ORIGINAL

Does student evaluation of on-demand video lectures vary with student characteristics? A questionnaire survey of medical students at Tokushima University

Harutaka Yamaguchi[1,2], Seito Kagoshima[3], Yoshihiro Okura[4], Yoshinori Nakanishi[4], Keisuke Kawahito[1], and Kenji Tani[4]

[1]Department of General Medicine, Tokushima University Graduate School of Biomedical Sciences, Tokushima, Japan, [2]Department of General Medicine, Taoka Hospital, Tokushima, Japan, [3]Medical student, Tokushima University, Tokushima, Japan, [4]Department of General Medicine and Primary Care, Tokushima University Hospital, Tokushima, Japan

Abstract : The popularity of online classes in university education has grown rapidly since the COVID-19 outbreak. This study aims to examine the association between the detailed characteristics/various contexts of students and the evaluation of online classes. An online questionnaire survey administered to third- and fourth-grade medical students of Tokushima University in September 2021—with 101 (42.8%) valid responses—showed the respondents' general impressions, comprehension, convenience, and desire for online classes even after the pandemic ends were significantly higher for the on-demand lectures than for simultaneous online classes. Notably, students who did not do other things while watching video lectures (10.9%) rated on-demand lectures as facilitating significantly higher impression, comprehension, and convenience than those who did other things (89.1%). A multivariate analysis revealed that students who did not do anything else while watching, whose waking time changed slightly, who commuted to school for shorter periods, who were not good at morning lectures, and who watched at high speed rated the video lectures highly. Thus, video lectures are appreciated by students who are committed to learning, which is a positive result for the future of on-demand education. J. Med. Invest. 70 : 483-493, August, 2023

INTRODUCTION

By the end of 2019, coronavirus disease (COVID-19) had spread globally and was still rampant with the continual emergence of new mutations. Notably, some institutions were providing online medical education even before COVID-19 (1-3). However, when medical students were restricted from attending colleges and universities in person owing to the pandemic, the popularity of online medical education increased rapidly and significantly (4-7).

The primary features of online medical education include online lectures, webcasting, virtual group discussions, video conferences, virtual simulators, and telemedicine (8). Online medical education has several advantages over traditional medical education, including easy accessibility, a safe and comfortable environment, repeated access to lectures at convenience, time flexibility, time-saving, and increased independence and self-learning capacities of students (8, 9). Conversely, its drawbacks include isolation from and minimal interaction with peers, dependence on good internet access and poor technical skills of educators, lack of hands-on exposure, lack of direct assessment, inability to acquire medical skills required of a physician, confidentiality issues, and family-related distractions (8, 10, 11). Numerous students consider classroom lectures suitable for online medical education (12-14), but not bedside teaching and practical training (12, 13), The two types of online lectures are asynchronous lectures and synchronous lectures (15). Asynchronous lectures are pre-recorded video lectures that students can watch repeatedly and at any time ; these lectures allow for high-speed watching, skipping, and watching videos while doing other things. With asynchronous lectures, some students can improve their learning efficiency by repeatedly watching parts that are difficult to understand (16), while others—with low motivation—might watch the video lectures while doing something else or appreciate them only for convenience. What kind of students appreciate online lectures? Li *et al*. analyzed factors associated with groups that were satisfied and unsatisfied with online education and reported that teachers' professional titles and students' years of study, country of origin (an Asian or African country), and location of current residence (inside or outside China) significantly influenced students' satisfaction (17). Song *et al*. reported that male students had higher learning interest, attention, and efficacy than female students (18). However, no studies have examined the impact of more detailed student attributes (e.g., commute time, the nature of enjoying conversation, etc.) on students' perceptions of online classes.

Studies have reported that students' rhythm of life changed during COVID-19 (16, 19, 20). However, to the best of our knowledge, no study has considered assessing how the evaluation of online classes differs between students whose life rhythm changed after COVID-19 and those whose life rhythm did not change. If only students who stay up late and oversleep highly evaluate online classes, there is a concern that the number of online classes will increase in the future.

At Tokushima University, almost all classes were conducted face-to-face until February 2020, but from March 2020, commuting to school was prohibited owing to COVID-19 ; thus, online classes were introduced. As of September 2021, first and second graders had only had an online learning experience, and all fifth and sixth graders had already finished attending their classroom lectures and were training in clinical practices. In contrast,

third- and fourth-grade medical students had experienced both face-to-face and online classes.

Therefore, we aim to examine whether there are differences in online class evaluation based on student characteristics and students whose life rhythm changed after COVID-19 and those whose did not by administering an online questionnaire to third- and fourth-grade medical students at Tokushima University.

MATERIALS AND METHODS

Impact of COVID-19 on Tokushima University

The School of Medicine at Tokushima University has a six-year course, with each year beginning in April and ending in March. The program's structure is as follows : lectures on general liberal arts and some specialized subjects in the first grade ; lectures on and practical experimentation in anatomy, physiology, biochemistry, and other subjects in the second grade ; lectures on and experimentation in pharmacology, microbiology, pathology, and others in the third grade ; and lectures on clinical subjects are held from January in the third grade to December in the fourth grade. Since April 2020, most lectures have been delivered as on-demand videos, while only some were delivered in the synchronous online class format. During the COVID-19 pandemic, online classes were introduced with a short preparation period ; therefore, most of the online classes other than the PBL (problem-based learning) tutorial were one-way by teachers with audio recorded on PowerPoint (Microsoft) slides. Moreover, all experiments and hands-on practice have been provided in an on-demand format or as simultaneous online classes.

