Undergraduate Students' Learning Outside of Class Time during the COVID-19 Pandemic in Japan: The impact of online education

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Abstract. Self-learning outside of class is an essential part of Japanese university education. With the drastic changes to university classes due to the COVID-19 pandemic, self-learning became all the more important. In this study, we used surveys to investigate the changes in self-learning from 2019 to 2020, as reported by 5,861 third-year students at 15 universities from June to July 2020. We examined many fields of study and analyzed students' responses based on their learning habits in high school and university, employment, and class type (on-demand, live, and hybrid). The results showed that differences in self-learning habits were reinforced between 2019 and 2020. Moreover, the amount of self-learning varied greatly depending on the field of study and type of class. Self-learning was highest in the on-demand, live, and hybrid classes, respectively, among students in the humanities, social sciences, and health sciences etc. Our results suggest the need to consider effective class methods and class types for a given specialization to promote students' self-learning when remote education is required.

Keywords: COVID-19 Pandemic, hybrid-class, learning time, live-class, on-demand-class, undergraduate student

Introduction

Self-learning outside the classroom is important for undergraduate students in Japan, primarily because Japanese universities have a foundation of self-led learning. Japanese universities stipulate that a single unit subject consists of 45 hours of total learning, both inside and outside of class. There are also many two-unit university subjects. Two-unit subjects have a total learning time of 90 hours.

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Given that weekly in-class meeting time is only two hours, in-class learning for a 15-week term totals 30 hours, leaving 60 hours of self-learning outside of class per term. Therefore, dividing these 60 hours equally across 15 weeks, students must undertake four hours of self-learning outside class each week.

Insufficient student learning at Japanese universities has long been a topic of discussion. Numerous studies have clearly shown that in many cases, class learning time itself is sufficient for students, but issues remain with a lack of self-led learning outside of class. One such study, the Nationwide University Student Survey (2019)[1], found that even if a student's class learning time increased to 28.6 hours per week, self-learning outside of class still did not exceed six hours per week. Another important reason for students to undertake self-learning outside of class is that it leads to gaining appropriate knowledge and skills. According to Miyoshi (2015), students felt that they gained knowledge and skills from their classes because of their engagement with serious learning activities including both participation in classes and actively engaging in self-learning outside of class.

The COVID-19 pandemic has resulted in a situation where many universities are forced to implement online education as a "new educational style," often using online conferencing applications like Zoom or Microsoft Teams to do so. Accompanying this development, self-learning outside of class is also being employed as a "new learning style," which is required for students. "Online education" refers to education and learning provided via online networks (Robison & Ikeda, 2002) and can take three forms: (1) "live classes," where lectures are delivered in real-time, and the class advances as the faculty and students exchange opinions; (2) "on-demand classes," where tasks are provided and question-and-answer sessions are conducted online while students study using lecture-style videos and/or other learning materials; and (3) "hybrid classes," which combine the positive qualities of both these methods. Moreover, more tasks exist within online education than in the regular university setting before the pandemic. According to the "Questionnaire on Online Education" conducted by Kansai University in 2020, many students completed five or more reports per week, especially in on-demand classes.

Given this background, this study sought to verify the effect of online education on the amount of time spent self-learning outside of class by undergraduate students in Japan during the COVID-19 pandemic. Comparing the data with pre-COVID-19 pandemic data allowed us to clarify how time spent self-learning outside of class changed due to the adoption of online education, across different disciplines. This comparison elucidates which of the three types of online learning were the most and least influenced. The results could be used to show faculty the most effective strategies to use when employing online learning to establish learning habits, such as preparation and review related to the class. This could also help faculty decide which type of online learning should be used and which kinds of class experiences are desirable.

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[1] The University of Tokyo, The Center for Research on University Management and Policy (http://ump.p.u-tokyo.ac.jp/crump/cat77/cat82/22018.htm).

