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Original article

Academic performance and satisfaction with face-to-face, distance and blended teaching in entry-level physiotherapy programme: A retrospective comparative study

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Abstract. *Background and aim:* The popularity of remote and blended teachings in physiotherapy higher education is increasing. Initial evidence suggests that these methods are as effective as face-to-face teaching for theoretical and practical skill learning in physiotherapy; however, further research is required. *Methods:* This was a retrospective comparative study. Three groups of physiotherapy students undertook the courses 'Biomechanics' and 'Kinesiology' through face-to-face, remote, and blended modalities, respectively. We compared the academic performance and satisfaction of three classes that underwent courses delivered face-to-face in 2019, remote in 2020, and blended in 2021. Each course included a basic observational skills section (25%). Oral examination assessed academic performance (mark range: 0-31). Student satisfaction was self-evaluated using a 5-point Likert scale ('completely dissatisfied' to 'completely satisfied'). Differences in outcomes were explored using Fisher's exact test and Kruskal Wallis test. *Results:* In the 'Biomechanics' course, the median mark (interquartile range) was 28 (27, 30) for the face-to-face group, 28.5 (27, 29) for the remote group and 29 (27, 30) for the blended group. In the 'Kinesiology' course, the median mark was 29 (27, 30) for the face-to-face, 28.0 (28, 30) for the remote and 29 (27, 30) for the blended. No statistically significant differences in academic performance were detected in either course. Satisfaction was good for both courses and teaching modalities; no statistically significant difference was detected. *Conclusions*: Students had similar satisfaction and academic performance, suggesting the potential efficiency of varying teaching methods in terms of learning and satisfaction. (www.actabiomedica.it)

Key words: physiotherapy, learning method, education, pandemic, blended learning

Introduction

'Digital Learning Design' integrates digital technology into the traditional program to promote student learning. It has been suggested to improve teaching practices and enhance the sustainability of higher education (1). Nevertheless, fully digital teaching, often referred to as distance or remote teaching, presents some disadvantages, including limitations in teaching practical skills that can be facilitated by the direct supervision of an educator (2). Blended teaching modalities combine traditional face-to-face teaching with digital activities delivered synchronously or asynchronously (3, 4). Blended teaching can combine the advantages of both face-to-face (e.g., the possibility of receiving in-presence teacher feedback) and remote teaching (e.g., the opportunity to follow registered lessons anytime), making this teaching modality particularly suited for courses requiring the acquisition of practical skills as in healthcare professions (5).

To date, evidence supporting the effectiveness of digital teaching is increasing, and its implementation in higher education is steadily growing (4). Furthermore, the recent Coronavirus Disease 2019 (COVID-19) pandemic has accelerated the shift from traditional to digital education, with many countries forcing the switch to remote teaching since the beginning of Spring 2020 (2, 6). Four years after the start of the pandemic, in-presence events with large numbers of attendees are returning in most Western countries because of different public health strategies, such as vaccination campaigns (2). With the students returning in presence, educators need to quickly redesign curricula and decide whether to embrace the opportunities brought by the COVID-19 crisis by moving towards a digital offer (fully or blended) or going back to traditional frontal teaching. In this context, evidence supporting the effectiveness of different digital teaching modalities is urgently needed, especially for fields requiring practical skills, such as entry-level physiotherapy (2).

As suggested by the 'World Physiotherapy Education Framework', physiotherapy curricula are characterized by the strong presence of skills training and practice, for which digital teaching has long been considered inadequate and thus under-researched (7, 8). Existing evidence suggested that remote and blended teaching seemed at least equally effective when compared to traditional face-to-face teaching in both undergraduate and postgraduate physiotherapy students for theoretical knowledge and practical skills (e.g., observation) and in other health professions (9, 10). However, none of the randomized and non-randomized studies directly compared remote, blended, and face-to-face teaching methods, providing limited evidence supporting a specific teaching mode and offering the possibility for future studies (11). Blended teaching could potentially be superior to remote teaching in courses where the teaching of practical and professional skills is required, offering the opportunity to acquire these skills face-to-face and achieve constructive alignment between learning outcomes, teaching, and learning activities (12).

Moving from this premise, with this study, we aim to compare the degree of satisfaction and academic performance across three classes of physiotherapy students attending two courses ('Biomechanics' and 'Kinesiology') that require the acquisition of theoretical (knowledge of human body movement) and basic observational skills (video assessment of human body movement) as taught by three different modalities (face-to-face, remote, and blended), over three consecutive academic years.