Participants

This study was conducted with the approval of the Tokushima University Hospital Ethics Committee. An online questionnaire was administered to third-grade (112 ; 69 male and 43 female) and fourth-grade students (124 ; 70 male and 54 female). With the approval of the Academic Affairs Division and the School of Medicine of Tokushima University, we sent emails to 236 participants three times, on September 2, 8, and 15, 2021. Responses from the participants were collected until September 21, 2021. The questionnaire survey was conducted before the clinical clerkship because it begins in January for fourth-grade students. We added questionnaire briefing documents, including information on voluntary participation ; no personal information was collected. Students were assured that they would not face any disadvantage for not attempting the questionnaire ; they were not rewarded for answering it either.

Questionnaire

Table 1 presents the English translation of the original Japanese questionnaire. Response time was assumed to be approximately seven minutes. The questionnaire included categories such as gender, grade, living environment, commute time, and good home internet environment and IT skills. The questionnaire also collected information on students' personality attributes, such as having a sociable personality, engaging in active conversation during breaks, and whether they are good at morning classes. Questions for on-demand lectures included increasing the playback speed, skipping the lecture video, watching the video repeatedly, and doing other things while watching the video. We considered the last question slightly sensitive for medical students ; therefore, they were free to provide a conservative answer. Therefore, in this study, we provided the choice of "seldom" next to "none" to detect whether students were doing other things while watching video lectures. Furthermore, we used a multi-choice question to ask

regarding "other things" : email/SNS, watching TV/videos, playing games, reading books, and others. Additionally, the questionnaire included questions regarding lifestyle changes before and after the COVID-19 pandemic, such as wake-up time, bedtime, physical condition, duration of using a smartphone, duration of reading books, duration of playing games, duration of watching TV/videos, daily time to exercise, frequency of part-time jobs, and frequency of participating in club activities. For each of the on-demand video lectures/simultaneous online classes/on-demand video experimentation/simultaneous online experimentation, participants evaluated "general impression," "comprehension," and "convenience" as very bad, bad, good, or very good, as well as answered "whether they hope for the same format" with strongly disagree, disagree, agree, or strongly agree. We also inquired about "asynchronous online lectures" and "synchronous online lectures." Asynchronous online lectures are on-demand lectures that students can access at any time, while synchronous online lectures are live online classes, including PBL (problem-based learning) tutorials.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics ver. 27. Results were expressed as medians (interquartile range). The Wilcoxon signed-rank test was used to compare on-demand and synchronized online classes in terms of general impression, comprehension, convenience, and whether they hoped for the same format. Additionally, the Wilcoxon signed-rank test was used to compare changes in sleep and lifestyle before and after the COVID-19 pandemic. In the Wilcoxon analyses, we replaced the 4-point scale and 7-point scale with the following numbers : "very bad 1, bad 2, good 3, very good 4," "strongly disagree 1, disagree 2, agree 3, strongly agree 4," and "none 1, 1/month 2, 2/month 3, 1/week 4, 2/week 5, 3/week 6, more 7." Regarding various situations of students (e.g., grade, gender, living environment, commute time, home network environment, IT skills, sociable personality, active conversation during breaks, and good at morning classes), the responses to each item were divided into two groups (for most of the items : agree or disagree ; how they watch on-demand lectures : none or others). For analyses, commute time was divided into two groups in two ways : ≤ 5 minutes vs. > 5 minutes and ≤ 10 minutes vs. > 10 minutes. As for sleep, the time to wake up and go to bed was divided into two groups : unchanged or earlier and one or more hours later. In each of the two groups, the Mann–Whitney test was used to compare the general impressions, comprehension, convenience, and whether they hope to receive the on-demand and the live online lectures in the same format. A multiple regression analysis was performed using items with $p<0.2$. A p-value of less than 0.05 was considered significant.

The sample size was examined using G * power (21). A total of 94 responses were required when the effect size was 0.3 (moderate), the power was 0.8, and the significance level was less than 0.05. For 236 third- and fourth-grade medical students, the target number of responses would be met if the response rate was 40% ; therefore, all third- and fourth-grade students were targeted.

RESULTS

A total of 105 medical students (52 male and 53 female) provided their responses. Three students did not respond to the question regarding the evaluation of on-demand video lectures, whereas one student did not respond to the question regarding the living environment. After excluding these four responses, a total of 101 responses (a valid response rate of 42.8%) were

Table 1.   Questionnaire

No.	Questions and choices
1	Please tell us your gender. - Male, Female, No answer
2	What is your grade? - third grade, fourth grade
3	What is your current living environment? - Parent's house, Living alone, Other
4	Please tell us how long you spend commuting to school. - ≤5, 5< ≤10, 10< ≤ 20, 20< ≤ 30, 30< (minutes)
5	Do you have a good network connection at home? - strongly agree, agree, disagree, strongly disagree
6	Do you have good IT skills? - strongly agree, agree, disagree, strongly disagree
7	Do you think you are sociable? - strongly disagree, disagree, agree, strongly agree
8	Do you have active conversations during breaks? - strongly disagree, disagree, agree, strongly agree
9	Are you good at morning classes? - strongly disagree, disagree, agree, strongly agree
10	How often do you increase the playback speed? - none, a quarter, half, almost all
11	How often do you skip the lecture videos? - none, a quarter, half, or almost all
12	Do you watch the videos repeatedly if they are difficult to understand? - strongly disagree, disagree, agree, strongly agree
13	How often do you do other things while watching video lectures? - none, seldom, sometimes, or often
14	Questions for those who answered "often or sometimes" in the previous question : What do you do during class? - use e-mail and SNS, read books, play games, watch TV or videos
	We would like to ask you about the changes in your lifestyle before the COVID-19 pandemic and around May 2021, when you were banned from posting at the university.
15	What is your wake-up time? Before the COVID-19 pandemic. - 4, 5, 6, 7, 8, 9, 10, 11, 12 (o'clock) Around May 2021. - 4, 5, 6, 7, 8, 9, 10, 11, 12 (o'clock)
16	What time do you go to bed? Before the COVID-19 pandemic. - 21, 22, 23, 24, 1, 2, 3, 4, 5 (o'clock) Around May 2021. - 21, 22, 23, 24, 1, 2, 3, 4, 5 (o'clock)
17	On average, over the course of a week, how much time do you spend using your smartphone per day? Before the COVID-19 pandemic. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours) Around May 2021. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours)
18	On average, over the course of a week, how much time do you spend reading books per day? Before the COVID-19 pandemic. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours) Around May 2021. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours)
19	On average, over the course of a week, how much time do you spend playing game (including time spent playing on smartphones) per day? Before the COVID-19 pandemic. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours) Around May 2021. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours)
20	On average, over the course of a week, how much time do you spend watching TV and videos (including on smartphones) per day? Before the COVID-19 pandemic. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours) Around May 2021. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours)
21	On average, over the course of a week, how much time do you spend exercising per day? Before the COVID-19 pandemic. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours) Around May 2021. - (1) <1, (2) 1≤ <2, (3) 2 ≤ < 3, (4) 3≤ <4, (5) 4≤ <5, (6) 5≤ (hours)

