EdBi Educatio Biologiae Extended summary

Received 11.11.2024.
Accepted 26.11.2024.
Published 28.11.2024.

Differences between contact and online biology classes

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ABSTRACT

The research on attitudes towards biology teaching was conducted in the fall of 2021 in an online format, with most statements contextually paired within contact and online teaching for the opinions of students and teachers, while parents responded about the online teaching they could follow. Student responses were mostly uniformly moderately positive for both teaching. Teachers with contact teaching have highly positive reactions in line with the guidelines for quality biology teaching, and they match students' responses for online teaching. Parents mostly have a good opinion of biology teaching in an online format. Student and teacher statements indicate significant differences between contact and online teaching related to teaching and learning, inquiry-based learning, motivation and activity. Significant differences were observed between participants in the assessment of teaching and learning performance, all closely related to the characteristics of the individual teacher. Based on the results, a modular three-stage professional development system with a mentoring support network was proposed that would significantly help in the application of hybrid teaching and learning, but also more successful implementation of quality biology teaching.

Keywords: *attitudes; students; teachers; parents; elementary and high school*

INTRODUCTION

Although online learning has been around for a long time, it has only been in the last few years that it has been developed and analyzed in more detail compared to the traditional face-to-face approach after its intensive introduction during the COVID-19 pandemic (Nambiar, 2020). Before the intensive online teaching during the pandemic, students, depending on the subject and the method of preparing learning materials and conducting classes, accepted face-to-face and online teaching with equal satisfaction and success (Fortune et al., 2011). Most accepted synchronous and asynchronous learning during the lockdown period, but did not have a positive perception of exclusively online teaching (Gamage et al., 2022). Some studies have reported improved academic performance due to the flexibility and accessibility of online learning, which allows students to learn at their own pace, however, other studies have highlighted challenges such as reduced engagement and isolation, and reduced interaction with instructors and peers (Akpen et al., 2024). The acceptance of online teaching by teachers and students depends on the design of online teaching, structure, level of interaction between students and teachers, quality and quantity of teaching content, technical support and overall experience with online teaching. All these elements affect the overall teaching and learning experience and determine the ultimate success or failure of online education (Nambiar, 2020).

Active learning positively affects student performance and is necessary for acquiring knowledge at higher cognitive levels (Dogani, 2023). It is important for students to conduct experimental research and observations, participate in biological demonstrations, think about causes and effects, and apply knowledge in everyday life (Uitto and Kärnä, 2014). Discovery learning is a very suitable strategy for learning science (Ladachart et al., 2022), including biology, and requires high cognitive engagement and indicates the development of metacognitive skills (Nunaki et al., 2019). These are all basic principles of quality biology teaching that should be applied in the vertical of biology learning with the

URL DOI: https://doi.org/10.32633/eb.10.6

continuous development of teaching knowledge and skills. In the time of great and rapid changes brought by today's times, teachers need to engage in development processes throughout their careers, be responsible for their practices, and learn based on personal research but also use the knowledge and evidence of other research as a valuable contribution to their thinking, their practice and their professional development (Mooney Simmie, 2023).

Students' attitudes towards the subject should be a key concern during teaching and learning, as it reflects the application of methodological recommendations within the framework of quality biology teaching, and teachers have to monitor their student's attitudes towards the subject and the teaching carried out (Adejimi et al., 2022). Teachers' and students' opinions about teaching play an important role in determining the effectiveness of teaching and learning (Mapulanga and Bwalya, 2024), and their comparison can provide teachers with insight into how they teach (Karamane et al., 2023). During online teaching during the pandemic, parents faced the challenges of keeping their children focused on schoolwork instead of other online activities, balancing their work and household responsibilities with helping their children learn (Grover et al., 2021). Since parents were also partly involved or at least present during their child's online learning during online teaching, they became an important link in learning the pros and cons of online teaching. Therefore, it was important to determine the opinions of students, teachers, and parents about teaching and learning biology and to determine the differences they notice between contact and online teaching so that teachers could consider their opinions and adjust their teaching to achieve effective learning.

METHODOLOGY

The research was conducted in the fall of 2021. using the LimeSurvey tool. The research measurement instruments were non-standard survey questionnaires constructed for the needs of this research, with most of the statements being contextually paired within the framework of contact and online biology classes. In this way, it was possible to compare the answers to the statements by using the mean values of the respondents' responses. The research involved 1,257 students, 124 of their teachers, and 719 parents. Parents were surveyed only about online classes since they have personal insight into this teaching.