Materials and Methods

Study design

We conducted a retrospective comparative study to compare the academic performance and satisfaction of three different entry-level physiotherapy classes, attending two courses delivered either face-to-face (2019), remote (2020), or blended (2021). The study is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline (13).

Study setting

This study was conducted at the Bachelor of Science (BSc) in Physiotherapy of the University of

Verona in Italy. The BSc in Physiotherapy is composed of a 3-year course of study for a total of 180 European Credit Transfer and Accumulation Systems (ECTS), aimed at educating and certifying the professional profile of physiotherapists in agreement with the Italian National Law (14).

Subjects

We considered eligible students who attended the courses in the three years (2019, 2020, and 2021) for whom data regarding outcomes were available. We included a sample of 70 entry-level physiotherapy students. One class of students (n = 25) was exposed to face-to-face teaching in 2019, another (n = 20) to remote teaching in 2020, and another one (n = 25) to blended teaching in 2021.

Course descriptions

We considered two distinct courses: ' Biomechanics' and 'Kinesiology'. Both courses were delivered during the second semester of the first academic year and aimed to ensure theoretical knowledge and practical skills for assessing human body movements in healthy people (without any diseases). These courses provide two ECTS each, with an estimated learning workload of 50 to 60 hours (15). All courses across the three years were homogeneous in terms of the learning aims and contents over the three years, with the same syllabus and no updates in the contents. Detailed learning outcomes, teaching methods, and assessments reported in the syllabus for each course are presented in Table 1. The admission criterion for the oral exam was 100% attendance to courses in the face-to-face, remote, and blended editions.

Each course consisted of a theoretical (75%) and a basic observational skills section (25%). The theoretical part was provided through lectures using PowerPoint slides to provide foundation knowledge. The basic observational skills section consisted of analysing and commenting on videos relating to human movements of people without diseases. In detail, the lecturers guided students in acquiring basic practical skills such as the visual assessment of segmental movements (for 'Biomechanics', e.g., shoulder movements; ankle movements) and global functional activities (for 'Kinesiology', e.g., reaching an object with the upper limb; walking). Basic observational skills represent core competence that physiotherapists should achieve during BSc (16). Neither course included instruction on other practical skills, such as manual hands-on procedures involving range of motion or force measurement, and assessment of joint end feel.

Courses design and delivery

In 2019, both courses were taught face-to-face. Students received all face-to-face lessons (100%) in the classroom of the BSc in Physiotherapy at the University of Verona in Italy. For both courses, each lesson lasted one hour and combined two parts: 50 minutes of teaching theoretical and/or practical knowledge, and 10 minutes of questions from the lecturer to provide a formative assessment and clarifications on the topic taught. Twenty lessons were delivered.

In 2020, due to the COVID-19 pandemic, courses were fully delivered remotely according to national directives (17). Specifically, students received all lessons remotely (100%) through the 'Panopto Secure Online Video platform' (18). The theoretical part (75%) was delivered through recorded lessons (asynchronous), and the basic observational skills part (25%) through live lessons (synchronous). During remote teaching, for the theoretical part, students emailed lecturers in the questions and answers section. For basic observational skills part, they interacted with each other during the online lesson using a university chat. No students were previously exposed to remote teaching before the COVID-19 pandemic. Twenty lessons were delivered.

In 2021, a blended teaching modality was used for both courses following national directives (19). As a result, all students received a theoretical part (75%) with recorded lessons (asynchronous) using the same recording session as the previous year. The basic observational skills part (25%) was delivered face-to-face at the BSc in Physiotherapy of the University of Verona in Italy. The students' questions and teachers' answers were permitted using email for the theoretical part, while being executed in the classroom for the practical part. Before the COVID-19 pandemic, no

Table 1. Syllabus of the courses.