22	How often do you work part-time? - (1) none, (2) 1/month, (3) 2/month, (4) 1/week, (5) 2/week, (6) 3/week, (7) more
23	How often do you participate in club activities, including club activities outside the university? - (1) none, (2) 1/month, (3) 2/month, (4) 1/week, (5) 2/week, (6) 3/week, (7) more
24	Tell us about your physical condition. Before the COVID-19 pandemic. - (1) very bad, (2) bad, (3) good, (4) very good Around May 2021 - (1) very bad, (2) bad, (3) good, (4) very good Let us ask you about online classes.
25	What is your general impression of on-demand video lectures compared to face-to-face classes? - very bad, bad, good, very good
26	How is your comprehension of on-demand video lectures compared to face-to-face classes? - very bad, bad, good, very good
27	How do you find the convenience of on-demand video lectures compared to face-to-face classes? - very bad, bad, good, very good
28	Do you hope for on-demand video lectures even if after the COVID-19 pandemic ends? - strongly disagree, disagree, agree, strongly agree
29-40	The four questions above were asked in the same way, for simultaneous online classes, on-demand video experimentation, and simultaneous online experimentation, using the same choices for each category.

analyzed.

In the final sample, there were 50 men and 51 women (the response rate was 37.4% for men and 54.6% for women) (Table 2). Thus, the response rate of women was significantly higher ($p = 0.011$). There were 53 third graders and 48 fourth graders (the response rate was 47.3% for third graders and 38.7% for fourth graders) ; thus, there was no grade-based bias ($p = 0.59$). As for the living environment, approximately 69.3% of the students lived alone, of whom 30.7% lived with their parents. No student chose the option "others." The most frequent commute time was 5 minutes or less, and 70% of the respondents chose 10 minutes or less. All students who commuted to school for 5 minutes or less lived alone, and 66 out of 72 students (91.7%) who commuted to school for 10 minutes or less lived alone ; therefore, there was a significant association between living environment and commute time (both ≤5 vs. 5< and ≤10 vs. 10< ; $p < 0.001$). Most students had a good internet connection at home, but only about half of them were confident about their IT skills. Of the 41 students who evaluated themselves as having a sociable personality, 40 responded that they had active break-time conversations, indicating a significant association ($p < 0.001$). Approximately 80% of students said they were not good at morning classes.

Table 3 describes how students watched on-demand video lectures. Most students (84.2%) watched the lectures at a higher playback speed, but a small proportion of students (31.7%) skipped while watching the video. Most students (95.0%) responded that they watched hard-to-understand points repeatedly. No significant association was found between students increasing playback speed and skipping or watching repeatedly ($p = 0.97$, 0.53, respectively) ; however, most students (89.1%) did other things while watching video lectures. Multiple choice questions regarding the breakdown of "other things" revealed that 38 students (37.6%) used email/SNS, five students (5.0%) watched TV/videos, five students (5.0%) played games, five students chose others, and none of the students read books. Furthermore, among the five students who watched TV/videos and the five who played games, only one did both ; the remaining eight responses were from eight different students. Similarly, five students who chose "others" were different from those who chose watching TV/videos and playing games.

Table 4 presents the evaluation results of on-demand video lectures and simultaneous online classes. All the items, including general impression, comprehension, convenience, and whether to hope for the same format in the future, were significantly highly evaluated for on-demand video lectures. For on-demand video lectures, more than 95% of the respondents rated the general impression, comprehension, and convenience as good or very good. In contrast, 82.2% responded to the item "hope for the same format in the future" with "agree" or "strongly agree," which was lower than the previous three items. For on-demand video experimentation and simultaneous online experimentation, the numbers of respondents were 58 or 59 and 51 or 52, respectively. These were about half of the respondents in the on-demand video lectures and simultaneous online classes, resulting in a very low response rate. Therefore, they were excluded from subsequent analyses.

Table 5 presents the relationship between student evaluation of on-demand video lectures and various student attributes (grade, gender, living environment, commute time, IT skills, and home network environment), students' characteristics (sociable personality, active conversation during breaks, and good at morning classes), and how they watched on-demand video lectures. The evaluation of the general impression and convenience of on-demand lectures by students living alone was significantly higher compared to that of students living with their parents ($p = 0.049$ and 0.002, respectively), and they strongly hoped for the same format in the future ($p = 0.006$). The evaluation of students who commuted to school for 10 minutes or less was significantly higher than that of students who commuted to school for longer than 10 minutes ($p = 0.007$ and 0.023, respectively), and they hoped for the same format in the future ($p = 0.023$). The evaluation of students with 5 minutes or less commute time was significantly higher for all items compared to that of students with more than 5 minutes of commute time ($p < 0.001$). Students who evaluated themselves as having a sociable personality significantly appreciated their comprehension and convenience and hoped for the same format in the future ($p = 0.002$, 0.010, and 0.008, respectively). However, there was no difference in general impressions between students who evaluated themselves as sociable and those who did not ($p = 0.198$). Students who evaluated themselves as active conversationalists