Students filled out a questionnaire that examined attitudes, with 56 statements about contact and online classes ($\alpha = 0.963$). Since students in grade school (ages 8 to 10) were also included, a three-point Likert scale was used for assessment. Teachers were given a questionnaire that examined teachers' attitudes towards contact and online teaching with 62 statements ($\alpha = 0.964$), and a six-point Likert scale was used. In the questionnaire that examined parents' attitudes towards online teaching with 34 statements ($\alpha = 0.824$), the Likert scale was used for assessment as with teachers, with the addition of the option to select "cannot assess". To compare the results of all questionnaires, the results were recoded into a three-point scale while the original value 6 (cannot assess) was code 0 assigned to be excluded from the calculation of mean values. The questionnaires had mostly similar contexts and were paired when possible to compare the responses in the questionnaires.

To compare the results in this analysis, contextual descriptors of quality teaching were determined and statements related to the same context were selected and processed together to obtain a clearer picture of the differences and similarities in the experience of contact and online teaching among all participants by summarizing them using mean values. In the responses of students, teachers and parents, a mean value was calculated for each response at the statement level for each group of participants to compare responses of the same context as the descriptors of teaching and compare the

URL DOI: https://doi.org/10.32633/eb.10.6

teaching environment. When interpreting responses at the level of mean values for statements, the term responses of the corresponding group of participants is used, and when expressing mean values, MK denotes the mean value of responses for contact teaching, and MO mean value of responses for online teaching. In interpreting the differences in mean values of paired responses of teachers and students, the mean difference of responses (MP-S) is used, where P denotes teachers, S denotes students, and these abbreviations are also used to denote the mean responses of individual groups of participants (MS for students and MP for teachers) with the designation MR for parents' responses. When calculating the mean value, statements with negative connotations were recoded into positive form so that the calculation was comparable for all statements. To interpret the comparison of the opinions of students, teachers and parents, the teaching descriptors were linked into groups based on their role or importance in teaching and learning, using the following scale: negative (0 – 0.9), neutral (1.0 - 1.9) and positive (2.0 – 3), except for statements with negative connotations in which positive and negative were interchanged.

To interpret the results of the Pearson correlation index (r) at the significance level of $p < 0.05$, which compared the correlation of student, teacher and parent responses in the same context when it was possible to analyze this concerning the baseline data and the number of statements included in the descriptors. Scale was used according to which the values are interpreted in the level of data correlation as: 0.0 – 0.1 irrelevant; 0.1 – 0.3 small; 0.3 – 0.5 moderate; 0.5 – 0.7 large; 0.7 – 0.9 pronounced; 0.9 – 1 almost complete (Hopkins, 2000). The Kruskal-Wallis Test was used to compare the performance methods and determine differences in attitudes between participants towards the descriptors.

RESULTS AND DISSCUSION

In the responses of students, teachers and parents, dominant positive attitudes were observed about the teaching biological content in the vertical of biology learning. The differences between students' responses to the *Subject* in addition to learning biology in the contact mode and the online form are small ($MS_{(K-O)}$ from 0.05 to 0.16), which is why there is almost complete correlation between students' responses ($r_S = 0.95$). Students respond moderately positively and evenly for both teaching that they like learning biological content, that they find the lessons interesting, and that they feel comfortable in the lessons of subjects in which they learn biology. They are less satisfied with the online teaching environment ($MS_O = 2.28 \pm 0.69$). That indicates an unchanged attitude towards subjects in addition to learning biology regardless of the teaching method, which is also confirmed by other authors (Fetalvero and Bagarinao, 2017; Adejimi et al, 2022). A small positive correlation was observed between the responses of students and parents ($r_O = 0.23$). Most of the parents' responses are higher than students are (M_{R-S} from 0.17 to 0.34), except for the opinion about the interestingness of the lessons, for which parents give neutral answers ($MR_O = 1.99 \pm 0.91$), while the students consider online lessons to be only slightly less interesting than contact biology lessons ($MS_K = 2.51 \pm 0.62$; $MS_O = 2.41 \pm 0.65$). Students respond moderately positively and evenly for both teaching that they like learning biological content. They feel subjects comfortable in which they learn biology, only they are less satisfied with the online teaching environment. Humphrey and Wiles, (2021) also established the preference for contact biology teaching, and many participants emphasized that they prefer personal laboratory and research teaching instead of remote laboratory experiences. Most of the parents' responses about the subject in which their children learn about biological content are higher than those of the students, except for the interestingness of the subject, which indicates that parents

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believe, probably based on observing their children during online classes, that this form of teaching was not interesting to them.

