

Comparison of conventional and digital lectures and examinations with respect to the conditions after COVID-19 period – an example for a bachelor lecture on textile finishing

Boris Mahltig 

Niederrhein University of Applied Sciences, Faculty of Textile and Clothing Technology, Webschulstraße 31, 41065 Mönchengladbach, Germany

*Corresponding author E-mail address: boris.mahlting@hs-niederrhein.de <https://orcid.org/0000-0002-2240-5581>

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CDAPT, ISSN 2701-939X
Peer reviewed article
2023, Vol. 4, No. 2, pp. 284-293
DOI 10.25367/cdatp.2023.4.p284-293
Received: 23 February 2023
Accepted: 10 October 2023
Available online: 02 December 2023

ABSTRACT

Due to the appearance of COVID-19, many lectures and examinations at universities are forced to digital formats. In the first post-pandemic semester again, the change from digital to conventional lectures was demanded. By this background the question arises, what is the better format for lecture and exam – digital or conventional? This question is discussed on the example of a bachelor lecture on textile finishing for the time period from 2019 to 2023. The combination of digital lecture and digital exam leads to strong participation numbers and by this to more successfully passing students. If the exam is done as conventional written text, the influence if the lecture is digital or conventional is weak. Also, the numbers of passing students or the finally achieved mark are mainly not dependent on the type of lecture format. Finally, it can be state that a digital lecture is more successful if there are also digital parts in the examination. Also, the return to conventional lectures and exams after the pandemic period is possible without influencing the student performance compared to pre-pandemic situation.

Keywords

lecture evaluation,
examination evaluation,
digital lecture,
student performance,
pandemic period,
textile finishing,
dyeing

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1 Introduction

The COVID-19 pandemic disrupted in the years 2020 to 2022 the social life in nearly all areas and especially in places where many persons meet each other. This pandemic situation hits especially

German universities from spring 2020. To limit the spreading of COVID-19, lectures had to be transferred to digital or online formats for prevention of personal contact between many persons. Also, some traditional written examinations are transferred to digital examinations. Several groups described this situation and their efforts to establish digital teaching and lectures [1-5]. A description of a bachelor lecture which was transferred completely to digital teaching and exam in year 2020/21 was given earlier [6]. This description was done for a lecture on the topic textile finishing, also containing the topics coloration, dyeing and printing. The content of this finishing lecture is in good accordance with the text book of R. H. Wardman and the review paper of Mahltig et al. [7,8]. A comparison of this digital lecture was done with the examination results of the former nine years (period 2012 to 2020) [6]. In the following winter semester 2021/22, this lecture was given digitally, but the exam had to be done as conventional written exam. Finally, in winter semester 2022/23 also the lecture has to be returned to a conventional form. By this background, the purpose of this current paper is to give a comparison of digital to conventional lectures and exams. A special view is made on the return from digital to conventional lecture after the COVID-19 period was finished. The advantages and disadvantages on both types (digital and conventional) are discussed.

2 Background and general conditions

The presented lecture is related to the topics of finishing, dyeing and printing. Main content of the lecture is covered by the book of R. H. Wardman [7]. Also, details due to testing of fastness properties or environmental issues are discussed. The lecture is given each winter semester and is regularly offered for students in the 3rd semester. However, students who did not pass the last years have the right to join again. This lecture is given in two different parts (each 90 minutes per week), which are tested together. Each lecture part counts 50 points, so 100 points can be reached maximum. Finally, 50 points are necessary to pass the exam. The registration to the lecture does not lead to an obligatory registration to the exam. Also, the registration to the exam makes it not obligatory to join the exam. Until the COVID-19 pandemic, this lecture was given conventionally by oral presentation to the student supported by paper scripts. The exam was a conventional written exam of 90 minutes duration. The winter semester 2019/20 with the written exam in beginning of February 2020 was the last semester which was not affected by the influence of the COVID-19 pandemic. In the following years, the situation changed and an overview is shown in Figure 1. In the semester period 2020/21, both lecture and exam were offered as digital form, as described earlier [6]. For the semester period 2021/22, a digital lecture as Zoom video conference was still necessary, but the exam was performed in conventional written form. Finally, in the semester period 2022/23, the return to a completely conventional lecture was demanded by the university administration.

semester period	lecture	exam
2019/20	<i>conventional</i>	<i>conventional</i>
2020/21	<i>digital</i>	<i>digital</i>
2021/22	<i>digital</i>	<i>conventional</i>
2022/23	<i>conventional</i>	<i>conventional</i>

Fig. 1 Schematic overview of the different formats during the semester periods from 2019 to 2023.