Table 2.   Students' characteristics

Sex (n = 101)	Male	Female			
n	50	51			
(%)	(49.5)	(50.5)			
Grade (n = 101)	Grade 3	Grade 4			
n	53	48			
(%)	(52.5)	(47.5)			
Dwelling environment (n = 101)	Parents' house	Single	Other		
n	31	70	0		
(%)	(30.7)	(69.3)	(0.0)		
Commute time (n = 101)	≤ 5	$5< \leq 10$	$10< \leq 20$	$20< \leq 30$	30 minutes <
n	39	33	13	10	6
(%)	(38.6)	(32.7)	(12.9)	(9.9)	(5.9)

	Strongly Disagree	Disagree	Agree	Strongly Agree
Good home network environment (n = 99)				
n	0	4	42	53
(%)	(0.0)	(4.0)	(42.4)	(53.5)
Good at IT skills (n = 101)				
n	5	45	36	15
(%)	(5.0)	(44.6)	(35.6)	(14.9)
Sociable personality (n = 99)				
n	11	47	26	15
(%)	(11.1)	(47.5)	(26.3)	(15.2)
Active conversation during breaks (n = 101)				
n	8	27	42	24
(%)	(7.9)	(26.7)	(41.6)	(23.8)
Not good at morning lectures (n = 101)				
n	8	13	17	63
(%)	(7.9)	(12.9)	(16.8)	(62.4)

Table 3.   How to watch on-demand video lectures (n = 101)

Watch at high speed	None	A quarter	Half	Almost all
n	16	6	9	70
(%)	(15.8)	(5.9)	(8.9)	(69.3)
Skip	None	A quarter	Half	Almost all
n	69	13	12	7
(%)	(68.3)	(12.9)	(11.9)	(6.9)
Watch repeatedly	Strongly disagree	Disagree	Agree	Strongly agree
n	2	3	33	63
(%)	(2.0)	(3.0)	(32.7)	(62.4)
Do other things while watching	None	Seldom	Sometimes	Often
n	11	42	37	11
(%)	(10.9)	(41.6)	(36.6)	(10.9)

While 84% of students watched videos at high speed, only 31% of the students skipped video lectures ; 89% of students answered that they did something else while watching video lectures.

Table 4.   Comparison of on-demand video lectures and simultaneous online classes

		Very bad	Bad	Good	Very good	p-value
General impression	OD (n = 101)	1 (1.0)	4 (4.0)	50 (49.5)	46 (45.5)	<0.001
	ST (n = 101)	4 (4.0)	30 (29.7)	58 (57.4)	9 (8.9)	
Comprehension	OD (n = 101)	1 (1.0)	4 (4.0)	50 (49.5)	46 (45.5)	<0.001
	ST (n = 100)	3 (3.0)	31 (31.0)	59 (58.4)	7 (7.0)	
Convenience	OD (n = 101)	2 (2.0)	1 (1.0)	38 (37.6)	60 (59.4)	<0.001
	ST (n = 101)	8 (7.9)	29 (28.7)	53 (52.5)	11 (10.9)	

		Strongly disagree	Disagree	Agree	Strongly agree	
Hope for the same format	OD (n = 101)	3 (3.0)	15 (14.9)	35 (34.7)	48 (47.5)	<0.001
	ST (n = 100)	18 (18.0)	30 (30.0)	42 (42.0)	10 (10.0)	

The on-demand video lectures were highly evaluated by respondents in all four items (Wilcoxon signed-rank test).
OD : on-demand video lectures, ST : simultaneous online classes

Table 5.   Relationship between the evaluation of on-demand video lectures and various situations and students' individualities

	General impression	Comprehension	Convenience	Hope for the same format
Grade	0.420	0.213	0.773	0.805
Sex	0.972	0.488	0.231	0.974
Living environment	0.049	0.262	0.002	0.006
Parents' house	3.0 (3.0–4.0)		3.0 (3.0–4.0)	3.0 (2.5–3.5)
Single	3.5 (3.0–4.0)		4.0 (3.0–4.0)	4.0 (3.0–4.0)
Commute time A	0.007	0.227	0.023	0.023
≤10 minutes	4.0 (3.0–4.0)		4.0 (3.0–4.0)	4.0 (3.0–4.0)
>10 minutes	3.0 (3.0–3.5)		3.0 (3.0–4.0)	3.0 (2.0–4.0)
Commute time B	<0.001	<0.001	<0.001	<0.001
≤5 minutes	4.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (4.0–4.0)	4.0 (3.0–4.0)
>5 minutes	3.0 (3.0–4.0)	3.0 (3.0–4.0)	3.0 (3.0–4.0)	3.0 (3.0–4.0)
Home network environment	0.791	0.650	0.565	1.000
IT skills	0.976	0.369	0.459	0.979
Morning lectures	0.053	0.032	0.054	0.081
good at morning lectures	3.0 (3.0–4.0)	3.0 (3.0–4.0)	3.0 (3.0–4.0)	3.0 (2.0–4.0)
not good at morning lectures	3.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (3.0–4.0)	3.5 (3.0–4.0)
Active conversation during breaks	0.154	0.013	0.367	0.016
scarce		3.0 (3.0–4.0)		3.0 (2.5–4.0)
often		4.0 (3.0–4.0)		4.0 (3.0–4.0)
Sociable personality	0.198	0.002	0.010	0.008
no		3.0 (3.0–4.0)	3.0 (3.0–4.0)	3.0 (3.0–4.0)
yes		4.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (3.0–4.0)
Watch at a high speed	0.046	0.186	0.221	0.132
no	3.0 (3.0–3.5)			
yes	3.0 (3.0–4.0)			
Watch by skipping	0.760	0.833	0.563	0.646
Watch repeatedly	0.602	0.666	0.513	0.602
Do other things while watching	0.011	0.013	0.025	0.093
none	4.0 (4.0–4.0)	4.0 (4.0–4.0)	4.0 (4.0–4.0)	4.0 (3.5–4.0)
yes (seldom ~ often)	3.0 (3.0–4.0)	3.0 (3.0–4.0)	4.0 (3.0–4.0)	3.0 (3.0–4.0)