The organization of teaching determines the success of teaching and learning. According to neutral responses (MP_K = 1.89 ± 0.23), teachers express that during contact teaching they rarely organize teaching using ready-made preparations from textbook publishers, while they express a weak positive opinion (MP_O = 2.16 ± 0.47) about the use of prepared video lessons offered by the Croatian Ministry of Education. Štargl et al. (2020) point out that the video lessons were prepared according to the instructions of the Croatian Ministry of Education as support for teachers during classes during epidemiological measures or as material for students who cannot attend classes due to illness. They should have been created following the principles and using active learning techniques, with the performance of activities through structured discovery and the inclusion of tasks at higher cognitive levels. In contrast, teachers give highly positive answers about the independent creation of tasks for active teaching. Due to the need for detailed interpretation and insight into the impact of teaching preparations and its impact on students and their learning, *Learning interest* was separated from the descriptor *Motivation* in which it is classified. Students found the tasks they were learning to be moderately interesting in both teaching (MS_K = 2.44 ± 0.07; MS_O = 2.35 ± 0.26), but despite a slightly positive response to online teaching (MS_O = 2.17 ± 0.13), they preferred contact teaching (MS_K = 2.53 ± 0.06).

The highest mean values of the descriptors of quality teaching based on the mean values of contextually related responses of the participants were recorded for *Teaching* and *Teacher and learning* (M = 2.70), *Student care* and *Teacher in class* (M = 2.67), and *Assignments* (M = 2.64). The lowest mean values were recorded for *Experience* (M = 1.31) and *Negative behaviour in class* (M = 1.27).

Within the *Student care* descriptor, an almost complete correlation between student and teacher responses can be observed in the contact mode of teaching (rK = 0.99) and the online mode (rO = 0.98). Dwivedi et al. (2019) confirm that concern and concern for students influence students' intention to persist in learning. In this case, positive responses are uniform, with better opinions of teachers compared to students regarding control of teaching monitoring ($MK_{(P-S)}$ = 0.36; $MO_{(P-S)}$ = 0.43) for showing warmth towards students during teaching ($MK_{(P-S)}$ = 0.45; $MO_{(P-S)}$ = 0.45) and similar trends of differences for contact and online teaching. The difference in mean values of teacher and student responses is much greater ($MK_{(P-S)}$ = 0.60) with the response that the teacher is aware of the feelings of each student in contact teaching, with teachers giving extremely positive responses (MP_K = 2.97 ± 0.03). In online teaching, the difference in mean values of student and teacher responses is small ($MO_{(P-S)}$ = 0.09), and teacher responses are only slightly positive (MP_O = 2.23 ± 0.42). Students uniformly for both teaching believe that the teacher knows them at the lower limit of positive responses (MS_K = 2.38 ± 0.65; MS_O = 2.35 ± 0.64), and teachers at the upper limit of positive responses claim to sympathize with their students (MP_K = 2.96 ± 0.23; MP_O = 2.90 ± 0.13).

The *Experience* descriptor was tested in the negative form. All mean values of student and parent responses are neutral to negative even when converted to the positive form, which was used to compare the descriptors, while the interpretation of the responses retained the negative form of the statement for better comprehensibility and meaning. An almost complete positive correlation was observed between student and parent responses in the online form (r_O = 0.92), with smaller differences ($M_{(R-S)}$ from 0.12 to 0.15) with the ability to follow classes and concentrate on learning. Parents express

URL DOI: https://doi.org/10.32633/eb.10.6

the most differences compared to students regarding understanding classes ($M_{(R-S)}$ = 0.19), and students have the smallest differences between contact and online ($MS_{(K-O)}$ = 0.13) related to a neutral response bordering on negative regarding how stressful classes were for them.

The descriptor *Negative Behavior in Class* was checked in the negative form. Student responses are neutral to negative, more pronounced for online classes. Parent responses for online classes are neutral to positive even when converted to a positive form, which was used to compare the descriptors, while the interpretation of the responses retained the negative form of the statement for better comprehensibility and meaning. As an example of a characteristic negative experience, Grover (2021) points out that one of the common problems reported by parents was disruption of classes, with children enjoying surfing the internet or participating in online games while attending classes. That can be attributed to a lack of supervision by parents, an apparent perception of teacher absence, a perception of not being caught, and the availability of opportunities to indulge in other activities as opposed to the structured nature of regular classes (Grover, 2021). Parents believe that their children are focused on online classes, although the responses are mostly neutral to negative, that their child is thinking about something else during classes (MR_O = 1.16 ± 0.68) and that he is just waiting for the time to pass (MR_O = 1.22 ± 0.70). Such a result is in contrast to responses in other studies (Kumar, 2020; Grover, 2021), but may also indicate that biology teachers were, according to parents' assessments, better prepared or coped better during online classes compared to other teachers, or that parents were more involved and supervised their child's learning. The differences concerning student responses are quite large (M_{R-S} = 0.81; 0.72). The difference between student responses is quite even, according to the partial agreement in both teaching ($MS_{(K-O)}$ = 0.15; 0.13). With *Behavior in class*, a high positive correlation was observed between students' responses in contact and online forms ($r_{S)}$ = 0.54), but oriented towards a moderate correlation. Students have very consistent medium positive responses with both modes of teaching ($MS_{(K-O)}$ from 0.05 to 0.16), with slightly lower values for online, which means that they declare that they carefully and actively followed the lessons and independently made notes and other tasks. Interestingly, the only difference between the responses of students and parents was in the independent completion of tasks in class (MR_O = 2.27 ± 0.99; MS_O = 2.27 ± 0.73). The largest difference is between the opinions of students and parents, with parents having a better opinion ($M_{(R-S)}$ = 0.34) that their children worked diligently on tasks that encouraged them to think.

