives for the desired development of Europe, when according to Hazelkorn et al. (2015) there has to be the interdisciplinary concept of science education in Europe. (3) BiO´s tasks could be characterized as learning tasks if they are viewed within the context of works e.g. Gropengießer (2006), Janiš and Ondřejová (2006) and Vaculová et al. (2008), for which the term "learning task" means a teaching method that poses an incentive for the active activity of the student which is based on the formulation of the teaching objectives and can be seen as an opportunity for learning or a means to focus attention on learning.

Research Problem

It follows from the above that the competitive tasks from BiO have the potential for use in teaching. However, the question arises whether the secondary school students are able to work meaningfully (they are able to solve BiO tasks without major problems comparing to BiO´s participants) with the BiO´s tasks in the teaching process or because of their specificity, demanding nature and complexity, whether BiO´s tasks cannot be used in teaching.

Research Focus

This research sought to find out the ability of secondary school students to work with the tasks designed for BiO via comparison of secondary school students to BiO participants in solving the test composed of BiO tasks. Moreover, the research focuses on the level of difficulty of BiO test tasks for common secondary school students,

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furthermore, on the possibility to use them (non-traditional biology tasks often with IBSE elements), directly or after certain adaptations, in daily lessons in the form of teaching tasks. The following research questions have been formulated:

- Are the overall test results of the secondary school students comparable to the results of the BiO participants?
- Is it possible to compare BiO participants´ results in particular tasks with the results of particular secondary school classes?

Research Methodology

Research Design

For the research, a test was created which consisted of 5 theoretical BiO tasks from category B (1st - 2nd year of secondary school). The time subsidy for completing the test was 45 minutes. The test was modified on the basis of a pilot survey involving the 1st year secondary school students (*n* = 8). Practical tasks were not included in the test for time and material reasons. The research took place between 24. 2. 2020 and 12. 3. 2020. The test was commissioned by the researcher who informed the students before the start the reason the testing was being carried out. The researcher addressed them verbally according to the instructions for completing the test, briefly described what is expected of them in the test and encouraged them to achieve the best possible results, and assured them that the test result would not be part of their class evaluation. The researcher was present during every test and was prepared to answer any questions about the test which had not come up. The tests were corrected and scored according to the author´s solutions of the individual BiO´s years. The maximum score of the test was 25,5 points. The validity of the test was ensured through evaluation by department of biology (Faculty of Education) of the University of South Bohemia (USB). Validity was obvious due to the fact that the BiO tasks themselves are created by a group of experts. A comparison of the secondary school student´s results from each task was undertaken with the results by the participants of BiO (hereinafter referred to as O). Their results from selected tasks were obtained from archived solutions of individual BiO´s years. To the comparison of the overall test results of all students, a fictional existing group was created, which was formed from the below mentioned three groups of BiO participants.

Research Sample

The research participants were students of the 2nd year of secondary school (*n* = 113) from schools (*n* = 4) in the South Bohemian Region. One school was science-oriented (hereinafter referred to as P) while three schools were grammar schools (hereinafter referred to as G). These schools were catchment schools, small to medium in size. Only secondary schools in the South Bohemia region were addressed (because of the driving distance). The total count of addressed schools was nine. Unfortunately, some schools did not want to cooperate in this study. Schools in České Budějovice were not addressed due to their congestion (other research studies, students´ practice). The research involved students from a broad economic-social spectrum. None of the students was foreign, and none had been diagnosed with a specific learning disability. The research took place in six classes (P and G_{1-5}) that were uneven in numbers of students. Students' absences and schools' size caused numerical imbalances in the classes. Teaching in each class was performed by a different teacher. From the research sample, there were 27 students who participated in BiO during their studies, including studies at the primary school. The participants of the regional rounds of BiO category B in the South Bohemian region (O) are from the competition held in 2010/2011 (*n* = 37), 2011/2012 (*n* = 38) and 2012 / 2013 (*n* = 34). The BiO participants´ data were provided by the BiO regional committee, which completely anonymized them before the handover. Secondary school students' data were provided also anonymously with agreement of the director of particular school hence the research design was with accordance of the Ethics Committee of the Faculty of Education of USB.