Learning objectives	Teaching	Assessment
Biomechanics		
Describe physiological/osteokinematic, accessory/artrokinematic joint movements, and viscoelastic properties of human connective tissues.	Theoretical*	Open questions
Describe the forces applied to a joint by calculating the internal and external moments in static and dynamic contexts.	Theoretical*	Open questions
Describe inertial properties and frictional forces and understand how these affect human movement.	Theoretical*	Open questions
Describe the physiology of the joints of the human body and analyse the stresses and strains of the joint, understanding the biomechanical factors that affect the muscle's ability to deliver force.	Theoretical*	Open questions
Analyze the segmental movements of the axial joints (spine) from a biomechanical perspective, considering: kinematics, kinetics, muscular activity, lever systems, and inertial systems.	Basic observation†	Video analysis
Analyze the segmental movements of the appendicular joints (upper limbs, lower limbs) from a biomechanical perspective, considering: kinematics, kinetics, muscular activity, lever systems, and inertial systems.	Basic observation†	Video analysis
Kinesiology		
Describe the kinesiological elements of human movement based on kinematics and dynamics movement concepts	Theoretical*	Open questions
Describe the concepts of muscle chain, synergistic muscles, agonists/antagonists, and stabilizers muscles involved in the functional gestures of the human body.	Theoretical*	Open questions
Describe postural adjustments, as feedback and feedforward mechanisms, involved in the maintenance of the static positions supine, sitting, and standing).	Theoretical*	Open questions
Describe postural adjustments, as feedback and feedforward mechanisms, during execution of dynamic functional gestures.	Theoretical*	Open questions
Analyze the kinesiology of the functional movements of the upper limbs (reaching, grasping, and manipulation).	Basic observation†	Video analysis
Analyze the kinesiology of functional movements of the lower limbs (walking, climbing and descending stairs, and sit-to-stand).	Basic observation†	Video analysis

Note: * performed using lectures using power-points slides; † performed analyzing and commenting on videos.

students had participated in the blended teaching sessions. Twenty lessons were delivered.

All the courses were delivered in May of each academic year. The same physiotherapy lecturers with eight years of experience (G.B., and A.P.) taught each course in all groups over the three years. Before the onset of the COVID-19 pandemic, lecturers had not encountered remote and blended teaching. The lecturer filled in the students' attendance in the face-to-face and blended groups (for practical sessions). For the group at remote and the theoretical parts of the blended group, attendance was recorded automatically by the 'Panopto Secure Online Video platform' as the students accessed the lectures.

Variables

Demographic data

We retrieved data on sample demographics (age and gender) and course information (number of participants attending the course, number of respondents, and number of passed students).

Outcomes

The outcomes of interest were students' satisfaction and academic performance.

Students' satisfaction was self-assessed using a standardized, nationally established 12-item questionnaire. For students, it is mandatory to anonymously complete the questionnaire before the final exam of each course taught in Italian universities (20). The questionnaire covered various aspects of the course (e.g., adequacy of preliminary knowledge, balance between the study load and the number of credits assigned to this course, and clarity of information on the exam structure). To summarize students' satisfaction, we considered the following question: "Overall, are you satisfied with the organization and the teaching of this course?". Answers are allowed upon a 5-point Likert scale (1= "I don't know", 2= "Strongly disagree", 3= "Somewhat disagree", 4= "Somewhat agree", 5= "Strongly agree").

Academic performance was assessed on a scale from 0 to 31, where 0 was the lowest value, 31 was the highest, and the minimum score to pass the course was 18/31, according to standard national metrics (21).

In July of each year, the same lecturer who delivered the course (G.B. for "Biomechanics" and A.P. for "Kinesiology") conducted a standardized oral exam adopting the same criteria for students' academic performance. The teachers examined the students in person for the face-to-face group and through a real-time video chat (*Zoom)* for the remote (17) blended groups (19). For all three modes of course delivery, the oral examination for each course lasted a maximum of 45 minutes for each student and combined theoretical and basic observational skills parts (22). For each course, lecturers used three open questions to evaluate the knowledge acquired (Biomechanics: e.g., "What are the viscoelastic properties of human connective tissues?"; Kinesiology': e.g., "What are synergistic muscles?"). For the theoretical part of both courses, following the rules of the BSc in the Physiotherapy University of Verona, each question was assessed using a 7-point Likert scale (1: "very bad knowledge"; 2: "bad knowledge"; 3: "a little bad knowledge"; 4: "not good, not bad knowledge"; 5: "a little good knowledge"; 6: "good knowledge"; 7: "very good knowledge") for a total of 21 points.

Moreover, for the basic observational skills part, the lecturer used two videos during the lessons for each course to assess students' performance in analyzing human movements (basic practical skills). In detail, students were asked to evaluate visually segmental movements (for 'Biomechanics', e.g., "Please analyze from a biomechanical perspective the movement of the elbow joint presented in this video") and global functional activities (for 'Kinesiology', e.g., "Please describe from a kinesiological perspective the functional movement of sit-to-stand presented in this video") reported on the videos, thus describing their features. Following the rules of the BSc in the Physiotherapy University of Verona for the practical part, each video was assessed using a 5-point Likert scale (1: "very bad analysis"; 2: "bad analysis"; 3: "not good, not bad analysis"; 4: "good analysis"; 5: "very good analysis") for a total of 10 points. The sum of the 21 and 10 points from the assessment of the theoretical and practical parts, respectively, comprised the final highest score of 31 points.