Literature review

Much research has been conducted on the primary factors promoting self-learning outside of class by undergraduate students in Japan. Kuzuki (2007) and Fujimura (2013), who conducted research at a private social science university in a regional city, found that the amount of self-learning undertaken outside of class after entering the university was affected by how students spent their time in high school when studying for tests. Hirao (2009), who conducted research at a private comprehensive university, described how part-time work outside the university reduced students' self-learning outside of class time. The same study found that part-time work within the university increased the amount of time students spent self-learning outside of class. Morozumi (2009) and Tanimura (2009) conducted research in economics and engineering departments and used the Nationwide University Student Survey data. They explained that in economics departments, classes that considered the situation of the students and used devices to make it easier to effectively understand subsequently increased student interest in the subject. Conversely, in engineering departments, interim task-type classes, classes that included group work, and classes that asked students to provide their thoughts and opinions were effective. Furthermore, Jiang (2010), who conducted interviews with students who had attended psychology classes at one university, found that increasing the level of class content covered while assigning homework and tasks was effective in promoting self-learning outside of class. Suzuki and Yasuoka (2007) similarly found that it was effective to assign highly difficult homework present in large quantities, as this caused students to both preview and review class content. Kaneko (2013) indicated the effectiveness of stationing TAs in improving education effectiveness and efficiency. Finally, Kawai and Mizokami (2012) pointed out the need for a community that conducts self-learning outside of class and allows for relationship building with others.

However, all the previous research concerning self-learning outside of class through face-to-face education was conducted prior to the COVID-19 pandemic. According to recent research by Latipah et al. (2020), who also used data collected prior to the COVID-19 pandemic, self-learning outside of class is influenced by parental involvement, peer support, and the perception of faculty agreeableness. Papadakis et al. (2019) explained that parental involvement is the role parents play as a form of control over their children's self-learning outside of class. Strandbu et al. (2019) divided parental involvement into subtypes. Lowe and Dotterer (2018) and Mayer et al. (2019) found that the form of parental involvement ranged from parents communicating with their children two to three times per week to parents who visited their children one to two times per semester. According to Ferrer-Cascales et al. (2019) and Nesi et al. (2018), peer assistance could help or benefit many children by increasing the amount of self-learning undertaken outside of class. Moreover, faculty with agreeable personalities improved students' drive to self-learn outside of class (Babar & Tahir, 2020; Sletten, 2017). Furthermore, according to recent research by Miyoshi (2021), self-learning outside class in COVID-19 pandemic is longer than before. However, Miyoshi's research only clarified the situation of

undergraduate students' self-learning outside class but did not verify the causes of it.

Self-learning outside class changed significantly during online education during the COVID-19 pandemic. This has occurred in the form of an increase in tasks provided as well as the amount of class content that was previewed and reviewed. In online education, faculty ask students for more tasks because they do not have face-to-face education. The number of tasks in on-demand classes is particularly high (Kansai University, 2020). According to the research by Ishibashi et al. (2021), on-demand classes are basically left to student's discretion to take classes at a time that is convenient for them. As a result of the student's autonomy, it has been clarified that faculty tend to give many tasks. Therefore, this study tested the hypothesis that, "it is possible that students who mostly attend on-demand classes conduct more self-learning outside class than students in other forms of education." Another hypothesis in this study concerned class experiences with each of the three types of online learning. Previous research has examined class experiences in face-to-face education prior to the COVID-19 pandemic (Ogata, 2015). However, there is a need for research on class experiences in each form of online education in recognition of the adoption of various forms of online learning in response to the COVID-19 pandemic. In each type of online learning, students and faculty do not directly face each other, necessitating new class devices and strategies. For on-demand classes there is a need to conduct more material preparation prior to class. Similarly, there is a need to clearly convey class procedures ahead of time, as there is no real-time contact between students and faculty. As a result, if students take a class following a clear explanation of the class plan, they will be more motivated to take the class and will conduct more self-learning outside of class. Therefore, this study examined the hypothesis that "it is possible that students, specifically those with class experiences in which faculties adequately provide explanations concerning how to progress through class objectives, will conduct more self-learning outside of class when taking on-demand classes."

Research methods

Dataset before the COVID-19 pandemic

In this study, we considered this hypothesis by comparing recent data with the dataset before the COVID-19 pandemic. Regarding the dataset from before the COVID-19 pandemic, the survey's targets were 15 universities for which survey cooperation was obtained, out of 80 public and private universities located throughout Japan to which the request was sent. The original 80 universities were selected at random from a list of all members of Japan's national, public, private universities associations.[2] An online survey was implemented over a two-month period, running from 1 June to 31

[2] The Japan Association of National Universities, List of Nationwide Member Universities (https://www.janu.jp/univ/gaiyou/files/20200207-pkisoshiryo-japanese.pdf); The Japan Association of Public Universities

July 2019. The online survey targeted second-year humanities, social science, physical sciences, engineering, agriculture, health science, home economics, and fine arts students from these 15 universities. A URL providing online access to the survey was distributed to 16,875 students and subsequently collected from 9,672 students: humanities, 1,289 students; social sciences, 1,689 students; physical sciences, 1,524 students; engineering, 1,921 students; agriculture, 1,011 students; health sciences, 1,529 students; home economics, 312 students; fine arts, 397 students. The response rate was 57%. The survey items are presented in Table 1.