Test tasks

The tasks were selected after studying the education plans of participating schools. This was done to verify that the subject matter included in the teaching tasks had already been taught, thus minimizing the advantage of BiO participants who may read the preparatory brochure before participating in the competition (and their above-standard

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interest or knowledge is also assumed). The tasks were part of the school years 2010/2011, 2011/2012 and 2012/2013, but were typologically consistent with newer tasks. The newer ones were not included because they either did not include explained subject matter or the contestants' participation in the current year would affect the results. For students to be able to solve a broader range of tasks, it was necessary to reduce them due to the time needed to solve them. Types of tasks were selected, whose solution encouraged the students to think scientifically and critically. The students were able to obtain a set of possible solutions from these tasks which they could use in the wider context for solutions in other school subjects or in everyday civil life. In the tasks students worked with charts, tables, schematics, and photographs and were presented in short to medium-length text. During the task solving process, they had to understand the text, sort out information, observe, derive, compare, set assumptions, and draw conclusions.

Data Analysis

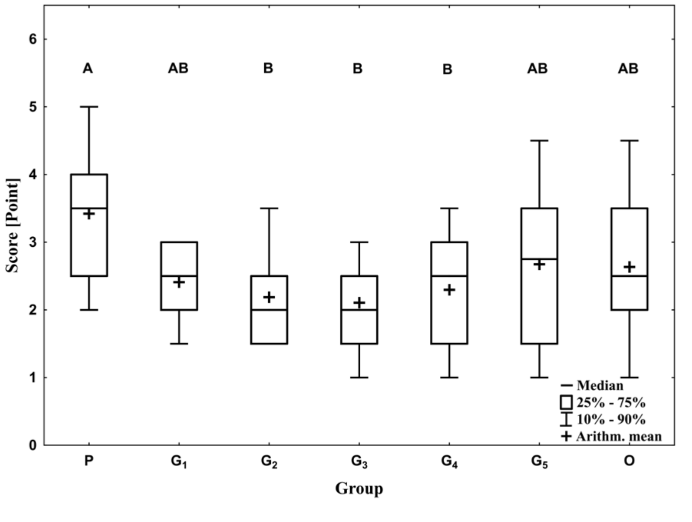
Test scores were written down into the table in Excel from the Microsoft Office 2016 program group. Subsequently, the data was transferred to Statistica 13.5, where a One-way analysis of variance (one-way ANOVA) was used to determine whether there is a significant difference between the results of the student groups (secondary school classes and BiO participants). Tukey´s multiple comparison test was used to ascertain a significantly better/worse result between classes and BiO´s participants' groups. The classes were divided into homogeneous groups at the statistical significance level $\alpha = .05$. The form of box plots was used for graphical representations of the research results.

Research Results

Comparison of Achieved Results in the Individual Tasks

The result of the one-way ANOVA showed that there was a significant difference between the classes results in task no. 1 ($F_{6;143} = 3.64$; $p = .005$) - Figure 1. Therefore, a post-hoc Tukey´s multiple comparison test was performed which showed that Class P achieved significantly better results compared to classes G_3 and G_4 results ($p = .08$; $p = .07$) and compared to Class G2 result ($p = .011$). The secondary school students solved task no. 1 with an average success rate of 42.40 ± 17.91 % (mean ± *SD*). Group O achieved an average success rate of 43.92 ± 20.38 %.

Figure 1
Comparison of Task Solution Results No. 1.



Class P achieved on average a statistically significantly higher score than classes G_2, G_3 and G_4. The other differences are not statistically significant. P – the science-oriented school, G_{1-5} – grammar schools, O – BiO´s participants' group of the year 2010/2011.