The p-value of each item and the median value (interquartile range) for items less than p <0.1 are shown (Mann–Whitney's U test).
For analyses, we replaced the 4-point scale with the following numbers : "very bad 1, bad 2, good 3, very good 4" and "strongly disagree 1, disagree 2, agree 3, strongly agree 4."

during breaks significantly appreciated their comprehension and hoped for the same format in the future (p = 0.013 and 0.016, respectively). Students who were not good at morning lectures evaluated their comprehension, general impression, and convenience of on-demand lectures higher than those who were good (p = 0.032, 0.053, and 0.054, respectively) and tended to hope for the same format in the future (p = 0.081). However, there was no significant relationship between students who were not good at morning lectures and how they watched on-demand lectures. The evaluation of the general impression of the lectures by students who increased the playback speed was significantly higher than that of those who did not (p = 0.046). Students who did not do other things while watching on-demand lectures had significantly higher evaluations of their general impressions, comprehension, and convenience compared to students who did other things while watching the lectures (p = 0.011, 0.013, and 0.025, respectively). Conversely, students who did not do other things while watching on-demand lectures tended to have a higher evaluation of their hope for the same format in the future than those who did other things, but not significantly (p = 0.093). Grade, gender, IT skills, and whether to skip or watch the lecture video repeatedly did not have a significant effect on students' evaluations of the items.

Table 6 presents changes in lifestyles before and after the COVID-19 pandemic. Wake-up time was 7.0 (7.0–8.0) hours (before) and 9.0 (8.0–0.0) hours (after), bedtime was 24.0 (24.0–25.0) hours (before) and 26.0 (24.0–26.0) hours (after), respectively, with a median delay of 2 hours (both p<0.001). Table 6 also includes changes in lifestyles before and after the COVID-19 pandemic. Regarding other lifestyle habits, the duration of using smartphones, duration of reading books, duration of playing video games, duration of watching TV/videos, and the frequency of part-time jobs increased significantly, while the frequency of club activities decreased significantly. Furthermore, the daily time spent exercising tended to decrease. There was no change in the physical condition by self-evaluation.

Regarding the relationship between changes in wake-up time and bedtime before and after the COVID-19 pandemic and the evaluation of on-demand lectures, 16 students (16.0%) reported no change or an earlier wake-up time, and 84 students (84.0%) reported waking up one hour later. There were 36 students (35.6%) who went to bed at the same time or earlier, and 65 students (64.4%) who went to bed one hour or more later. General impressions of on-demand lectures tended to be higher for those who went to bed at the same time or earlier than those who went to bed one hour later (p = 0.087). Post hoc analyses compared students whose wake-up time and bedtime were delayed by 2 hours or more (n = 55 and 37, respectively) with those whose wake-up time and bedtime did not change or become earlier (n = 16 and 36, respectively). The analyses showed that students whose wake-up time and bedtime were the same or earlier tended to give higher scores (p = 0.074, 0.086, respectively). Regarding the degree of comprehension, convenience, and hope for the same format using on-demand lectures, no relationship was found with changes in wake-up time and bedtime by 1 hour or more.

There were a few significant differences in the evaluation of simultaneous online lectures (not shown in the table). The students with a commute time of 10 minutes or less evaluated their hope for the same format in the future highly (p = 0.044) and tended to evaluate general impressions higher (p = 0.084), and students who were not good at morning lectures tended to appreciate convenience (p = 0.071). Students who went to bed one or more hours later tended to feel that online lectures were more convenient than those who did not (p = 0.068). All other items had no significant effect at p > 0.1.

The results of the multiple regression analyses are shown in Table 7. Regarding general impressions, students who were not good at morning lectures, students who watched videos at high speed, students who had shorter commute time, students who did not do other things while watching, and students whose wake-up time changed slightly rated the lectures highly (Table 7A). Students who were more active during breaks, who had shorter commute time, and who did not do other things while watching rated comprehension higher (Table 7B). Furthermore, students who evaluated themselves as sociable, who had shorter commute time, and who did not do other things rated convenience higher (Table 7C). Regarding whether they hope for the same format in the future, students who were less comfortable with morning lectures and those who had shorter commute times rated it higher (Table 7D).

Table 6.   Changes in waking time, bedtime, and other lifestyle habits before and after the COVID-19 pandemic

	Median (interquartile range)		p value
	pre	post	
Wake-up hour	7.0 (7.0 - 8.0)	9.0 (8.0 - 10.0)	< 0.001
Bedtime hour	24.0 (24.0 - 25.0)	26.0 (24.0 - 26.0)	< 0.001
Physical condition	3.0 (3.0 - 4.0)	3.0 (3.0 - 4.0)	0.869
Duration of using smartphones (hours/day)	4.0 (3.0 - 5.0)	5.0 (4.0 - 6.0)	< 0.001
Duration of watching TV/video (hours/day)	2.0 (2.0 - 3.0)	3.0 (3.0 - 4.0)	< 0.001
Duration of playing video games (hours/day)	1.0 (1.0 - 2.0)	1.0 (1.0 - 3.0)	0.002
Duration of reading books (hours/day)	1.0 (1.0 - 1.0)	1.0 (1.0 - 2.0)	< 0.001
Frequency of part-time jobs	4.0 (1.0 - 6.0)	5.0 (3.0 - 6.0)	< 0.001
Frequency of club activities	5.0 (1.0 - 6.0)	1.0 (1.0 - 3.0)	< 0.001
Daily time to exercise (hours/day)	2.0 (1.0 - 2.0)	1.0 (1.0 - 2.0)	0.073

Wilcoxon signed-rank test.
For analyses, we replaced the 4-point scale of "Physical condition" with the following numbers: "very bad 1, bad 2, good 3, very good 4" and "Frequency of part-time jobs/club activities" "none 1, 1/month 2, 2/month 3, 1/week 4, 2/week 5, 3/week 6, more 7."