The Kruskal-Wallis test indicated statistically significant differences between contact and online teaching regarding the descriptors: *Teaching and learning* (χ^2_{K-O} = 6.126; p = 0.013), *Inquiry learning* (χ^2_{K-O} = 5.769; p = 0.016), *Motivation* (χ^2_{K-O} = 6.587; p = 0.010), and *Activity* (χ^2_{K-O} = 6.182; p = 0.013).

The Kruskal-Wallis test indicated statistically significant differences between contact and online teaching regarding the descriptor *Teaching and learning*. This result is a consequence of a large negative correlation between student and teacher responses to what was done in class and how it was learned during contact teaching (r_K = -0.65). In contrast, in online teaching, positive correlations were observed between participant responses. The smallest correlation was between student and teacher responses, although it showed moderate values (r_O = 0.37), the correlation between student and parent responses was high (r_O = 0.67), while a strong correlation was observed between teacher and parent responses (r_O = 0.87). Student responses during contact teaching were mostly moderately positive. The differences between teacher and student responses during contact teaching were medium about group and pair work (M_{P-S} = 0.51), project development (M_{P-S} = 0.41) and experiments (M_{P-S} = 0.56). There is a large difference (M_{P-S} = 0.71) with organized field teaching at least once a year,

URL DOI: https://doi.org/10.32633/eb.10.6

with students giving a positive response to neutral (MS_K = 2.13 ± 0.81), and teachers giving a highly positive response (MP_K = 2.84 ± 0.50). During contact teaching, teachers respond highly neutrally that students learned frontally with lecture teaching (MP_K = 1.77 ± 0.79), while students claim moderately positively that the teacher mostly lectured (MS_K = 2.68 ± 0.54), thus indicating the largest difference between the responses (M_{P-S} = -0.91). A constant is observed in the student's response to lecture teaching and that the teacher used discussion on the topic in addition to the lecture (MS_K = 2.68 ± 0.52), while the teachers' response, somewhat contradictory, moderately positively confirms that students learned frontally with heuristic discussion (MP_K = 2.49 ± 0.64). Student responses in online classes are not significantly different compared to contact classes for lectures (MS_O = 2.61 ± 0.58) and class discussions (MS_O = 2.58 ± 0.60), which mostly coincides with the responses of parents (MR_O = 2.53 ± 0.91; 2.39 ± 0.03), and to some extent with the responses of teachers (MP_O = 2.10 ± 0.81; 2.27 ± 0.76). Teachers report less use of lectures and slightly more discussions during their online classes, less so than students do. Contrary to the responses to face-to-face teaching, students claim that during online teaching they did much fewer projects (M_{P-S} = 0.44) and conducted experiments (M_{P-S} = 0.38) compared to teachers, while parents' responses are more consistent with teachers' responses (M_{R-P} = -0.03; 0.11). Shamma (2024) also points to the encouragement and connectedness of teachers and parents during online education, implying that higher levels of teacher-parent attitudes indicate a better relationship between them. In online teaching, the most consistent responses of students, teachers, and parents are, as expected, at the lower limit of positive with pair and group work, and moderately neutral with field teaching, where the responses of teachers (M_{P-S} = 0.13; 0.11) and parents (M_{R-S} = 0.01; -0.08) are closest to the responses of students. Kisiel (2003) also notes that learning in out-of-school settings is generally not well prepared and evaluated by teachers.

Regarding the application of practical teaching with demonstrations of experiments and research within the framework of the *Inquiry learning* descriptor, an almost complete correlation of student and teacher responses is noticeable in the online mode of teaching (r_O = 0.92), which is a consequence of smaller differences in student and teacher responses ($MO_{(P-S)}$ from 0.04 to 0.19). In the contact mode, the noticeable differences in responses are significantly greater ($MK_{(P-S)}$ from 0.44 to 0.60) with still a high correlation of responses (r_K = 0.64). Such a result indicates that exploratory learning and similar forms of teaching are carried out with very different frequency in schools. Uitto and Kärnä (2014) found that observation and inquiry-based teaching is not routinely used in the teaching and learning of biology, even though it is necessary for the development of biology education. The Kruskal-Wallis test indicated statistically significant differences between contact and online teaching with the descriptor *Inquiry learning*. Students report moderately positive with smaller fluctuations and lower response values in the online form that they learned with the results of research (MS_K = 2.40 ± 0.66; MS_O = 2.23 ± 0.71) and that they discussed the results of research (MS_K = 2.47 ± 0.66; MS_O = 2.34 ± 0.73), which is the closest response also from teachers ($MO_{(P-S)}$ = 0.04). Given that Štargl et al. (2020) pointed out that short research was included in the video lessons whenever possible, whether it was research based on literature review or research based on original reality, we cannot be sure what the participants assumed as project-based learning. This could have been researching online sources that teachers often use as assignments for students, rather than discovery learning or inquiry learning, which in biology teaching also includes the creation of small independent research projects by students necessary for successful biology learning. Demonstrations of experiments were included in online teaching at the very lower limit of positive student response (MS_O = 2.03 ± 0.77). They are not significantly present during contact teaching either (MS_K = 2.25 ± 0.73; MP_K = 2.85 ± 0.44). Accordingly,