Table 1. The items in the survey

Item	
Field of Specialization	"What is your field of specialization?" (1 = Humanities, 2 = Social Sciences, 3 = Physical Sciences, 4 = Engineering, 5 = Agriculture, 6 = Health Sciences, 7 = Home Economics, 8 = Fine Arts)
Learning Circumstances prior to COVID–19 Pandemic	
Academic Performance	"How is your average academic performance (GPA)?" (1 = Not–passable (D), 2 = Passable (C), 3 = Good (B), 4 = Great (A), 5 = Superior (S))
Out–of–class Learning Time	"How many hours of out-of-class learning do you conduct during the term?" (1 = Conduct no out-of-class learning whatsoever, 2 = Conduct 1–5 hours of learning per week, 3 = Conduct 6–10 hours of learning per week, 4 = Conduct 11–15 hours of learning per week, 5 = Conduct 16–20 hours of learning per week, 6 = Conduct more than 21 hours of learning per week)
Current State of Learning during the COVID–19 Pandemic	
Out–of–class Learning Time	"How many hours of out–of–class learning do you conduct among the most online education forms you take during the term?" (1 = Conduct no out–of–class learning whatsoever, 2 = Conduct 1–5 hours of learning per week, 3 = Conduct 6–10 hours of learning per week, 4 = Conduct 11–15 hours of learning per week, 5 = Conduct 16–20 hours of learning per week, 6 = Conduct more than 21 hours of learning per week)
Presence/Lack of Online Class to Attend	Are you currently attending online classes? (1 = Attending, 2 = Not Attending)
Online Education Forms	"Among your currently–attended online classes, what is the most common class type?" (1 = Live Classes, 2 = On-Demand Classes, 3 = Hybrid Classes)
Class Experiences	"How useful are the following class methods in online classes for deepening learning?" (1 = The faculty possesses sufficient knowledge concerning the class content, 2 = The faculty proactively participates in class administration, 3 = Appropriate feedback regarding tasks and tests are conducted by the faculty, 4 = The class teaching materials bare logical and deepen student understanding, 5 = Adequate explanation is carried out regarding class objectives and procedures Regarding these, there are four stages from "useful" to "not useful"
Part–time Work Hours within University	"How many hours at a part-time job inside the university do you work per term?" (1 = None, 2 = 1–5 hours per week, 3 = 6–10 hours per week, 4 = 11–15 hours per week, 5 = 6–20 hours per week, 6 = 21 or more hours per week)
Part–time Work Hours outside University	"How many hours at a part-time job outside the university do you work per term?" (1 = None, 2 = 1–5 hours per week, 3 = 6–10 hours per week, 4 = 11–15 hours per week, 5 = 6–20 hours per week, 6 = 21 or more hours per week)
Parental Involvement	"How often do you communicate with your parents per week?" (1 = None, 2 = 1 time, 3 = 2 times, 4 = 3 times, 5 = 4 times, 6 = More than 5 times)
Peer Support	"How often do you work with your friends on homework per week?" (1 = None, 2 = 1 time, 3 = 2 times, 4 = 3 times, 5 = 4 times, 6 = More than 5 times)

This study was based on the National University Student Survey (2019). It assumed that the actual learning situation would differ depending on the student's specialization; therefore, analyses were conducted within each specialization. The scope of analysis in this research was 5,861 students (humanities: 721 students, social science: 959 students, physical sciences: 791 students, engineering: 1,341 students, agriculture: 734 students, health sciences: 901 students, home economics: 191 students,

(http: //www.kodaikyo.org/?page_id=718); the Association of Private Universities of Japan (https://www.shidaikyo.or.jp/apuji/member/).

fine arts: 223 students) who cooperated with both the "Before COVID-19 Pandemic" survey and "During COVID-19 Pandemic" survey.