The numbers of registered students for the different semester periods are presented in Figure 2. In the years before COVID-19, no registration to the lectures was required, so these numbers are not available and presented here. Nevertheless, for the years before COVID-19 the student number beginning in this study course can be estimated to be in the range of 75 to 100 persons [9]. For the semester 2020/21, the highest number of 158 students is registered to the lecture. Most of these registered bachelor students are in their 3rd semester. However, around 60 students are from higher semesters because they failed the exam earlier or even do not join the exam. In the following two years, the total number of registered students is significantly lower. One reason is the decreased number of freshman students due to the pandemic situation, but also the high number of students who successfully finished the digital exam offered in February 2021. For the semester 2021/22, only two students in the 5th semester are registered for the lecture. Probable from that semester group most students passed the exam in the year before. The lowest total number of 68 registered students for semester 2022/23 is mainly caused by the decreasing number of only 30 freshmen students, because of the pandemic situation.

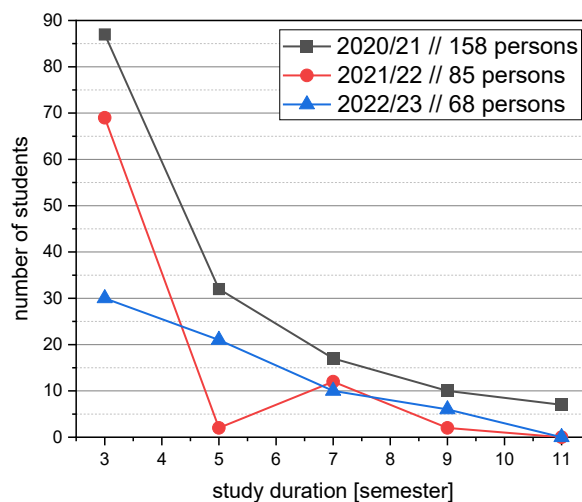


Fig. 2 Number of students registered for the lecture in different years shown as function of the semester study duration. Students with semester durations of more than 11 semester are not presented here. The total number of registered students is as well mentioned. For the semester period 2019/20 no registration data are available.

3 Lecture and student feedback

The number of students attending the lecture over the complete semester is shown in Figure 3 as function of the semester week. Compared are the numbers for the three semester periods 2020/21, 2021/22 and 2022/23. The total number of given lecture events is for every year different, due to different total lengths of the semesters and days with public holidays or lecturer's absence. For both digital years, the numbers are counted by taken the participants at the zoom video conference. For the period 2022/23, the students appearing personally in the lecture room are counted. For all three years, the number of students joining the lecture is even in the first lecture below the total number of registered students (compare Figures 2 and 3). Also, during the semester the number of participants decreased drastically. It should be mentioned that not always the same students attend. This decrease in student numbers is evaluated by performing a linear fit (Figure 3). According to this linear fit, the decrease in participating students is for the semester 2022/23 most significant with a slope of -4.5. With this conventional lecture, the efforts of personal appearance are probable higher compared to simply joining a zoom lecture from home. Several students are not living in the town where the university is placed, so travelling efforts might be one explanation for lower participation numbers of conventional lectures. Due to the offered paper scripts and other distributed lecture materials, some students probably have the confidence that the lecture participation is not necessary to pass the final exam successfully.