URL DOI: https://doi.org/10.32633/eb.10.6

Kumar (2020) points out that practical subject cannot be taught effectively in virtual classrooms, but more discussion can increase the effectiveness of online learning.

Despite the lower positive responses of students to *Motivation* during online classes, the range of responses is not as large compared to contact classes (M_S from 2.32 to 0.47) and a high correlation of student responses was recorded (r_S = 0.52). Akpen et al. (2024) conclude that motivation is an equally important element in online and contact learning, because students need self-motivation to achieve learning outcomes, and students who stated that they were able to participate actively in class attributed their success to self-motivation. The Kruskal-Wallis test indicated statistically significant differences between contact and online teaching on the *Motivation* descriptor. Teachers believe (MP_O = 2.39 ± 0.81) that students perform tasks less well during online classes (MP_O = 2.50 ± 0.61). Notably, the smallest mean difference between student and teacher responses was observed regarding the perceived interest in learning during online classes ($MO_{(P-S)}$ = -0.09), with teachers still believing that the classes were less interesting compared to students. While there were smaller differences in how interesting the students found the tasks they were doing (MS_K = 2.44 ± 0.63; MS_O = 2.35 ± 0.65), at the lower limit of positive responses they liked how they learned in online classes (MS_K = 2.53 ± 0.61; MS_O = 2.17 ± 0.70).

The Kruskal-Wallis test indicated statistically significant differences between contact and online teaching regarding the *Activity* descriptor. An almost complete negative correlation was recorded between the responses of students and teachers in the contact mode of teaching (r_K = -0.99) with larger differences regarding active participation in classes ($MO_{(P-S)}$ = 0.52) and project development ($MO_{(P-S)}$ = 0.46) and a smaller difference regarding homework writing ($MO_{(P-S)}$ = 0.23). Accordingly, Sertić Perić and Draženović (2024) have proven that older teachers resist novelties in the curriculum, which primarily include a conceptual approach to teaching with active learning and teaching biology strategies based on experiential learning, discovery learning, and inquiry learning, and that years of service affect the level of resistance. In the online form, the correlation is positive, but quite small (r_O = 0.18). That is in line with the small range of differences in student and teacher responses ($MO_{(P-S)}$ from -0.07 to -0.22) and again the less positive opinion of teachers concerning students, except for the willingness of students to create projects. Akpen et al. (2024) point out that during online classes, maintaining student engagement was the biggest challenge, and effective strategies to improve student engagement such as interactive elements, discussion forums, and multimedia resources, along with appropriate teacher-student interaction, were key to improving engagement and learning success.

Based on the paired responses of students and teachers, insight can be gained into the differences in opinions regarding the implementation of classes. Teachers generally have a more favourable opinion of classes than students do. Fitzgerald et al. (2020) also observed that teachers overestimate themselves, but also that students tend to underestimate their teachers, which may be an additional reason for the differences in teacher and student responses. Despite this, due to the majority of student responses being consistent with contact and online teaching, with responses being somewhat less positive, the student responses can still be trusted in this study. Among all participants, and coinciding with the differences in student and teacher attitudes, significant differences were recorded by the Kruskal-Wallis test for the descriptors: *Teaching* (χ^2_{P-S} = 6.372; p = 0.012), *Teacher in class* (χ^2_{P-S} = 6.372; p = 0.012), *Assignments* (χ^2_{P-S} = 4.723; p = 0.030), and *Teacher and learning* (χ^2_{P-S} = 6.372; p = 0.012).