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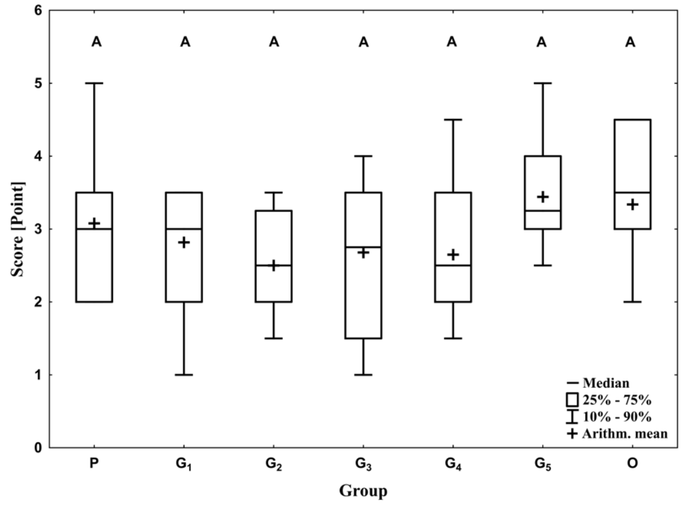
Figure 2
Comparison of Task Solution Results No. 2.

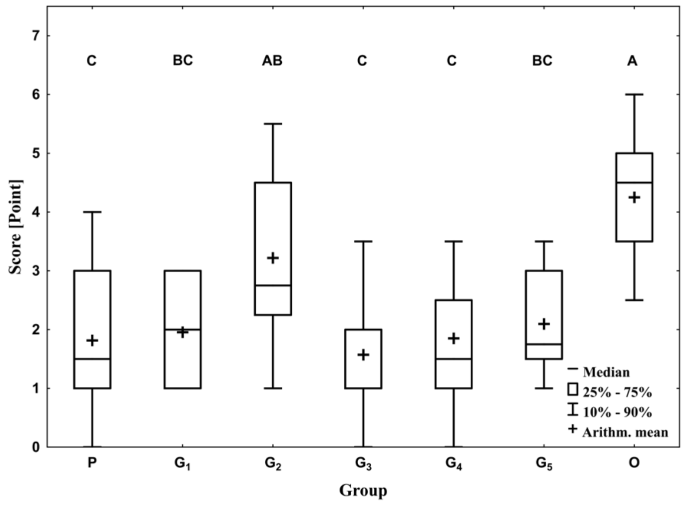


The effect of class on the result is statistically significant, although post-hoc multiple comparison showed no significant differences between classes. P – the science-oriented school, $G_{1\text{-}5}$ - grammar schools, O – BiO´s participants' group from 2010/2011.

Also, in terms of the second task (Figure 2), there was a significant difference between the individual classes' results ($F_{6;\,143}$ = 2.97; p = .01). Therefore, a post-hoc multiple comparison by Tukey´s test was performed, but none of the classes achieved statistically significant better results than others. Differences between G_5 vs G_2 and G_5 vs G_4 were marginal (p = .06; p = .073). The secondary school students solved task no. 2 with an average success rate of 52.78 ± 19.13 %. BiO participants achieved an average success rate of 60.69 ± 19.29 %.

The result of the one-way ANOVA showed the statistically significant influence of the class on the result of solving the 3rd task ($F_{6;\,144}$ = 14.45; p < .001) - Figure 3, so a post-hoc multiple comparison of the Tukey´s test was performed. This showed that Group O achieved a significantly better result than Class P, G_1, G_3, G_4 and G_5 (all p < .001). In addition, the results achieved by class G_2 were significantly different from those of classes P, G_3 and G_4 (all p < .04). The secondary school students solved task no. 3 with an average success rate of 29.58 ± 20.20 %. BiO participants achieved an average success rate of 60.71 ± 20.05 %.

Figure 3
Comparison of Task Solution Results No. 3.