Table 7. Multiple regression analysis

A) General Impression

	Partial regression coefficient	95% confidence interval		p value
		lower	upper	
Commute time	-0.176	-0.265	-0.087	<0.001
Morning lectures	0.198	0.085	0.310	0.001
Watch videos at high speed	0.142	0.003	0.049	0.234
Difference in wake-up time	-0.097	-0.160	-0.033	0.003
Do other things while watching videos	-0.152	-0.281	-0.023	0.021

Variables : living environment, commute time, morning lecture, active conversation, watch videos at high speed, do other things, sociable personality, difference in wake-up time, difference in bedtime

B) Comprehension

	Partial regression coefficient	95% confidence interval		p value
		lower	upper	
Active conversation	0.195	0.056	0.334	0.006
Commute time	-0.184	-0.332	-0.036	0.015
Do other things while watching videos	-0.116	-0.218	-0.013	0.027

Variables : commute time, morning lecture, active conversation, sociable personality, watch videos at high speed, do other things

C) Convenience

	Partial regression coefficient	95% confidence interval		p value
		lower	upper	
Commute time	-0.140	-0.240	-0.041	0.006
Sociable personality	0.179	0.045	0.313	0.009
Do other things while watching videos	-0.160	-0.302	-0.018	0.028

Variables living environment, commute time, morning lecture, sociable personality, do other things

D) Hope for the same format

	Partial regression coefficient	95% confidence interval		p value
		lower	upper	
Commute time	-0.193	-0.322	-0.064	0.004
Morning lecture	0.183	0.021	0.345	0.028

Variables : living environment, commute time, morning lecture, active conversation, sociable personality, watch videos at high speed, do other things

DISCUSSION

We conducted an online questionnaire survey targeting third- and fourth-grade medical students at Tokushima University who have experienced both face-to-face traditional education and online education. Generally, pre-recorded lectures were rated higher than live online classes. A notable finding in the multivariate analysis was that medical students who did not do other things while watching video lectures evaluated their general impression, comprehension, and convenience significantly higher than those who did other things while watching. Furthermore, those with shorter commute times, those who were not good at morning lectures, those who increased playback speed, those who had smaller wake-up time differences, those who were

active conversationalists during breaks, and those with sociable personalities rated pre-recorded video lectures highly.

On-demand video lectures were significantly highly evaluated, and the number of students who hoped for the same format in the future was as high as 82.2% (Table 4). Conversely, 52.0% of the respondents hoped for synchronous online classes in the future. Stoehr *et al.* reported that almost no student wanted online classes before COVID-19 (mean of 14%), but after the COVID-19 pandemic, the number of students who hoped for online learning increased (mean of 42%) (22). Furthermore, Tayem *et al.* conducted a questionnaire survey with medical students who were exposed to COVID-19 and found that only 28.6% wanted completely online classes after the pandemic, whereas 73.3% of the students wanted partial online classes (23).

Al-Balas *et al*. (9) reported that 5.2% of students desired complete e-learning, 75.6% desired a mixed format, and 19.4% desired traditional learning, indicating most students wanted a hybrid format. Kim *et al*. (24) reported that 62.2% of students preferred online classes, whereas 29.5% preferred offline classes ; they also reported that, of the students who preferred online classes, 75.5% preferred recorded video lectures and 11.3% preferred live online classes, indicating that an overwhelming majority preferred recorded video lectures. Additionally, they reported that 38.8% of students hoped for online classes in the future, even after the COVID-19 pandemic is over ; 45.5% hoped for blended classes ; and 15.7% hoped for offline classes (24). In their report, 84.3% of students hoped for full or partially online classes in the future. Our survey also showed that 82.2% of students hoped for pre-recorded video lectures in the future ; therefore, this result agrees with that of Kim *et al*.

Students who did not do other things while watching video lectures rated on-demand lectures significantly higher than those who did other things while watching the lectures (Table 5, Tables 7A-C). Many students wanted on-demand education ; however, students who evaluated on-demand education highly were not those who were less engaged but those who could concentrate on learning. High appreciation of on-demand lectures, from students who do not do other things while watching, supports the continuation and development of future online classes. However, 31% of students skipped watching online classes, and 89% of students did other things while watching online classes. Furthermore, many students who do other things while watching online classes have a relatively lower evaluation of online classes ; thus, this result means that the quality of education in the current online classes is low. Video learning is superior to face-to-face lectures in certain aspects, such as easy accessibility, a safe and comfortable environment, time flexibility, and repeated access, but learning through video lectures has a drawback : students are prone to concentration loss (8). Dong *et al*. claimed that the most important aspect of online lectures is attracting students (15). Therefore, educators will be required to devise more attractive lectures so that students do not do anything else while watching video lectures or to encourage students to watch online classes through interactive communication between teachers and students and formative evaluation of students' level of understanding and attainment.

Active conversationalists during breaks and sociable students highly rated comprehension and hope for the same format after the COVID-19 pandemic ends (Table 5). In the multivariate analyses, active conversationalists during breaks rated comprehension (Table 7B), whereas sociable students rated convenience (Table 7C). We assumed that students who enjoyed break-time conversations would underestimate video lectures because video lectures would reduce their chances of meeting friends in the classroom, but the results were the opposite. Stoehr *et al*. reported that medical students find it difficult to build relationships with classmates because online classes can lead to social isolation (22). Thus, students who are not active conversationalists tend to be socially isolated and have a great disadvantage when taking online classes. In contrast, students who are active conversationalists could avoid "isolation" by actively meeting their peers outside the classroom and contacting them through various means, such as social media, thereby reducing the disadvantages of online classes. This may be the reason students who are social and active conversationalists can appreciate online classes. Nonetheless, extra care should be taken in online classes to prevent isolation, especially for less sociable students.