Dataset during the COVID-19 pandemic

Regarding the dataset from during the COVID-19 pandemic, we conducted an online survey of students who cooperated with the "Before the COVID-19 Pandemic" survey and were actively attending online classes during the COVID-19 pandemic between June 1 and July 31, 2020. We distributed the URL to 9,672 students. This allowed them to access the survey. We received valid responses from 5,861 students (the breakdown of the samples in the specialization is as shown in the previous paragraph). The response rate in the second survey was 61%.

Results and discussions

Learning conditions before the COVID-19 pandemic outbreak

Table 2. Self-learning outside class time before the COVID-19 pandemic

	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts	ANOVA
Conducted no out-of-class learning whatsoever	43.7% (1375)	51.3% (232)	52.3% (244)	43.9% (203)	42.7% (223)	41.9% (206)	30.0% (139)	43.9% (45)	43.6% (83)	(8, 38)=21.62, p<.001
Conducted 1 - 5 hours of learning per week	21.8% (672)	22.3% (101)	23.7% (111)	21.1% (98)	20.9% (109)	20.1% (99)	17.7% (82)	22.6% (23)	25.9% (49)	(8, 38)=20.52, p<.001
Conducted 6 - 10 hours of learning per week	14.2% (453)	14.5% (66)	13.2% (62)	17.7% (82)	13.1% (68)	12.9% (63)	15.7% (73)	13.3% (14)	12.9% (25)	(8, 38)=19.11, p<.001
Conducted 11 - 15 hours of learning per week	7.5% (236)	6.1% (28)	5.9% (28)	7.1% (33)	7.6% (40)	7.9% (39)	9.9% (46)	7.6% (8)	7.5% (14)	(8, 38)=18.33, p<.001
Conducted 16 - 20 hours of learning per week	5.9% (183)	3.2% (14)	2.9% (14)	3.8% (18)	8.2% (43)	9.3% (46)	5.8% (27)	7.2% (7)	7.1% (14)	(8, 38)=17.21, p<.001
Conducted more than 21 hours of learning per week	6.9% (235)	2.6% (11)	2.0% (8)	6.4% (29)	7.5% (39)	7.9% (39)	20.9% (97)	5.4% (6)	3.0% (6)	(8, 38)=16.78, p<.001

Note: Brackets denote n values, F (degrees of freedom between groups, degrees of freedom within groups).

When looking at learning conditions prior to the emergence of COVID-19, there were many students with superior (S) academic performance in agriculture: All: 11.6%, 368 students; humanities: 11.5%, 52 students; social sciences: 12.3%, 57 students; physical sciences: 10.9%, 50 students; engineering: 11.1%, 58 students; agriculture: 15.2%, 73 students; health sciences: 9.8%, 45 students; home economics: 10.1%, 10 students; fine arts: 11.9%, 23 students. We found many students with an academic performance of fail (D) in engineering: All: 6.8%, 215 students; humanities: 5.2%, 24 students; social sciences: 5.9%, 28 students; physical sciences: 6.1%, 28 students; engineering: 9.8%, 51 students; agriculture: 6.2%, 31 students; health sciences: 6.9%, 32 students; home economics: 7.1%, 7 students; fine arts: 7.3%, 14 students.

Table 2 indicates the amount of time spent self-learning outside of class before the COVID-19 pandemic. The table shows that, across all specializations, the most popular response was that students did not conduct any self-learning outside of class. However, this was particularly true in the humanities and social sciences. In contrast, in the health sciences, there were many students conducting self-learning outside of class for 21 or more hours per week. Thus, many students spent a large amount of self-learning outside the class before the pandemic. Table 2 shows multiple ANOVA

comparisons performed using Tukey to analyze the influence of specialization on the amount of self-learning undertaken outside of class prior to the COVID-19 pandemic. The results showed a significant difference between the humanities and health sciences, as well as between the social sciences and health sciences, for students who do not study outside of class. Therefore, it was reconfirmed that there are many students in the humanities and social sciences who do not study outside of class. On the other hand, there is a significant difference between health sciences and humanities for students who study 21 hours or more per week outside the class. This also confirmed that students who study 21 or more hours per week outside of class tended to be in the health sciences.