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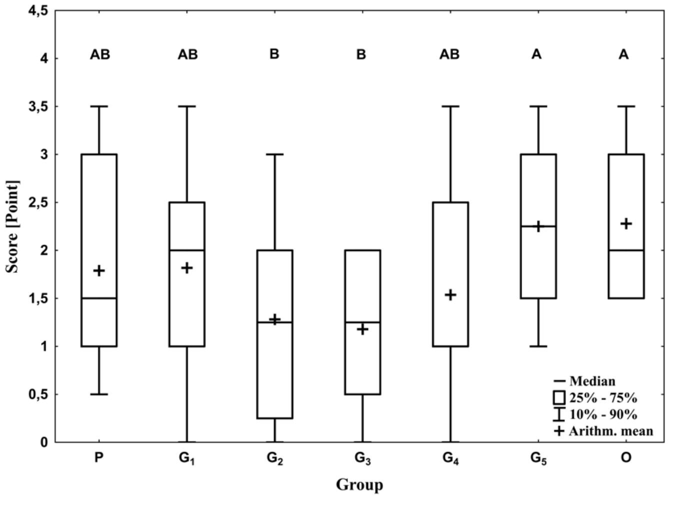
BiO´s participants' group from the year 2011/2012 achieved statistically significantly better results than all of other classes except class G_2. P – the science-oriented school, G_{1-5} - grammar schools, O – BiO´s participants' group of the year 2011/2012.

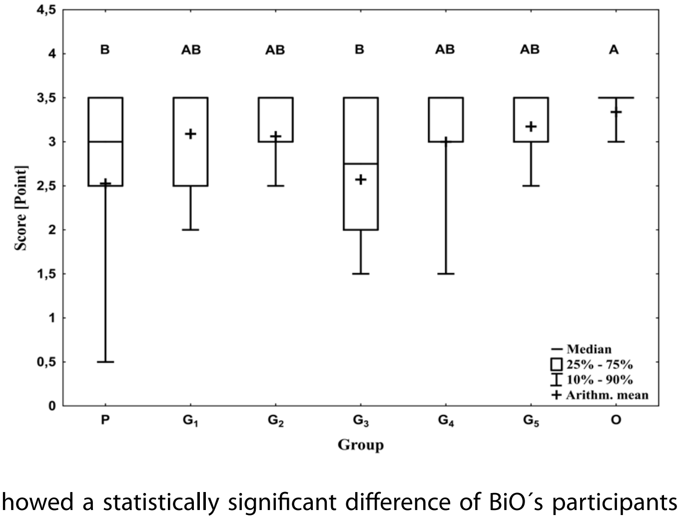
A significant difference between classes appeared in the results of the 4th task solution ($F_{6;140}$ = 4.27; p < .001) - Figure 4. Tukey´s multiple comparison test showed that group O achieved significantly better results in comparison to classes G_2 (p = .014) and G_3 (p = .007), also the difference of group O compared to class G_4 was marginal (p = .051). Additionally, the results achieved by class G_5 were conclusively different from those of classes G_2 (p = .03) and G_3 (p = .017). The secondary school students solved tasks no. 4 with an average success rate of 48.29 ± 30.44 %. BiO participants achieved an average success rate of 65.13 ± 23.65 %.

Figure 4
Comparison of Task Solution Results No. 4.



BiO´s participants' group of the year 2012/2013 achieved comparable results with classes P, G_1, G_4 and G_5. P – the science-oriented school, G_{1-5} - grammar schools, O – BiO´s participants' group from the year 2012/2013.

Figure 5
Comparison of Task Solution Results No. 5.



This task's results showed a statistically significant difference of BiO´s participants of the year 2012/2013 against classes P and G_3; classes G_1, G_2, G_4 and G_5 were comparable to all the others. P – the science-oriented school, G_{1-5} - grammar schools, O – BiO´s participants' group from 2012/2013.