Students with shorter commute times rated on-demand classes significantly higher on all four items of on-demand classes in the multivariate analysis (Tables 7A-D). Regarding the living environment, students living alone evaluated their general impression and convenience highly and significantly hoped for the same format in the future (Table 5). Ibrahim *et al*. (25) asserted that 59.2% of students agreed that online classes would save time, while AlQhtani *et al*. (26) reported that 60.4% of students found it convenient. Tayem *et al*. (23) also reported that 78.2% of students agreed that online lectures offer flexibility and convenience. Students who spend a lot of time commuting to school were expected to appreciate online classes, but the results indicated the opposite. A possible reason is that all students who commute to school for less than 5 minutes live alone—91.7% of students with a commute time of fewer than 10 minutes live alone. Concentrating on online lessons while living with family is challenging (11, 15) and as a result, students who spend considerable time commuting to school, that is, students who live with their families, may have a lower evaluation of online classes. Another possible reason is that if students need to attend lectures or experiments at the university, those living far away from the university might not be able to return home in time and might attend them in the university library. In that case, the advantages of online learning are not being utilized at all ; rather, its disadvantages increase. Therefore, to avoid this when using both online and face-to-face classes, separating the days of online and face-to-face classes is crucial.

Students who were not good at morning classes valued on-demand lectures highly, which is understandable. Conversely, students who were not good at morning classes did not skip or do other things. This was a statistically significant result ; this time flexibility can be considered an advantage of video lectures, as students can access them at any time.

Many students had later wake-up times, consistent with previous studies (Table 6) (16, 19, 20). Interestingly, when comparing students whose wake-up time did not change or conversely became earlier with those whose rhythms changed (i.e., woke up later or went to bed later), the former rated on-demand classes more highly than the latter. To the best of our knowledge, no studies have investigated the relationship between changes in daily life rhythm and class evaluations, and the present study's findings shed a positive light on on-demand classes.

Compared to on-demand lectures, there were only a few differences in synchronous classes. Of the 60 items in total, only 4 had a difference of $p < 0.1$. Additionally, only one item showed a significant difference at $p < 0.05$ (future prevalence of students whose commute time was 10 minutes or less). If it were a true difference, that would mean that people living nearby appreciate online live classes as well as on-demand video classes. However, unlike the evaluation of on-demand classes, there was no difference between students with a commute time of 5 minutes or less and more than 5 minutes, and no difference was found for the living environment either. As the p-value of the future prevalence of students whose commute time was 10 minutes or less was also high at $p = 0.044$, the possibility of an accidental result cannot be denied.

Limitations

There are several limitations to this study. First, the valid response rate was only 42.8%. Second, there was a bias between the male and female respondents. Both of these limitations can lead to self-selection bias ; therefore, future studies with high response rates are needed to confirm our findings. Third, this survey did not investigate the learning achievement of students through online classes, so the educational effects of online classes could not be verified. Fourth, this survey was performed during the COVID-19 pandemic ; therefore, the student responses may be strongly influenced by a desire to ensure safety against infectious diseases. Additionally, because the university

decided on whether to provide learning as video lectures or on-time lectures, a lecture with an originally low evaluation may have been given as a live lecture, and it may not be the result of a simple comparison between video lectures and online live lectures. Nevertheless, the fact that students who did not do other things while video learning evaluated video lectures highly is the most meaningful finding of this study.

Conclusion

We found that medical students generally highly rate online education. It showed that video lectures were rated higher than synchronous classes, and students who did not do other things while watching video lectures evaluated these lectures highly compared to those who did other things. Although this implies that students who are committed to learning tend to appreciate video lectures more than those who are less motivated, currently, many students do other things during recorded video classes, and some kind of improvement measures are required to conduct effective recorded video classes. To confirm these findings, future studies need to conduct surveys with (1) higher response rates, (2) RCTs that compare recorded video lectures and face-to-face lectures with the same content, and (3) RCTs that compare recorded video lectures and online live lectures with the same content.

CONFLICTS OF INTEREST

ACKNOWLEDGMENTS

REFERENCES

1. Tang B, Coret A, Qureshi A, Barron H, Ayala AP, Law M : Online lectures in undergraduate medical education : scoping review. JMIR Med Educ 10 : e11, 2018. doi : 10.2196/mededu.9091

2. Pei L, Wu H : Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. Med Educ Online 24 : 1666538, 2019. doi : 10.1080/10872981.2019.1666538

3. Petit RK, Kinney M, McCoy L : A descriptive, cross-sectional study of medical student preferences for vodcast design, format and pedagogical approach. BMC Med Educ 17 : 89, 2017. doi : 10.1186/s12909-017-0926-z

4. Abbasi MS, Ahmed N, Sajjad B, Alshahrani A, Saeed S, Sarfaraz S, Abduljabbar T : E-learning perception and satisfaction among health sciences students amid the COVID-19 pandemic. Work 67 : 549-556, 2020. doi : 10.3233/WOR-203308

5. Garg M, Eniasivam A, Satterfield J, Norton B, Austin E, Dohan D : Rapid transition of a preclinical health systems science and social justice course to remote learning in the time of coronavirus. Med Educ Online 25 : 1812225, 2020. doi : 10.1080/10872981.2020.1812225

6. Nimavat N, Singh S, Fichadiya N, Sharma P, Patel N, Kumar M, Chauhan G, Pandit N : Online medical education in India - different challenges and probable solutions

in the age of COVID-19. Adv Med Educ Pract 12 : 237-243, 2021. doi : 10.2147/AMEP.S295728