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Within the statements related to the *Teaching* descriptor, a strong correlation was observed between the responses of students and teachers in the contact mode of teaching (r_K = 0.76), while in the online mode of teaching, the correlation between the responses of students and teachers was almost complete (r_O = 0.93). Significant differences were recorded between students and teachers using the Kruskal-Wallis test for the *Teaching* descriptor. Given that teachers' responses support the assumptions of quality teaching, it is highly likely that they gave the expected good answers for contact teaching, which may indicate their weaker ability to evaluate or a tendency to present their teaching following methodological recommendations. Such a result is in line with Nwagbo's (2006) conclusion that biology teaching is not always conducted under methodological recommendations. Interestingly, the greatest similarity between the responses of students and teachers was related to the teacher's insight into what is happening in the classroom during online teaching ($MO_{(P-S)}$ = 0.03), this opinion of students is also maintained about contact teaching (MS_K = 2.48 ± 0.61). Teachers are convinced that in contact teaching they are very successful in controlling the course of teaching (MP_K = 2.97 ± 0.18). Although parents claim that students solve tasks independently during classes (MR = 2.65 ± 0.23), they still respond neutrally (MR = 1.90 ± 0.53) about their child's independent work suitability during online classes. Given the demanding nature of online classes, students and teachers express a slightly greater need for effort during online classes compared to its use in a hybrid form during contact classes. In contrast, both students (MS_K = 1.61 ± 0.36; MS_O = 1.56 ± 0.46) and parents (MR = 1.23 ± 0.66) have a borderline neutral opinion towards a negative opinion about learning more with online classes. In the descriptor *Adapting teaching to students*, teachers expressed moderately positive opinions in contact teaching (MP_K from 2.60 to 2.74). That significantly differs from extremely positive opinions for other statements while opinions about online teaching are lower for the entire descriptor (MP = 0.25). Ranging from the median response for the use of special tasks for students with adaptation and individualization of teaching (MP_O = 2.65 ± 0.65), to borderline responses related to their inclusion in the learning of the whole class (MP_O = 2.21 ± 0.89). Selvik and Herrebrøden (2024) found that adapting teaching to diverse learners remains a significant challenge for teachers, especially in online learning environments, and class size further complicates meeting individual needs, especially for students with special needs, and consequently increased flexibility and smaller class sizes can support the implementation of personalized education. In contrast, teachers report moderately positively that gifted students create special tasks during class or at home (MP_K = 2.65 ± 0.65; MP_O = 2.44 ± 0.79), while their involvement in the learning of the whole class is somewhat higher due to the contributions of learning with the creation of specific tasks in contact teaching (MP_K = 2.74 ± 0.58; MP_O = 2.44 ± 0.80). Given that there was a lot of work done with pre-service and biology teachers regarding various forms of hybrid online learning before the pandemic, this result is in line with McCormick and Guilbault (2024). They conclude that teachers who received sufficient technology training felt more able to integrate creativity into their virtual teaching and expanded traditional teaching to include strategies that facilitate student interaction, opportunities for enrichment of learning, and timely feedback for gifted students. Despite the differences and somewhat weaker adaptation of teaching to students with adaptation or individualization and gifted students, a high correlation of teachers' responses within the descriptor between the contact and online teaching is still observed (r_P = 0.69). Teachers experience the activity of quiet and introverted students most evenly for both forms of teaching (MP_K = 2.25 ± 0.79; MP_O = 2.23 ± 0.75).

The smallest mean difference in teacher and student responses to the descriptor *Teacher in class* was recorded when students were not focused on their work ($MO_{(P-S)}$ = -0.04), with teachers (MP_O = 2.34 ± 0.81) having a slightly less positive response than students (MS_O = 2.38 ± 0.67), which is very rare. The

URL DOI: https://doi.org/10.32633/eb.10.6

correlation between student and teacher responses is lower than other descriptors, but it is still high both in the contact mode of teaching (r_K = 0.54), and in the online form (r_O = 0.66). Significant differences were recorded between students and teachers using the Kruskal-Wallis test for the descriptor Teacher in class. The largest mean difference in teacher and student responses ($MK_{(P-S)}$ = 0.55) indicates that students have a moderately positive perception that teachers take into account the problems of all their students, in contrast to the very high positive opinion of teachers (MP_K = 2.98 ± 0.15). In this descriptor, it is significant to note that students in both forms of teaching express the same difference in opinion concerning teachers ($MK_{(P-S)}$ = 0.45; $MO_{(P-S)}$ = 0.47) in addition to how much time the teacher gives students in class to explore and gain understanding of new learning. Similar relationship is observed in encouraging reflection on learning ($MK_{(P-S)}$ = 0.42; MO(P-S) = 0.43).

Significant differences were recorded between students and teachers using the Kruskal-Wallis test for the *Assignment* descriptor. In the Tasks descriptor, an almost complete correlation was observed between student and teacher responses in the contact mode of teaching (r_K = 0.95) and online (r_O = 0.99). The largest difference between the teaching modes was observed in the responses to how much the teacher managed to keep all students' attention on the work tasks ($MK_{(P-S)}$ = 0.54; $MO_{(P-S)}$ = 0.13). The difference in opinions between teachers and students was even regarding how much the teacher cared that the tasks he/she assigned encouraged all students to think ($MK_{(P-S)}$ = 0.43; $MO_{(P-S)}$ = 0.45). In online teaching the difference in encouraging students to persevere until they reach the correct solution to the task was somewhat smaller ($MO_{(P-S)}$ = 0.36) compared to contact teaching ($MK_{(P-S)}$ = 0.44).