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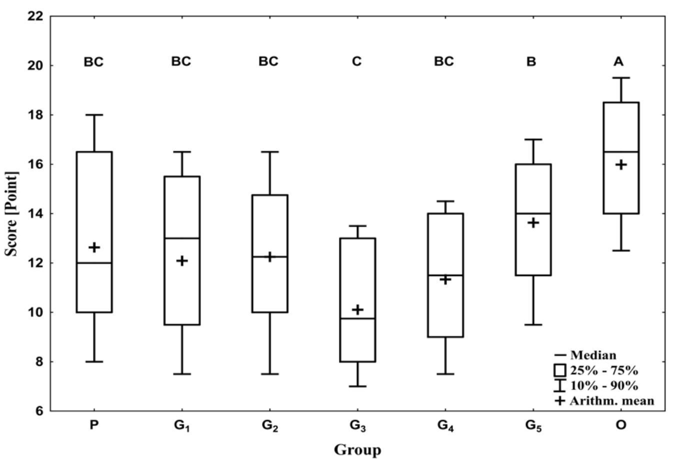
Also, in the case of the 5th task (Figure 5) was the impact of the class on the task result was evident ($F_{6;140}$ = 3.08; p = .007). Tukey´s multiple comparison test indicated that the results of Group O were significantly different from those of classes P (p = .006) and G3 (p = .037). The secondary school students solved tasks no. 5 with an average success rate of 83.57 ± 25.77 %. BiO participants achieved an average success rate of 95.38 ± 9.77 %.

Comparison of Achieved Results in the Test

In the analysis of all five test tasks combined (Figure 6), the class's influence was also statistically provable ($F_{6;140}$ = 10.02; p < .001). Tukey´s multiple comparison test conclusively indicated that the best results were achieved by the fictitiously created group of real BiO´s participants which differed significantly from all other classes (excluding O vs G_5 (p = .037) all p < .003). Moreover, the results of G_5 were provably different from the G_3 results (p = .006), and the difference between G_5 and G_4 was marginal (p = .07). Overall, the secondary school students solved the test tasks with an average success rate of 47.58 ± 12.51 %. BiO participants solved the test tasks with an average success rate of 62.69 ± 9.86 %.

Figure 6
Comparison of Solution Results of the Test (Summarization of All Five Tasks).



The fictionally created class of the real BiO´s participants achieved a significantly better result than all other classes. P – the science-oriented school, $G_{1\text{-}5}$ - grammar schools, O – fictitiously created class of the real BiO´s participants.

Discussion

The idea of using BiO's tasks as teaching tasks in daily biology classes may have occurred to many teachers over the years, and probably some of the "enthusiasts" had already used them during their teaching practice. The idea of incorporating BiO's tasks into the teaching process appeared in the literature for the first time in Petr (2010). Petr (2010) invites their use both in the classical-transmissive as well as the constructivist model of teaching. Until then, BiO has been mentioned, e.g., in the context of increasing the interest and motivation of students by means of participation in the competition (e.g., Feist, 2006; Staziński, 1988). The first effort to experimentally verify the applicability of BiO's tasks in the teaching process was researched by Dvořáková (2012). Using the worksheet´s form, which was created from four modified BiO tasks, she found that during worksheets solving exercises, secondary school students of biology seminar achieved an average success rate of 54.7 %. However, the average success rate of solutions by those students who took extra science classes does not fully reflect the applicability of BiO's tasks in the teaching process. Hence the possibility of using them was researched by undertaking a comparison of the average success rate of school students (47.58 ± 12.51 %) in BiO tasks with an average success rate of BiO participants (62.69 ± 9.86 %).