Data collection and analysis

All data were acquired from lecturers' personal accounts at the University of Verona (Italy) at the end of each academic year. Descriptive statistics were used to summarize students' demographics and outcomes. Absolute and percentage frequencies were used to report the gender of students. The normal distribution of the age, satisfaction and academic performance variables was assessed with the Quantile-Quantile Plot, Skewness and Kurtosis values (Age: 3.33,15.30; Biomechanics Satisfaction:-0.892, -1.240, Biomechanics performance: -0.911, 0.261, Kinesiology satisfaction: -1.34, 1.84, Kinesiology performance: -1.94, 5.86), and Shapiro-Wilk normality test (Age: $W=0.63$, $p<.001$, Biomechanics Satisfaction: $W=0.58$, $p<.001$, Biomechanics performance: $W=0.87$, $p<.001$, Kinesiology satisfaction: $W=0.78$, $p<.001$, Kinesiology performance: $W=0.79$, $p<.001$). Age was described using median values and interquartile range (IQR, 25th -75th percentile). Mean and median values with interquartile range (IQR) and standard deviation, respectively, were reported to describe academic performance and satisfaction. Differences in satisfaction and academic performance were explored using the Kruskal

Wallis test, according to their non-normal distribution and the small sample size. The alpha level was set at 0.05. We performed the statistics using R software v3.4.1 (23). The datasets used and analyzed during the current study are available at the OSF (https://osf.io/3zvmw/).

Ethics

This retrospective study involving human participants was conducted in accordance with the ethical standards of the institutional and national research committee and the principles of the Declaration of Helsinki (24). We obtained written informed consent from each participant when students completed and submitted the survey after reading the purpose statement of the study strategies, guaranteeing the confidentiality and privacy of the data collected. We entirely and irreversibly anonymized data (25). Moreover, we did not require ethical approval during this pandemic according to the "Ethics and Data Protection" regulations of the European advisory body and the European Commission (25-27).

Results

Participants' characteristics

The groups comprised 25 (face-to-face), 20 (remote), and 25 (blended) students (Figure 1). The face-to-face group included 14 men and 11 women, with a median age of 21 years (IQR 21, 23) (Table 2). The remote group included nine men and 11 women with a median age of 20.5 years (IQR 20, 23.5). The blended group included 14 men and 11 women with a mean age of 21 (IQR 21, 23).

Academic performance and satisfaction

In the 'Biomechanics' and 'Kinesiology' courses, groups obtained similar marks with no statistically significant differences (Biomechanics, p = .562, Kinesiology, p = .931, Table 2). The median mark was 28 (IQR, 27-30) for the face-to-face group, 28.5 (IQR, 27-29) for the remote group and 29 (IQR, 27-30) for the blended group. In the 'Kinesiology' course, the groups obtained similar marks between the different teaching