7. Salari F, Sepahi V : Challenges of virtual medical sciences education during the COVID-19 pandemic : a systematic review. Educ Res Med Sci 10 : e117948, 2021. doi : 10.5812/erms.117948

8. Althwanay A, Ahsan F, Oliveri F, Goud HK, Mehkari Z, Mohammed L, Javed M, Rutkofsky IH : Medical education, pre- and post-pandemic era : a review article. Cereus 12 : e10775, 2020. doi : 10.7759/cureus.10775

9. Al-Balas M, Al-Balas HI, Jaber HM, Obeidat K, Al-Balas H, Aborajooh EA, Al-Taher R, Al-Balas B : Distance learning in clinical medical education amid COVID-19 pandemic in Jordan : current situation, challenges, and perspectives. BMC Med Educ 20 : 341, 2020. doi : 10.1186/s12909-020-02257-4

10. Wilcha RJ : Effectiveness of virtual teaching during the COVID-19 crisis : systematic review. JMIR Med Educ 6 : e20963, 2020. doi : 10.2196/20963

11. Dost S, Hossain A, Shehab M, Abdelwahed A, Al-Nusair L : Perceptions of medical students towards online teaching during the COVID-19 pandemic- a national cross-sectional survey of 2721 UK medical students. BMJ Open 10 : e042378, 2020. doi : 10.1136/bmjopen-2020-042378

12. Tashkandi E : E-learning for undergraduate medical students. Adv Med Educ Pract 12 : 665-674, 2021. doi : 10.2147/AMEP.S314509

13. Ikonne U, Campbell AM, Whelihan KE, Bay RC, Lewis JH : Exodus from the classroom : student perceptions, lecture capture technology, and the inception of on-demand preclinical medical education. J Am Osteopath Assoc 118 : 813-823, 2018. doi : 10.7556/jaoa.2018.174

14. Yagi S, Fukuda D, Ise T, Yamaguchi K, Kusunose K, Kadota M, Kawabata Y, Matsuura T, Soga T, Yamada H, Soeki T : Clinical clerkship students' preferences and satisfaction regarding online lectures during the COVID-19 pandemic. BMC Med Educ 22 : 43, 2022. doi : 10.1186/s12909-021-03096-7

15. Dong C, Lee DW, Aw DC : Tips for medical educators on how to conduct effective online teaching in times of social distancing. Proceedings of Singapore Healthcare 30 : 59-63, 2021. doi.org/10.1177/2010105820943907

16. Nishimura Y, Ochi K, Tokumasu K, Obika M, Hagiya H, Kataoka H, Otsuka F : Impact of the COVID-19 pandemic on the psychological distress of medical students in Japan : cross-sectional survey study. J Med Internet Res 23 : e25232, 2021. doi : 10.2196/25232

17. Li W, Gillies R, He M, Wu C, Liu S, Gong Z, Sun H : Barriers and facilitators to online medical and nursing education during the COVID-19 pandemic : Perspectives from international students from low- and middle-income countries and their teaching staff. Hum Resour Health 19 : 64, 2021. doi : 10.1186/s12960-021-00609-9

18. Song Y, Wang S, Liu Y, Liu X, Peng A : Online education at the medical School of Tongji University during the COVID-19 pandemic- a cross-sectional study. BMC Med Educ 21 : 512, 2021. doi:10.1186/s12909-021-02951-x

19. Romero-Blanco C, Rodríguez-Almagro J, Onieva-Zafra MD, Parra-Fernández ML, Prado-Laguna MDC, Hernández-Martínez A : Sleep pattern changes in nursing students during the COVID-19 lockdown. Int J Environ Res Public Health 17 : 5222, 2020. doi : 10.3390/ijerph17145222

20. Ji Y, Shi Y, Zhou J, Li X, Qin R, Zhu Q : Analysis on the change of college students' life pattern and its impact during the COVID-19 outbreak in China. Am J Health Behav 46 : 218-230, 2022. doi : 10.5993/AJHB.46.3.2

21. Faul F, Erdfelder E, Lang AG, Buchner A : G*Power 3 : A

flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods 39 : 175-191, 2007. doi:10.3758/bf03193146

22. Stoehr F, Müller L, Brady A, Trilla A, Mähringer-Kunz A, Hahn F, Düber C, Becker N, Wörns MA, Chapiro J, Hinrichs JB : How COVID-19 kick-started online learning in medical education—the DigiMed study. PLoS One 16 : e0257394, 2021. doi : 10.1371/journal.pone.0257394

23. Tayem YI, Almarabheh AJ, Abo Hamza E, Deifalla A : Perceptions of medical students on distance learning during the COVID-19 pandemic- a cross-sectional study from Bahrain. Adv Med Educ Pract 13 : 345-354, 2022. doi : 10.2147/AMEP.S357335

24. Kim JW, Myung SJ, Yoon HB, Moon SH, Ryu H, Yim JJ : How medical education survives and evolves during COVID-19 : our experience and future direction. PLoS One 15 : e0243958, 2020. doi : 10.1371/journal.pone.0243958

25. Ibrahim NK, Al Raddadi R, AlDarmasi M, Al Ghamdi A, Gaddoury M, AlBar HM, Ramadan IK : Medical students' acceptance and perceptions of e-learning during the Covid-19 closure time in King Abdulaziz University, Jeddah. J Infect Public Health 14 : 17-23, 2021. doi : 10.1016/j.jiph.2020.11.007

26. AlQhtani A, AlSwedan N, Almulhim A, Aladwan R, Alessa Y, AlQhtani K, Albogami M, Altwairqi K, Alotaibi F, AlHadlaq A, Aldhafian O : Online versus classroom teaching for medical students during COVID-19 : measuring effectiveness and satisfaction. BMC Med Educ 21 : 452, 2021. doi : 10.1186/s12909-021-02888-1