Current state of learning during the COVID-19 pandemic

Table 3. Self-learning outside of class time during the COVID-19 pandemic

	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts	ANOVA
Conducted no out-of-class learning whatsoever	24.5% (778)	33.9% (153)	31.3% (146)	23.4% (108)	21.3% (111)	20.9% (103)	19.6% (91)	22.7% (23)	22.5% (43)	(8, 38)=18.12, p<.001
Conducted 1 - 5 hours of learning per week	17.9% (568)	18.3% (83)	19.9% (93)	18.1% (84)	18.5% (97)	18.1% (89)	15.1% (70)	17.5% (18)	18.0% (34)	(8, 38)=15.23, p<.001
Conducted 6 - 10 hours of learning per week	17.5% (547)	15.1% (68)	14.9% (70)	19.9% (92)	19.4% (101)	19.1% (94)	14.3% (66)	17.1% (18)	19.8% (38)	(8, 38)=16.21, p<.001
Conducted 11 - 15 hours of learning per week	17% (527)	11.3% (51)	13.8% (64)	17.1% (79)	19.9% (104)	19% (93)	16.9% (78)	17.5% (18)	20.9% (40)	(8, 38)=15.55, p<.001
Conducted 16 - 20 hours of learning per week	12.9% (392)	11.1% (50)	10.7% (50)	11.8% (55)	10.8% (56)	10.9% (54)	18.3% (85)	15.9% (16)	13.8% (26)	(8, 38)=12.01, p<.001
Conducted more than 21 hours of learning per week	10.2% (340)	10.3% (47)	9.4% (44)	9.7% (45)	10.1% (53)	12% (59)	15.8% (72)	9.3% (10)	0.5% (10)	(8, 38)=12.98, p<.001

Note: Brackets denote n values, F (degrees of freedom between groups, degrees of freedom within groups).

Table 4. Increase/decrease in self-learning outside class from before/during pandemic

	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts
Non-learners	-19.2	-17.4	-21.0	-20.5	-21.4	-21.0	-10.4	-21.2	-21.1
Short-period Learners	-3.9	-4.0	-3.8	-3.0	-2.4	-2.0	-2.6	-5.1	-7.9
Mid-period Learners	12.8	5.8	9.6	12.2	18.6	17.3	5.6	13.7	20.3
Long-period Learners	10.3	15.6	15.2	11.3	5.2	5.7	7.4	12.6	4.2

Table 3 shows the amount of time spent self-learning outside of class during the COVID-19 pandemic. The table shows that many humanities students still did not conduct any self-learning outside of class. In contrast, the percentage of health sciences students who spent 21 or more hours on self-learning outside of class per week remained unchanged.

In Table 3, ANOVA multiple comparisons using Tukey were also performed to analyze the influence of specialization on self-learning outside of class time during the COVID-19 pandemic. The results showed a significant difference between the number of humanities and health sciences students who did not study outside of class. Therefore, it was reconfirmed that there were many students in the humanities who did not study outside of class. The results also showed that there was a significant difference between the number of health sciences and fine arts students who studied 21 or more hours per week outside of class. Moreover, it was reconfirmed that students who studied 21 or more hours per week outside of class were more concentrated in the health sciences than other specializations.

We examined the increases and decreases in self-learning outside of class time before and during the COVID-19 pandemic. Table 4 shows the respective fluctuations (increase/decrease) in the student

ratio, with learners divided into the four subcategories of "non-learners," defined as students who did not conduct self-learning outside class at all; "short-period learners," defined as students who conducted 1–5 hours of self-learning outside class per week; "mid-period learners," defined as students who conducted either 6–10 or 11–15 hours of self-learning outside class per week; and "long-period learners," defined as students who conducted either 16–20 or 21 or more hours of self-learning outside class per week.

From Table 4, we can see that there was a decrease in non-learners to all specializations and an increase in long-period learners during the COVID-19 pandemic. This tendency was particularly visible in the humanities and social sciences. Given this background, we believe that face-to-face education at universities prior to the COVID-19 pandemic might have been class-focused and based on passive learning, like education seen in high school and lower levels. However, with online education during the COVID-19 pandemic, even if the class-focused nature of the classes remains, current circumstances require students to individually conduct active learning outside of class, such as content preview and review. Specifically, regarding the high levels in the humanities and social sciences, while there were simply many non-learners present in face-to-face education before the COVID-19 pandemic, educational technology and strategies were applied to turn the COVID-19 pandemic into an opportunity to move toward active learning.