Regarding the influence of teachers on learning with understanding in the *Teacher and learning* descriptor, the mean differences in student and teacher responses for both teaching were equal ($M_{(P-S)}$ from 0.34 to 0.49). Exception for equal responses regarding teachers' insight into what is happening in the classroom during online teaching ($MO_{(P-S)}$ = - 0.03) with a slightly less positive response from teachers and students compared. Among all participants, which coincides with student and teacher attitudes differences, significant differences were recorded using the Kruskal-Wallis test for the Teacher and *Learning* descriptor. Therefore, there is an almost complete correlation between teacher and student responses during online teaching (r_O = 0.93) in contrast to a less pronounced correlation between responses in the contact teaching (r_K = 0.75). Students report equally positively for both teaching that they do not always do the same tasks (MS_K = 2.51 ± 0.60; MS_O = 2.45 ± 0.62) and somewhat less positively that they learned from tasks that others did (MS_K = 2.34 ± 0.65; MS_O = 2.25 ± 0.68). Teachers believe that students collaborate very successfully in group work and pair work, as well as in collaborative learning in contact teaching (MPK = 2.98 ± 0.15) and at the lower limit of positive response with online teaching (MP_O = 2.14 ± 0.83). Kalmar et al. (2022) argue that although teachers established and supported cognitive interactions, socio-emotional interactions were not well supported even in facilitated teams in online teaching, even though they play a key role in the dynamics of group work and learning. It is commendable that teachers recognize the importance of group work and have encouraged students to engage in collaborative learning during online classes. Hayes et al. (2024) have determined that pair work and group work play a major role in the successful development of student's academic performance in terms of interaction, conveying the meaning of their knowledge, and strengthening relationships among students themselves. Students think borderline positively that they can solve the tasks they do in class themselves without any problems (MS_K = 2.38 ± 0.60). This is in contrast to the teachers' strongly positive opinion about learning following the students' abilities for

URL DOI: https://doi.org/10.32633/eb.10.6

contact classes (MP_K = 2.90 ± 0.37). Responses for online are uniform (MS_O = 2.27 ± 0.62; MP_O = 2.23 ± 0.81) with a slightly less positive response from the teacher ($MO_{(P-S)}$ = - 0.04).

Within the *Learning* descriptor, students have a moderately positive opinion that they learned in class (MSK = 2.53 ± 0.59), while teachers think that it was much better and that students learned everything that was expected of them and achieved the learning outcomes (MP_K = 2.83 ± 0.42). For online classes, students believe that they learned somewhat less well (MS_O = 2.33 ± 0.66), and this time teachers have a similar opinion with a very small difference ($M_{(P-S)}$ = 0.02) and parents who have a slightly better opinion of their child's learning than themselves ($M_{(R-S)}$ = 0.12). When it comes to statements about their effort during learning, students also give moderately positive answers, somewhat better for contact classes than for online classes ($MS_{(K-O)}$ = 0.15). Students have a very uniform neutral opinion regarding their additional learning in contact (MS_K = 1.93 ± 0.72) and online (MS_O = 1.93 ± 0.72) classes. The response of parents and teachers concerning students shows smaller differences for online classes (M_{R-S} = 0.14; M_{P-S} = 0.27), while teachers in contact classes (M_{P-S} = 0.97) believe that students often show great interest in additional content in addition to learning (MP_K = 2.90 ± 0.31). This result is in line with the conclusion of Sirovina et al. (2023) that teachers' perception of students' interests is not in line with students' actual interests, because although they are attracted to content that includes simple practical work in the field of biology, their participation in extracurricular activities in the field of natural sciences is very low.

Based on the differences between the descriptors of quality teaching, one can observe the consistency of opinions, but also significant differences between contact and online teaching. No difference exceeds the value of 0.5, and given that the scale included the highest value of 3, this indicates the prevailing uniformity of the participants' opinions. The smallest difference was recorded with the participants' thoughts on the *Subject* including biological content (M_{K-O} = 0.03). Differences in favour of contact teaching prevail, with the largest differences observed with *Collaboration* (M_{K-O} = 0.46), followed by *Motivation*, *Inquiry learning* and *Activity*. The largest difference in the direction of online teaching was recorded with *Negative behaviour in class* (M_{K-O} = -0.16), which is not that large, followed by smaller differences with *Behaviour in class* and *Organization of class*.