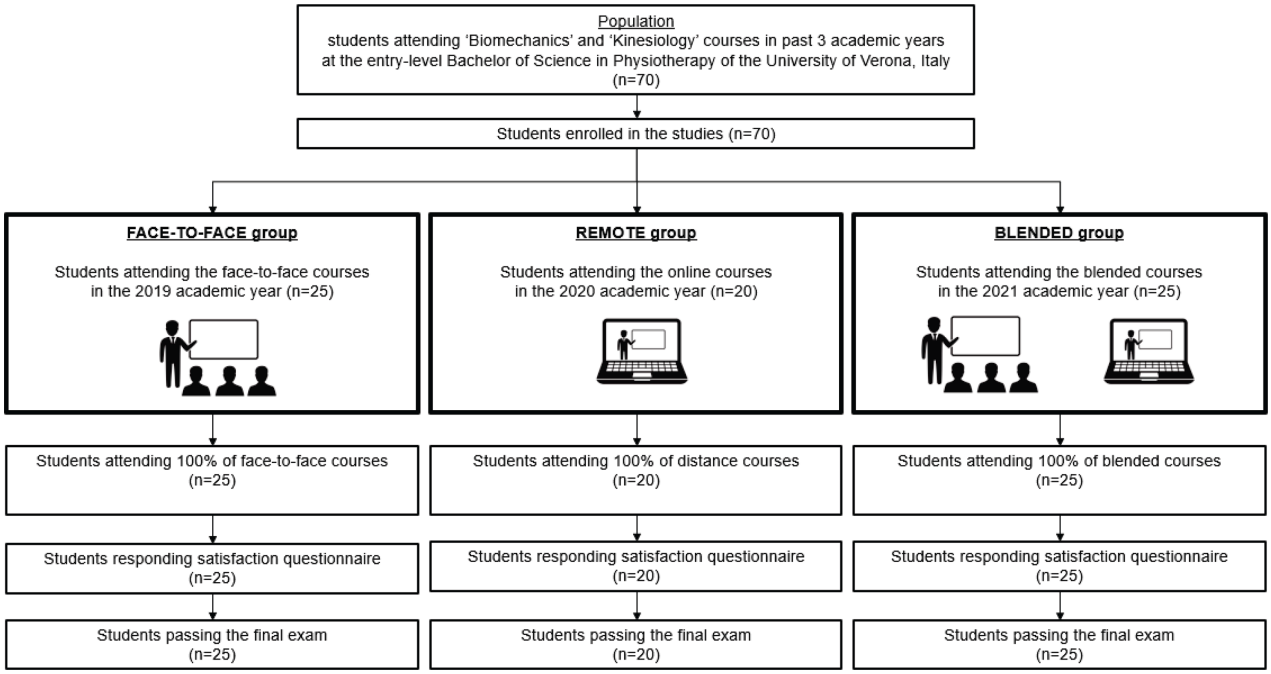

Figure 1. Flowchart of study participants**.**

Table 2. Demographics, academic performances, and satisfaction according to groups and the course attended.

		Groups			
		Face-to-face	**Distance**	**Blended**	
Demographics					
N. of students	N (Male, %)	25 (14, 56%)	20 (9, 45%)	25 (14, 56%)	–
Age	Median (IQR)	21.0 (21.0, 23.0)	20.5 (20, 23.5)	21 (21, 23)	–
Biomechanics					***p-value***
Academic Performance	Median (IQR)	28 (27, 30)	28.5 (27, 29)	29 (27, 30)	0.562 †
	Mean (SD)	27.71 (2.18)	28.33 (1.09)	28.39 (1.73)	
Satisfaction	Median (IQR)	5 (5, 5)	5 (4, 5)	5 (4, 5)	.655†
	Mean (SD)	4.76 (0.46)	4.70 (0.47)	4.64 (0.49)	
Kinesiology					
Academic Performance	Median (IQR)	29 (27, 30)	28 (28, 30)	29 (27, 30)	0.931 †
	Mean (SD)	28.08 (2.06)	28.19 (1.8)	28.02 (2.62)	
Satisfaction	Median (IQR)	4 (4, 5)	4 (3, 4.25)	4 (4, 5)	.076†
	Mean (SD)	4.04 (0.98)	3.70 (1.21)	4.44 (0.58)	

Abbreviations: IQR = Interquartile Range (25th -75th percentile); N = number; % = percentage; SD, Standard Deviation. Note: † Kruskal-Wallis test.

modalities (face-to-face: 29, IQR 27, 30; remote: 28, IQR 28, 30; blended: 29, IQR 27, 30).

Satisfaction with the courses was high, with median and mean values equal to or greater than 4 ("Somewhat agree") across all teaching modalities, with no statistically significant differences (Biomechanics, p = .655, Kinesiology, p = .076, Table 2).

Discussion

Main findings and interpretation

Our main findings show that physiotherapy students who underwent the 'Biomechanics' and 'Kinesiology' courses reached similar levels of satisfaction and academic performance, regardless of the mode of delivery (remote, face-to-face and blended).