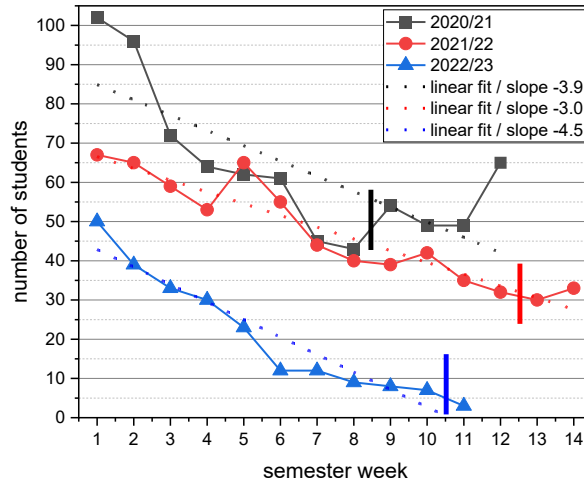


Fig. 3 Number of students joining the lecture during the proceeding semester. The solid line is shown as guide for the eyes. Linear fits are shown as dotted lines. The vertical bar indicates the Christmas holiday in the current winter semester. For the semester period 2019/20 no data are available.

From the number of decreasing participants, it may be concluded that the students are not satisfied with the lecture and simply stay away. To discuss this statement, the lecture is evaluated by the students with an anonymous questionnaire. However, only students participating in the lecture are evaluated by the questionnaire, so the gained data of the questionnaire are only related to this group of students. A selection of some student statements from this questionnaire is given in Figure 4.

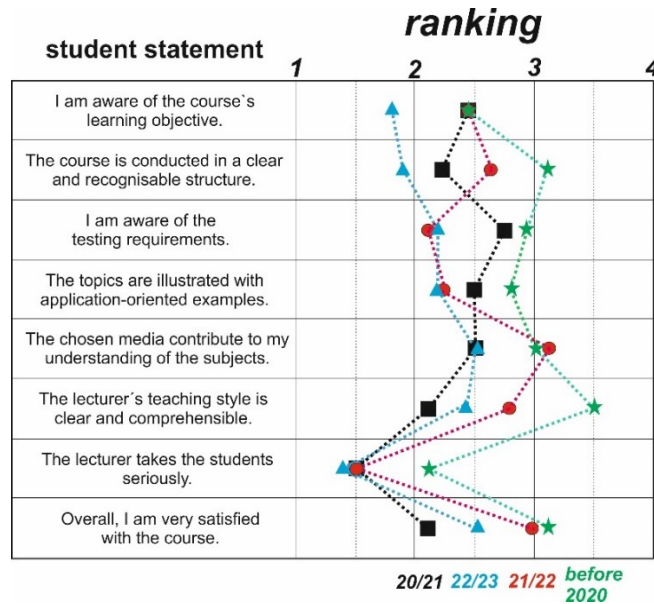


Fig. 4 Results from student evaluation. The ranking is shown from 1 to 4, with 1 as the best ranking. Compared are the answers for different semester periods on selected answers of a questionnaire.

In Figure 4, a comparison to an average number of several evaluations from the years before 2020 is given. The answers are graded with a ranking from 1 to 5, with 1 as the best ranking. The first conclusion from these student evaluations is that the lectures given in the years 2020 to 2022 show a better performance compared to the long-term average value before year 2020. The understanding of learning objectives is much better in the conventional lecture 2022/23 compared to the both digital lectures in the two years before. The overall satisfaction of the students is in contrast the best for the digital lecture 2020/21. However, the conventional lecture 2022/23 comes next and exhibits a significantly better performance than the digital lecture 2021/22. Remark, the digital lecture 2021/22 exhibits the smallest

decrease of participants during the semester (compare Figure 3). For this, a clear correlation of student participation and student satisfaction should not be made. By interpretation of the questionnaire it can also not be justified if the students prefer a digital or a conventional lecture.