However, Table 4 only shows fluctuations for each learner ratio. It does not show how the learners' pre-pandemic learning habits developed during the pandemic. Accordingly, Table 5 shows the distribution of each of the 16 learning habit transition types, adapted from Tanimura (2009) and Miyoshi (2011), who analyzed learning times. Based on Tanimura's typology, we categorized the learning habit transitions from the third year in high school to after entering university (based on the two core divisions of "non-learners" and "learners") into four types: "non-learning habit maintenance type (third year in high school, non-learner × after entering university, non-learner)"; "learning habit acquisition type (non-learner × learner)"; "learning habit disappearance type (learner × non-learner)"; and "learning habit maintenance type (learner × learner)."

Additionally, Miyoshi's types revised these classifications to include the three core divisions of "non-learners," "short-period learners," and "long-period learners" in the third year of high school. As can be seen from the 16 learning habit transition types shown in Table 5 and the distribution shown in Table 6, except for the health sciences, the mid-term learning habit acquisition type, long-term learning habit acquisition type, and short-term learning habit acquisition type became more numerous. Additionally, this ratio was particularly high in the health and social sciences. Table 6 shows the results of multiple ANOVA comparisons using Tukey to analyze the influence of specialization on this learning habit transition type. The results showed a significant difference in health sciences and fine arts, social science, and fine arts for students with the mid-period learning habit acquisition type, long-period learning habit acquisition type, and short-period learning habit acquisition type. Therefore, it was reconfirmed that there were many students in health science and social science who fell into these

learning habit transition types. Before the COVID-19 pandemic, health sciences clinical training and learning were conducted through face-to-face education. However, after the COVID-19 pandemic began and with the adoption of live classes, many discrepancies resulted from differences in learning styles. This might be a possible explanation for the high ratios. Additionally, education samples for the social sciences have also grown more numerous (298). However, in education prior to the COVID-19 pandemic, nursing and teaching practice for acquiring elementary, middle, and high school teaching licenses were conducted in person. During the COVID-19 pandemic, live classes conducted by universities were accepted as alternative academic units for said practice as an exceptional measure. This seemed to have an effect.

Table 5. Sixteen learning habit transition types

Prior to COVID-19 Outbreak	During COVID-19 Pandemic	16 Types of Learning Habit Transitions
Non-learners	Non-learners	Non-learning Habit Maintenance Type
	Short-period Learners	Short-period Learning Habit Acquisition Type
	Mid-period Learners	Mid-period Learning Habit Acquisition Type
	Long-period Learners	Long-period Learning Habit Acquisition Type
Short-period Learners	Non-learners	Short-period Learning Habit Disappearance Type
	Short-period Learners	Short-period Learning Habit Maintenance Type
	Mid-period Learners	Short-to-Mid-period Learning Habit Acquisition Type
	Long-period Learners	Short-to-Long-period Learning Habit Acquisition Type
Mid-period Learners	Non-learners	Mid-period Learning Habit Disappearance Type
	Short-period Learners	Mid-to-Short-period Learning Habit Decline Type
	Mid-period Learners	Mid-period Learning Habit Maintenance Type
	Long-period Learners	Mid-to-Long-period Learning Habit Acquisition Type
Long-period Learners	Non-learners	Long-period Learning Habit Disappearance Type
	Short-period Learners	Long-to-Short-period Learning Habit Decline Type
	Mid-period Learners	Long-to-Mid-period Learning Habit Decline Type
	Long-period Learners	Long-period Learning Habit Maintenance Type