According to Farkač and Božková (2006), BiO´s participants are gifted students who tend to ward biology and acquire more extensive knowledge in it. Accordingly, the researchers assumed that they would achieve an overall significantly better average result in task solving in the test compared to secondary school students. This assumption was

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only partially confirmed. BiO participants actually achieved an overall statistically significantly better mean result (all $p < .003$ excluding O vs G_5, where the difference ($p = .037$) was marginal). However, in each task their results were matched by the results of some classes of secondary school students. In other words, in neither task did BiO participants form a performance-homogeneous group that differed significantly from all classes' performance. Even though the tasks for the test were selected based on the school´s education plans of participating schools, it should not be forgotten that BiO participants, according to the contribution of Petr et al. (2018), systematically prepare for competitive tasks themselves. It may therefore be considered that the secondary school students are capable of working meaningfully with the BiO´s tasks, even though they might have less biological knowledge and less developed competencies to solve these competitive tasks than BiO participants.

Naturally, there was a difference between the classes' results because there are differences in the students' abilities within the collective group, and different teacher work affects each class (Chráska, 2016), which consequently makes each class unique. This is also obvious from each task's results, whereby the classes' results depended on the type of task being solved. The types of selected tasks had mainly an evaluation function. Still, as tasks that students should primarily work with within biology classes, they should contain elements to practice the competencies that students need to acquire in progressively becoming scientifically literate persons during the biology classes (Blažek & Příhodová, 2016). This transformation process requires working with tables, diagrams and graphs in the classroom (Svobodová, 2013), but understanding these types of tasks causes problems for students (Vondrášová, 2009). On the other hand, the students who work with these tasks during the daily classes achieve better results in the comparisons (Blažek et al., 2019). In all tasks, except task no. 5, students needed to have some biology knowledge before the test because it was impossible to deduce everything while solving the tasks. In task no. 5, students could deduce everything from the graph, so they achieved the best results in it. Most probably because students were able to use competencies they gained in other teaching subjects during the solution, e.g., in mathematics classes. Except for another schema, the graph was also part of task no. 2. Students in this task showed the most balanced results of all and achieved on average worse results than in task no. 5. For BiO participants, the task represented as the second average worst-performing result.

Task no. 4 was created on the commonly known relationship of the ocellaris clownfish (*Amphiprion ocellaris*) with certain sea anemones species. The assignment of the task included the fictional character Nemo from the animated film *Finding Nemo*. According to Havlíčková (2020), the influence of linking the context of the task with the animated film character may have increased the success of the solution among students. Secondary school students in task no. 4 achieved an average success rate, the value of which was in the middle of the achieved average results of the selected tasks. However, it was the second most successful average solution of the tasks for BiO participants. According to the secondary school students' average success rate, the task no. 1 was the second most challenging, and BiO participants achieved the worst result. Students had to compare two photographs of the same landscape during the solution, which were taken in a time span of 54 years. Based on the comparison, they were to draw the consequences of changes in the landscape regarding animals, plants and nature protection management. The task can be modified to high degree and can be commissioned to students in many ways. In the work of Petr (2014), the task is given as an example of a teaching task with BOV elements and her use in teaching is recommended. From the results, the researchers conclude that this type of task was often not encountered by the secondary school students and the BiO participants in biology classes. The most input knowledge was required from students in task no. 3, wherein the first part, the students selected the correct solutions from multiple options and in the second part, they derived from two pictures the function of two plant cells with regard to the influence of shape of the cell. In this task the most significant performance difference was between the secondary school students and the BiO´s participants. This supports the claim that BiO participants possess a greater amount of natural science knowledge (Petr, 2014).

For the possible incorporation of BiO tasks into teaching, the only limitation is not their level of difficulty, which has been dealt with so far, but also their complexity, specificity, and the inclusion of the subject matter beyond the curriculum. These limits are due to the way the BiO tasks are invented. BiO tasks are designed in such a way that students penetrate in-depth and understand the context during the problem-solving process, rather than addressing the topic only superficially (Černý et al., 2016). Consequently, there is a focus of the competition each year on a single theme because a broader definition would risk making the competition too demanding or not sufficiently addressing the particular themes. On the one hand, it makes it easier for teachers who would like to use the BiO tasks because while the searching for tasks, they have more narrowly defined topics, but on the other hand, if they do not work with students who do not take extra science seminars, for example, it will be necessary to modify the tasks. This is particularly true because of their complexity and specificity, since these characteristics of BiO tasks create a temporal and content barrier to direct introduction into teaching. If the task had not been modified, it would have played an autonomous role in the school