Given all the identified differences between contact and online teaching, hybrid learning that includes the use of online materials and tasks during contact teaching is a significantly better solution than fully online teaching. This conclusion is in line with the opinion of Oraif and Elyas (2021) that despite the numerous obstacles identified in online learning, teachers have recognized the good sides, but also the challenges of such teaching and learning. Noticing the good sides and what still needs to be developed is a good step towards achieving better quality teaching and learning. The quality of teaching and appropriate learning platforms with audio and video content and interactive tasks within the framework of good instructional design must be of high quality so that the student can maintain attention, engage, and achieve success in learning. Dwivedi et al. (2019), points out that although students enjoy interactive content, it must be well and directly linked to learning outcomes to ensure student success.

In interpreting the results, it is necessary to take into account the limitations of the conclusions as a result of the research implementation. Students and teachers completed the questionnaire online in the form of a parallel presentation of questions for contact and online classes. This method of data collection could have influenced the answers because they could control their statements in the direction of positive answers with contact and negative ones with online classes. In addition, the initial

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negative or positive attitude of parents towards online classes and their opinion about their child and his or her learning ability could have influenced the parents' answers. Due to the general insight into the opinions of students, teachers and parents about contact and online biology classes, possible differences in factors that may influence the opinions of the research participants (e.g. gender, age, teacher experience or other sociological and social characteristics of the participants) were not considered.

After insight the differences in the opinions, more research is needed on the implementation of online, contact and hybrid biology classes, in parallel with insight into the attitudes of the participants, to clarify the specific elements and structures of classes that can maximize the learning of biological skills and concepts by students.

CONCLUSIONS AND DIDACTIC SIGNIFICANCE

Positive attitudes were observed in the responses of students, teachers and parents. Participants assessed other activities and characteristics more objectively while self-criticism was weaker especially concerning expected desirable activities such as writing assignments for students or using active biology teaching strategies during classes for teachers. Student responses were mostly uniformly moderately positive for both teaching, with slightly higher values for online classes. Teachers' reactions to online classes were much closer to those of students and parents, which indicates their greater self-criticism during online classes. Due to the very high positive responses related to contact classes, it is common for there to be greater differences in opinion compared to students, because teachers tend to equate their effort in preparing classes with its success. The largest opinions differences of students and teachers between contact and online classes were observed with: collaboration, research learning, motivation and activity, but also for additional learning in biology. Students uniformly confirm that they are not ready to learn biology additionally while teachers in contact classes believe that students often show great interest in additional content in addition to learning. There are medium differences in the opinions of students and teachers for: teaching, learning, student care and assignments. Parents and teachers uniformly assessed the organization of teaching. Despite great effort, teachers were aware they were somewhat less successful in adapting classes to students during online classes. Parents, compared to students, assess the experience in classes and behaviour in classes better, although they notice negative behaviour. When they are not sure of the answer, they tend to give the expected answer or stick to their attitude about classes, but still mostly answer positively, which confirms their good opinion of biology classes in an online form. Based on the research findings, further investigation should be conducted into the implementation of online, contact, and hybrid biology classes. This should be accompanied by an understanding of participant attitudes to identify the specific elements and structures of teaching and learning that can enhance students' biological skills and concepts. Additionally, this research could contribute to improving quality criteria for biology classes.

Based on this comparative analysis of the responses of students, teachers and parents, valuable guidelines can be drawn for the preparation and implementation of biology classes in contact and online form. Continuous monitoring of classes is important to maintain and improve the quality of biology class performance. Students are honest in their answers, while parents, and especially teachers, tend to give expected or desired answers following the topic of the statement, which is less pronounced in online classes because the answers of all participants are more similar. Therefore, it is important to work on self-assessment of teachers' work to be successful reflective practitioners. A modular three-stage professional development system with a mentoring support network would

URL DOI: https://doi.org/10.32633/eb.10.6

significantly help in the more successful implementation of quality biology classes. Labak et al. (2024), conclude that it takes more time to show a positive effect with an effective teaching intervention, and it can be expected that changes in teaching will become more visible when everything that teachers have learned during their professional development becomes a well-established and common teaching practice and a way of learning that is familiar to students. Along with frequent well-intentioned peer assessments and open discussions about classes, it would be good to reintroduce advisory visits for the needs of teacher teaching development. It would also be useful for teachers to check periodically the opinions of students and parents based on this example and compare them with their previous personal critical self-assessment, as this will provide them with valuable guidelines for more successful teaching of biology.

ACKNOWLEDGEMENTS

This work has been supported in part by Croatian Science Foundation under the project (IP-CORONA-2020-12-3798). I would like to thank all the collaborators who made the project possible, the teachers, students, and their parents who participated in the project, and the principals who allowed the research to be conducted in their schools.

The statistical calculations were made using the SPSS 22 software package (IBM, 2013) with the kindness of the staff of the Centre for Educational Research and Development / CERD of the Institute for Social Research in Zagreb / IDIZ, for which I would like to express my sincere gratitude.

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