This result aligns with previous studies showing that digital modalities, including remote and blended teaching, are at least as effective as face-to-face when concerning students' academic performance and may sometimes even be superior to the latter (2, 10, 28). Interestingly, teaching basic observational skills in the courses analyzed did not seem to influence academic performance, suggesting that remote and blended modalities may be appropriate for teaching skills based on visual assessment. Nevertheless, our findings need to be interpreted in the context of the courses analyzed. The 'Biomechanics' and 'Kinesiology' courses aim to teach basic observational skills part to entry-level physiotherapy students. Thus, our results may not apply to courses in the second/third years requiring the acquisition of more advanced practical skills (e.g., assessment of the accessory range of motion of the spine, test of muscle force) that students will apply to individuals with different clinical conditions (e.g., musculoskeletal, neurological, and geriatric) during clinical placements (29). On the other hand, the fact that the students of this course were entry-level physiotherapy students with limited experience suggests that unsupervised practical learning, as in the case of the remote course, may be feasible for delivering basic practical content even to students with limited experience. Moreover, our study extends previous evidence by showing similar results for blended and remote teaching regardless of the presence of practical skills in the

course (9). This evidence also aligns with other studies showing that blended systems appear to be more effective, or at least as effective as non-blended modalities, on students' academic performance (10, 30). Nevertheless, in our study, teaching modalities did not appear to have a meaningful association with the students' satisfaction. These results confirm what was shown in previous reports where students reached similar levels of satisfaction with remote (either distance or blended) and face-to-face teaching (9,31). However, fewer students were dissatisfied with the blended modality than remote or face-to-face in the' Kinesiology' course. Nevertheless, the observed difference needs to be considered from the perspective of the significant uncertainties derived from the small sample size and unclear practical importance. Nevertheless, the trends observed in our data suggest that students may sometimes prefer blended teaching methods. Although our data do not allow us to speculate on the reason why the students may have favored certain teaching modalities, previous reports suggest that blended teaching may favor a more diverse interaction and help build a stronger sense of community than either traditional or entirely remote courses which may positively influence students' satisfaction (32).

This study was possible because of the rapid changes in teaching modalities dictated by the COVID-19 pandemic. However, the emergency also limited the resources available to lecturers, including time for instructional design and the possibility of implementing new technologies (e.g., more advanced software, virtual reality), which could have improved students' academic performance and/or satisfaction (2). Moreover, the COVID-19 pandemic may have influenced the results of this study by altering the teaching context. Even remote, teaching and learning require interactions between students and lecturers in a complex social environment that can influence learning and experience (32). In this context, leaders' (in this case, the lecturers') emotional intelligence and leadership, together with students' interactions, may acquire more significant importance in a way that is impossible to quantify using this study's design (33). Thus, our results should be interpreted in the context of the historical events in which teaching occurred.

Limitations

This study had some significant limitations that need to be considered. This retrospective comparative study presented a limited sample size and a short follow-up, which increases the uncertainties regarding the observed differences, or lack thereof, and limits the generalizability of our results. Future studies employing longitudinal designs (e.g., randomized controlled trial), a larger sample (e.g., from more universities) and long-term outcomes (e.g., retention of knowledge) are thus needed to provide more definitive evidence regarding the effectiveness of different teaching modalities (2). The students included in this study were entry-level physiotherapy students, which may limit the generalizability of the results to other populations (e.g., master's students) (2). We did not collect students' and lecturers' perspectives on their learning and teaching experience with different modalities during the COVID-19 pandemic, thus offering opportunities for future qualitative analysis (e.g., focus groups, semi-structured interviews) (34-36). Moreover, course lectures likely learned how to improve course content delivery over time, which may have skewed the results. Finally, students' satisfaction was measured using a standardized, nationally established questionnaire (20), in which validity and reliability properties were not investigated. Ultimately, the essential practical teaching undertaken by the students was centered on the development of observational skills and did not require the acquisition of manual hands-on skills

Conclusion

In conclusion, face-to-face, remote, and blended teaching appear to lead to similar student satisfaction and academic performance when used to deliver courses requiring theoretical and basic observational skills in entry-level physiotherapy programs. Thus, the choice of delivery mode should thus be debated according to other factors, including, resource availability, students' expectations and lecturer preferences.

Ethical Approval: This retrospective study involving human participants was in accordance with the ethical standards of the

institutional and national research committee and with the principles of the Declaration of Helsinki. We acquired written informed consent from each participant when students completed and submitted the survey after reading the purpose statement of the study strategies, guaranteeing confidentiality and privacy of the data collected. We entirely and irreversibly anonymised data. Moreover, we did not require ethics approval during this pandemic according to the "Ethics and data protection" regulations of the European advisory body and European Commission.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors Contribution: All authors meet the following 4 criteria based on ICMJE recommendations: Have made a substantial contribution to the concept or design of the article; or the acquisition, analysis, or interpretation of data for the article; AND Drafted the article or revised it critically for important intellectual content; AND Approved the version to be published; AND Agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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