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lesson since the usual time required for the solution is usually 45-60 minutes. (Farkač & Božková, 2006). That is didactically inappropriate (Kalhous & Obst, 2002). From the point of view of content, fundamentally curricular documents, the school learning plan content should be integrated into teaching tasks while not containing any excessive amount of information that does not focus on their comprehension. This is particularly significant because students would negatively perceive biology teaching as overly difficult (Škoda & Doulík, 2009). Moreover, they might not imagine how they could possibly use all the information they had acquired during the educational process in civic life (Prokop et al., 2007).

In the case of appropriate selection and modification of BiO tasks, students could work with tasks containing IBSE elements (e.g., Petr et al., 2018), which in the course of the problem–solving task would stimulate students to perform intricate thought operations. Their use may help students understand the subject matter content in context, engage creative thinking, critically evaluate the text, and practice a range of competencies, from maps to problem-solving competencies, as well as skill development such as working with the stereoscopic microscope or practicing the preparation of the solution. In essence, using the BiO tasks in pedagogical practice could help to improve today's concept of teaching science subjects (e.g., Ušáková & Višňovská, 2005) and to reduce the deficiencies of Czech students in biological knowledge and skills (e.g., Blažek & Příhodová, 2016; Papáček, 2010a). Some BiO´s task authors affirm their use in teaching (e.g. Šíma, 2018; Buchbauerová, 2019; Černý, 2020; Černý, 2021; Čurnová, 2020; Smyčková, 2020; Vosolsobě, 2020), who published their tasks in the contributions of the science journal *Živa* (the oldest science journal in the Czech Republic), where they described them as a suitable supplement to classroom teaching, which can serve to connect various parts of the curriculum.

Limitations of this study could be relatively small sample size (n = 113), so the conclusions that follow from this research might not be fully corresponding with daily school reality. Another limitation could be seen in the selection of the schools for the research. Only secondary schools in the South Bohemia region were addressed and unfortunately, some schools did not want to cooperate in this study. Further, the results could be affected by choosing suitable tasks for the research but choosing the appropriate learning tasks is the preference of good teachers and it should be a priority for every teacher. Other limitations could be a small count of tested tasks or using only non-practical BiO tasks during the research. Despite these facts, the results of this study indicate the possibilities of using competitive tasks from the BiO as learning tasks in the daily teaching process.

Conclusions and Implications

By the comparison of results of secondary school students and BiO´s participants in a test composed of modified BiO´s tasks, it was examined whether the secondary school students are eligible to work with the BiO´ tasks because of the possibility of their incorporation into the educational process. Although the BiO participants' average result in the test was significantly better than the average result of secondary school students, it did not reach a noticeable level. The research results indicate that none of the tasks did BiO participants form a homogeneous group that was statistically distinct from the secondary school students participating classes. Thus, some secondary school students' classes achieved similar results in tasks as the BiO participants´ group. This indicates that secondary school students are eligible to work with BiO tasks and that using BiO tasks in teaching may be considered feasible.

Of course, there are limits to incorporating BiO's tasks into biology lessons. Some tasks are not didactically appropriate, and not in every class would it be convenient to use them. Nevertheless, if a teacher who responsibly considers his students' possibilities can modify the tasks appropriately in order to use them in the motivational, exposure, fixative or diagnostic part of the teaching, this should not pose any problem for the students. On the contrary, students may work with teaching tasks that will make them observe, derive, hypothesize, think scientifically and critically, and understand the subject matter in context. Using the BiO tasks in teaching, students will gain experience with non-traditional biology lessons, and teachers will have a variety of didactically appropriate teaching tasks.