Table 6. Distribution of sixteen learning habit transition types

	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts	ANOVA
Non-learning Habit Maintenance Type	10.9% (558)	15.8% (98)	9.1%(74)	12.3%(97)	11.2%(150)	7.9%(58)	5.5%(50)	11.1%(21)	14%(10)	(8, 52)=32.12, p<.001
Short-period Learning Habit Acquisition Type	25.6% (1331)	23.3%(148)	29.1%(239)	24.5%(190)	25.5%(242)	26.9%(157)	29.3%(264)	23.1%(40)	22.7%(51)	(8, 52)=39.07, p<.001
Mid-period Learning Habit Acquisition Type	24.9% (1298)	22.2%(140)	28.7%(235)	23.4%(185)	24.9%(234)	26.1%(152)	30.2%(271)	22.1%(32)	21.9%(49)	(8, 52)=38.71, p<.001
Long-period Learning Habit Acquisition Type	22.3% (1203)	20.1%(125)	24.2%(212)	20.3%(161)	20.7%(228)	21.2%(136)	29.1%(262)	21.9%(32)	21.2%(47)	(8, 52)=36.21, p<.001
Short-period Learning Habit Disappearance Type	5% (262)	0.9%(45)	0.8%(57)	0.5%(40)	0.4%(54)	0.3%(22)	0.1%(9)	0.9%(17)	0.8%(18)	(8, 52)=17.12, p<.001
Short-period Learning Habit Maintenance Type	5.1% (606)	16.5%(99)	6.9%(46)	17.1%(135)	15.2%(153)	15.9%(85)	3.2%(29)	19.8%(28)	18.6%(31)	(8, 52)=25.33, p<.001
Short-to-Mid-period Learning Habit Acquisition Type	0.5% (250)	0.8%(38)	0.7%(47)	0.6%(47)	0.5%(67)	0.3%(22)	0.1%(9)	0.6%(11)	0.4%(9)	(8, 52)=17.19, p<.001
Short-to-Long-period Learning Habit Acquisition Type	2.8% (181)	0.1%(7)	0.2%(19)	0.3%(24)	0.3%(40)	0.3%(22)	0.7%(63)	0.2%(4)	0.1%(2)	(8, 52)=17.11, p<.001
Mid-period Learning Habit Disappearance Type	2.1% (140)	0.1%(7)	0.1%(10)	0.2%(16)	0.2%(27)	0.3%(22)	0.6%(54)	0.1%(2)	0.1%(2)	(8, 52)=16.29, p<.001
Mid-to-Short-period Learning Habit Decline Type	0.2% (136)	0.1%(7)	0.1%(10)	0.3%(24)	0.3%(40)	0.2%(15)	0.4%(36)	0.1%(2)	0.1%(2)	(8, 52)=15.33, p<.001
Mid-period Learning Habit Maintenance Type	0.1% (94)	0.1%(7)	0.1%(10)	0.1%(8)	0.3%(40)	0.1%(7)	0.2%(18)	0.1%(2)	0.1%(2)	(8, 52)=14.98, p<.001
Mid-to-Long-period Learning Habit Acquisition Type	0.1% (9)	0%(0)	0%(0)	0%(0)	0%(0)	0%(0)	0.1%(9)	0%(0)	0%(0)	F (8, 52)=2.34, p<.001
Long-period Learning Habit Disappearance Type	0.1% (22)	0%(0)	0%(0)	0%(0)	0.1%(13)	0%(0)	0.1%(9)	0%(0)	0%(0)	F (8, 52)=2.32, p<.001
Long-to-Short-period Learning Habit Decline Type	0.1% (101)	0%(0)	0%(0)	0.2%(16)	0.2%(27)	0.3%(22)	0.4(36)	0%(0)	0%(0)	F (8, 52)=3.19, p<.001
Long-to-Mid-period Learning Habit Decline Type	0.1% (28)	0%(0)	0%(0)	0.1%(8)	0.1%(13)	0.1%(7)	0%(0)	0%(0)	0%(0)	F (8, 52)=2.18, p<.001
Long-period Learning Habit Maintenance Type	0.1% (28)	0%(0)	0%(0)	0.1%(8)	0.1%(13)	0.1%(7)	0%(0)	0%(0)	0%(0)	F (8, 52)=2.18, p<.001

Note: Brackets denote *n* values, F (degrees of freedom between groups, degrees of freedom within groups).

Relationships between online education forms and self-learning outside class

Table 7 shows the relationship between online education forms and self-learning outside class during the COVID-19 pandemic. The table shows that self-learning outside of class time differed according to the form of online education the students attended and by specialization. First, in the humanities, most

students who attended on-demand classes spent 11–21 hours more self-learning outside of class per week. Multiple ANOVA comparisons using Tukey show a significant difference in humanities and fine arts for the students who studied 11–21 hours more of self-learning outside class per week. This reconfirmed that there were many students in humanities who attended on-demand classes and spent 11–21 hours or more self-learning outside class every week.