4 Examination results

The examination results are evaluated and discussed for all four semester periods from 2019/20 to 2022/23. The number of students who registered to the exam is given in Figure 5 as function of the study duration of each student. This registration is not obligatory but necessary to participate in the exam. If a registered student does not join the exam event, it has no negative consequences. The number of registrations to the exam are significantly below the numbers for registration to the lectures in the beginning of the semester (compare Figures 2 and 5). Naturally, the most registered students are from the third semester, because in this third semester this lecture is given according to the regular study plan. Remarkable is that this statement is not valid for the period 2022/23. In this semester most students registered for the exam are from the 5th semester. One explanation for this issue may be the lower number of freshmen student in the year before, because of the pandemic situation. A further reason is probably that there are students which have still deficits with first or second semester courses and like to cover them at first before joining an exam from third semester course.

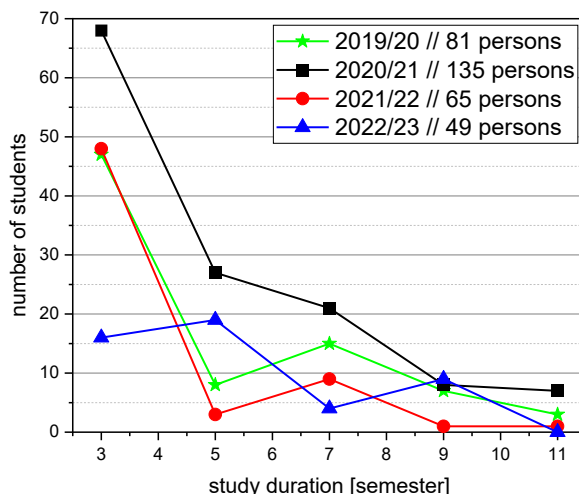


Fig. 5 Number of students who registered for the exam end of winter semester shown as function of semester study duration. Students with study duration more than 11 semesters are not mentioned here. The total number of joining students is as well mentioned.

The number of students who finally join the exam are presented in Figure 6. These numbers are significantly below the numbers for registration (compare Figure 5). Remarkable is the higher number of exam participants for the semester period 2020/21, where a digital exam was offered instead of a conventional written exam. In 2020/21 as part of the exam also three digital work sheets have to be done during the semester. Probably these digital work sheets motivate the students to participate also in the final exam event.

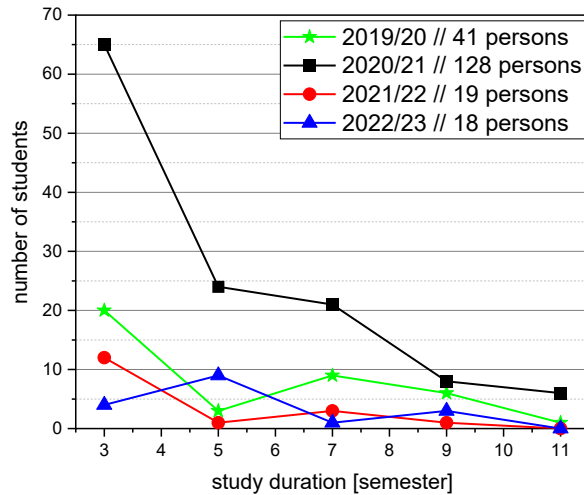


Fig. 6 Number of students who joined finally the exam at the end of the winter semester as function of the semester study duration. Students with an extended duration of more than 11 semester are not presented here. The total number of joining students is as well mentioned.

The participating students at the different examination events are given in Figure 7. Here it is also distinguished between the students who passed or passed not. The first exam event for the exam is usually in February. In the same year the students have the chance to repeat the exam in a second and third event in July or September. Due to the pandemic situation in 2020, for this year no third exam event was offered. The results for these additional events are also shown in Figure 7. Also, at these events a significant number of students passed the exam, so altogether with all three exam events the majority of students passed usually the course. By view on the big number of students passing the exam in February 2021, it could be stated that this combination of digital lecture and digital exam is the most successful combination. However, in this exam period also the number of students who did not pass the exam is the highest compared to all other exam events.