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Declaration of Interest

Authors declare no competing interest.

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Appendix

Description of the Test Tasks

Task no. 1 – made up a part of the BiO in the school year 2010/2011 (Falteisek et al., 2010). The task was divided into four parts. The assignment included two aerial landscape photographs of the military area in Boletice near Sumava. The first picture was taken in 1950 and the second in 2004. Students had to contrast the aerial photographs. Based on the comparison, they responded in three parts in closed tasks with the choice of answers of multiple correct options. In the fourth part, students wrote a short production reply. According to Tollingerová (1970), the researchers included it among the tasks focused on deducing, which require complex thought necessitating operations background knowledge. The task was fully defined, so the students had all the necessary information to solve in the assignment. The students used observation and comparison during the solution, solved the problem, formulated hypotheses internally, drew conclusions, made assumptions, and had to orient aerial photographs in relation to changes in landscape, occurrence and distribution of natural communities. In his monograph, Petr (2014) evaluated this task as suitable for use IBSE at school lessons. The maximum score was 6 points.

Task no. 2 – came from a part of the BiO in the school year 2010/2011 (Falteisek et al., 2010). The task focused on the direct consequences of water eutrophication, where the ratio of phytoplankton, zooplankton and the substances contained in water changes. Subdivided into three parts, the assignment included a short text. In the first part, there was a schema, and the students supplemented + and -, thus expressing a dependency on changing circumstances. In the second part, the students selected answers, and in the third part, the task contained a graph. In the graph, there were two curves, and students had to choose which curve indicated the fluctuation of phytoplankton during the growing season and which represented the fluctuation of zooplankton. Subsequently, they should justify their choice. According to the taxonomy presented by Tollingerová (1970), the researchers included the tasks focused on deducing as well as a task combining elements of a closed and open task. Students used work with both graph and text, had to orient

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themselves with the schema, sorting information, internally establishing assumptions, and drawing conclusions in the course of solving the task. The maximum score was 5.5 points.

Task no. 3 –part of the BiO in the school year 2011/2012 (Baláž et al., 2011). The task was started by a short text that introduced the students to the topic of cell biology. Combining elements of a closed and open task, it was separated into two parts. The first part consisted of a text with a choice of responses, while the second part contained two pictures of specialized plant cells. The students had to determine the function of the cells from these images and deduce the influence of cell shape on this function. According to Tollingerová (1970), the researchers deduce that in these tasks were elements of enumeration requiring simple thought operations as well as elements of a complex task requiring complex thought operations. In the course of the solution, the students observed, made assumptions, deduced conclusions, sorted information and worked with the text. The maximum score was 7 points.

Task no. 4 **-** part of the BiO in the school year 2012/2013 (Balážová et al., 2012). The task began with a short text focused on epigenetic sex change of fish by environmental action. The task was divided into three parts. A short production response was requested from the students in each part. In two parts, clownfish (*Amphiprion ocellaris*) appeared as an example of fish, thereby the authors wanted to make the assignment more attractive because of the popular animated film *Finding Nemo*, to which they refer. The task was fully defined, and by Tollinger's taxonomy (1970), the researchers describe it as a task combining simple and complex thought operations with knowledge in which students determined assumptions, deduced conclusions, sorted information and worked with the text. The maximum score was 3.5 points.

Task no. 5 – consisted of a part of the BiO in the school year 2012/2013 (Blážová et al., 2012). The task was initially part of task no. 4 with other parts. The task included a graph showing the change in the proportion of male red-eared turtle (*Trachemys scripta elegans*) during incubation. In the course of the solution, the students determined the proportion of males during incubation at 32 °C and then in the second part, they filled into the table answers about whether the claims were true or not. According to Tollingerová (1970), the researchers consider it a task on discovering the relationship between facts and on deducing. Students worked with a graph during the course of the solution, determined assumptions, deduced conclusions, sorted information, and worked with the text. The maximum score was 3.5 points.

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