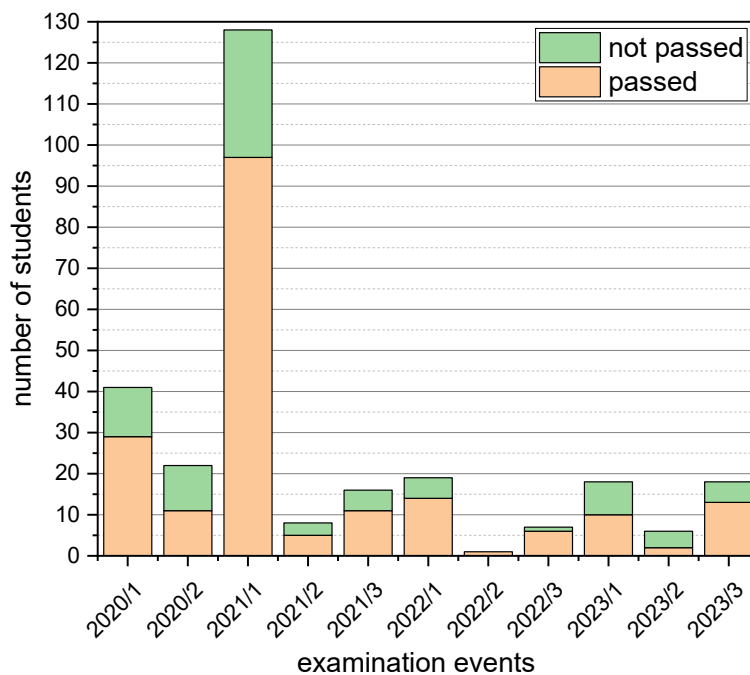


Fig. 7 Number of students joining the different examination events.

A detailed comparison for exam participation and exam success is given in Figure 8. Here, for the four periods from 2019/20 to 2022/23 the values for the first exam event in February are compared. It is distinguished between students who are registered and joining finally the exam. Students who gained more than 24 points in the exam part for lecture 1 (dyeing & printing) are mentioned and compared to number of students who finally passed the complete exam. With exception of the period 2020/21, there is a strong difference between the number of registered students and the students who join finally the exam. However, students who join the exam mainly also pass the exam. By view on the high number of registered students it is probably the main task to motivate the registered students also to join the exam. This task was obviously solved by the digital exam 2020/21. In contrast, a digital lecture combined with a conventional written exam is for this not suitable and led to similar results as a conventional lecture.

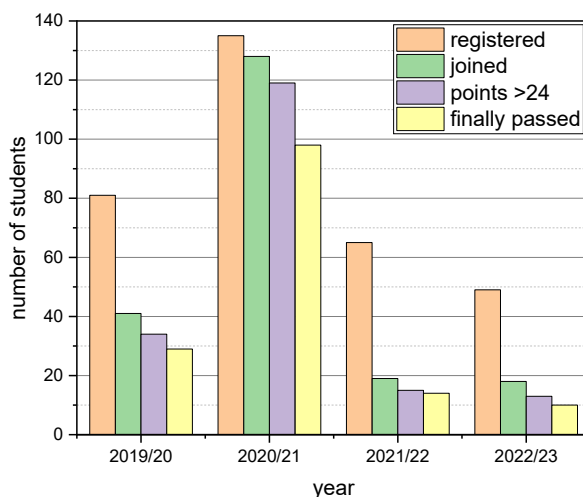


Fig. 8 Number of students joining the different examination events (first exam event in February) – comparison of participation and exam success.

In addition to the simple total number of passing students, a more detailed evaluation should be supported to evaluate and discuss the students' success (Figure 9). First, the number of passing students should be set in relation to the registered and participating students. Second, the achieved points beyond the minimum points just to pass the exam should be discussed. For most years the ratio of participating students who pass the exam are nearly around 75%. Only for the last period 2022/23, this ratio is with around 55% significantly lower (Figure 9). From these values no difference is obvious for digital or conventional lecture/exam. Digital exams are probably not easier to pass as conventional written exams. Also, a digital lecture is not in any case a better preparation for an exam compared to a conventional lecture. Unfortunately, the participation rate for the conventional written exam is beyond the participation rate for the digital exam.

The evaluation of achieved points is done for the lecture part 1 (dyeing & printing). In maximum 50 points can be reached as best result. More than 24 points are required for passing the exam. Figure 9 presents here the average volume for all students and for students who gained more than 24 points. For the digital exam 2020/21 no better results are reached, so also from this point of view, the digital exam is not easier compared to the conventional exam.

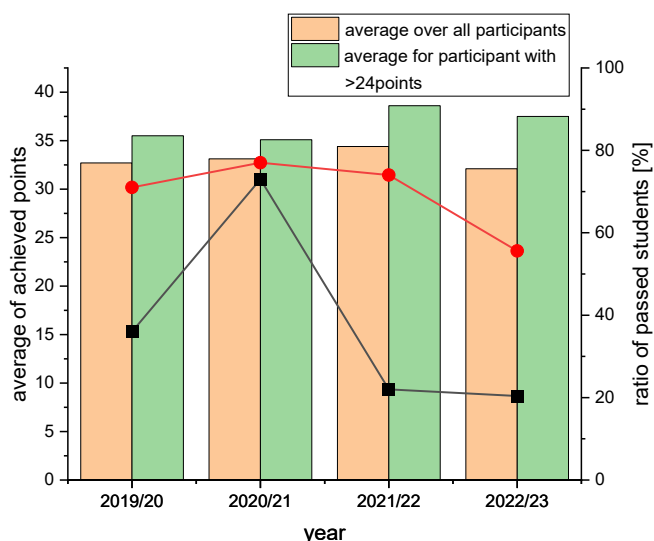


Fig. 9 Comparison of exam results for the four years. Compared are the averages of achieved points from all participating students (maximum points 50) and the averages from participants with more than 24 points. Compared is this with the ratio of passed students in relation to registered (black line) and participating students (red line).

5 Comparison of written exam before and after COVID-19 period

After intensive comparison between digital and conventional lectures, there is still one question left: Is there a difference in student performance in conventional lectures before and after the COVID-19 period? By view on Figure 9, it is possible to compare the average numbers of the last pre-pandemic semester period 2019/20 and the first post-pandemic semester period 2022/23. In both semester periods, lecture and examination are conventional. The average numbers from these semester periods do not justify a clear statement, whether the student performance is improved or decreased after the pandemic period. In comparison, the ratio of passed students decreased for 2022/23 compared to 2019/20. However, the students who passed the exam achieved higher number of points and better marks, so the successfully passing students show a better performance in post-pandemic period.

Additionally to this view on average numbers, a more detailed evaluation is done by view on some single questions in the written exams of periods 2019/20 and 2022/23. In both periods a conventional written exam is made and few of the exam questions are kept similar. In Tables 1 to 3, three of these similar questions are summarized and the ratio of students giving the fully correct answer is mentioned. The difficulty level of the three questions is different. The first two questions are mainly related to repetition of dye category and composition of dye bath, so they can be solved by simple learning and repetition. In contrast, the third question requires the application of knowledge to analyze a chemical structure of a dye molecule.

In the first example for an exam question (Table 1), the students have to draw the typical structural chemical element which is related to a certain dye category, so for example for the category azo dye stuff the related azo group $-N=N-$ has to be drawn. Altogether, five dye categories are asked and for most of them the student from post-pandemic period 2022/23 show better performance. Especially remarkable is that in the pre-pandemic period 2019/20 less than 70% of the students are able to draw the azo group, even if it is one of the most important chromophores in dye molecules. The least known structure is anthraquinone, probably due to the larger chemical structure it is more difficult to remember. Also, the nitro group is related to a lower number of correct answers. The nitro group is an auxochromic group and the students probably prefer learning only chromophore group.

Table 1. Student performance for the exam question “draw the typical structural element related to the mentioned dye category”. For each dye category the ratio of fully correct answers is given.

Dye category	Correct answers 2019/20 (%)	Correct answers 2022/23 (%)
Azo dye	68	83
Nitro dye	29	39
Sulphur dye	63	61
Anthraquinone dye	17	44
Acid dye	59	61

The second question example (Table 2) is related to common components in a dye bath and the students have to describe the purpose of each component in dye bath. The purposes of seven different components are asked. For this question it is not possible to make a clear decision, in which semester period the student performance is better, because for three asked components students of past-pandemic period have higher values. However, it is especially surprising that only 72% of students understand the reason for adding dye stuff to a dye bath.

Table 2. Student performance for the exam question “give a short statement to the purpose of the following components in the dye bath and the dyeing process”. For each component, the ratio of fully correct answers is given.

Component in dye bath	Correct answers 2019/20 (%)	Correct answers 2022/23 (%)
Water	80	61
Dye stuff	88	72
Dispersing agent	41	56
Sodium sulphate	24	33
Stabilizer	54	33
Acid	46	50
Alkali	46	44

The last question example (Table 3) is related to the evaluation of the chemical structure of a dye molecule shown in Figure 10. Here, the students have to decide to which dye category this dye belong and should suggest a type of fiber which can be dyed by it. Further, the four auxochromic groups should be marked in the chemical structure of the dye molecule. Due to the fact that this dye molecule was not shown in the lecture, the students have to use their knowledge to evaluate this unknown chemical structure. From that point of view, this question is more difficult compared to both the first questions. The ratio of correct answers is in the range from 44% to 61%, so roughly half of the students are able to solve this task, this is a quite good result compared to the results from the other two questions. However, also for this question it is not possible to decide in which semester period the student performance is better, because for evaluation step +A+ the pre-pandemic group performed better but in step +C+ the past-pandemic group is better. For evaluation step +B+ both groups exhibit nearly the same results.

Table 3. Student performance for the exam question on evaluation of the chemical structure of the dye molecule shown in Figure 10. For each evaluation step the ratio of fully correct answers is given.

Evaluation step	Task in step	Correct answers 2019/20 (%)	Correct answers 2022/23 (%)
+A+	Decision on dye category	54	44
+B+	Suggestion for dyeable fibers	59	61
+C*	Marking of four auxochromic groups	46	50

A comparison between the pre-pandemic period (2019/20) and past-pandemic period (2022/23) cannot lead to a clear decision, if there is a change in student performance due to the pandemic situation. If the past-pandemic students pass the written exam, they show a slightly better performance. However, over

the complete average the performance of both groups is mainly the same. The higher number of non-passing students from the past-pandemic group is a reason to worry and could be explained that the students lost their connection to university and student university life due to the pandemic regulations and isolations.

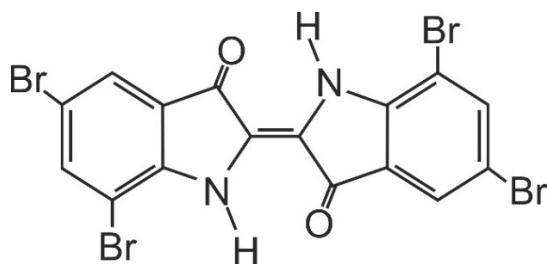


Fig. 10 Chemical structure of a vat dye based on indigoid structure with four bromine atoms as auxochromic groups.

6 Summary & Conclusions

By view on student satisfaction and success in the exams, no clear statement can be made if a digital or a conventional lecture is better. However, a clear statement is possible that the combination of a digital lecture with a digital exam can be a useful tool, because by this a high number of students can be motivated to join the exam. Even if the exam results itself are not improved, the total number of passing students is increased by offering a digital exam. Nevertheless, it should be remarked that the workload for the lecturer is higher if digital exams are made and conventional exams are often demanded because of administrative reasons. Also, there may occur legal restrictions for digital exams which are related to stable internet connection and the cases of possible cheating during the digital exam. Possible types of cheating during digital exam are covering personal identity, the use of Chatbots, contacting classmates or external experts by social media. Finally, a clear statement on positive or even negative influence of the pandemic situation on the student performance cannot be justified.

Conflicts of Interest

The author declares no conflict of interest.

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