Table 7. Relationship between self-learning outside class and online education forms during the COVID-19 pandemic

	On-demand Classes									
	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts	ANOVA
Conducted no out-of-class learning whatsoever	3.1% (70)	0.6% (3)	6.3% (29)	1.4% (6)	1.2% (6)	0.5% (2)	0.2% (1)	4.2% (4)	10.1% (19)	(8, 38)=12.52, p<.001
Conducted 1 - 5 hours of learning per week	9.8% (270)	3.8% (17)	7.3% (34)	9.8% (45)	9.9% (52)	6.7% (33)	6.9% (32)	9.3% (10)	24.4% (47)	(8, 38)=15.33, p<.001
Conducted 6 - 10 hours of learning per week	27.2% (871)	9.3% (42)	34.3% (160)	32.3% (150)	31.8% (166)	33.7% (166)	25.2% (116)	31.3% (32)	20.3% (39)	(8, 38)=20.21, p<.001
Conducted 11 - 15 hours of learning per week	25.1% (812)	38.9% (176)	20.1% (94)	22.3% (103)	23.5% (123)	24.9% (123)	28.3% (131)	23.2% (24)	19.7% (38)	(8, 38)=17.51, p<.001
Conducted 16 - 20 hours of learning per week	17.9% (579)	23.2% (105)	16.7% (78)	17.3% (80)	17.1% (89)	17.6% (87)	21.3% (98)	16.9% (17)	13.2% (25)	(8, 38)=15.22, p<.001
Conducted more than 21 hours of learning per week	16.9% (549)	24.2% (109)	15.3% (71)	16.9% (78)	16.5% (86)	16.6% (82)	18.1% (84)	15.1% (16)	12.3% (23)	(8, 38)=15.01, p<.001

	Live Classes									
	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts	ANOVA
Conducted no out-of-class learning whatsoever	4.6% (138)	7.1% (32)	7.2% (34)	4.6% (21)	0.1% (1)	2.2% (11)	4.3% (20)	3.1% (3)	8.2% (16)	(8, 38)=13.21, p<.001
Conducted 1 - 5 hours of learning per week	15.6% (477)	15.2% (69)	9.8% (46)	15.2% (70)	20.1% (105)	19.3% (95)	8.2% (38)	18.3% (19)	18.3% (35)	(8, 38)=15.42, p<.001
Conducted 6 - 10 hours of learning per week	19.5% (597)	26.3% (119)	10.1% (47)	24.8% (115)	21.1% (110)	20.3% (100)	9.2% (43)	24.5% (25)	19.9% (38)	(8, 38)=22.31, p<.001
Conducted 11 - 15 hours of learning per week	19.4% (601)	21.9% (99)	10.9% (51)	23.9% (111)	22.3% (116)	22.4% (110)	11.8% (52)	21.3% (22)	20.7% (40)	(8, 38)=19.11, p<.001
Conducted 16 - 20 hours of learning per week	26% (843)	19.3% (87)	36.7% (171)	20.2% (94)	24.3% (127)	23.9% (118)	39.2% (181)	22.7% (23)	21.8% (42)	(8, 38)=21.99, p<.001
Conducted more than 21 hours of learning per week	14.9% (495)	10.2% (46)	25.3% (118)	11.3% (52)	12.1% (63)	11.9% (59)	27.3% (126)	10.1% (10)	11.1% (21)	(8, 38)=13.21, p<.001

	Hybrid Classes									
	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts	ANOVA
Conducted no out-of-class learning whatsoever	2.9% (89)	5.9% (27)	2.7% (13)	3.0% (14)	1.6% (8)	2.3% (11)	2.2% (10)	4.8% (5)	0.7% (1)	(8, 38)=12.78, p<.001
Conducted 1 - 5 hours of learning per week	6.8% (201)	14.2% (64)	10.3% (48)	3.2% (15)	3.4% (18)	3.6% (18)	3.5% (16)	10.2% (11)	5.8% (11)	(8, 38)=13.19, p<.001
Conducted 6 - 10 hours of learning per week	14.8% (440)	25.3% (114)	26.2% (122)	5.2% (24)	5.3% (28)	5.2% (26)	18.4% (85)	25.9% (27)	7.2% (14)	(8, 38)=19.11, p<.001
Conducted 11 - 15 hours of learning per week	24.8% (785)	21.9% (99)	25.6% (120)	25.6% (119)	25.1% (131)	25.3% (124)	25.9% (120)	24.9% (26)	24.1% (46)	(8, 38)=20.51, p<.001
Conducted 16 - 20 hours of learning per week	29.2% (119)	17.2% (78)	18.7% (87)	37.2% (172)	37.9% (198)	37.7% (185)	31.1% (144)	18.1% (19)	36.1% (69)	(8, 38)=22.38, p<.001
Conducted more than 21 hours of learning per week	21.4% (686)	15.5% (70)	16.5% (77)	25.8% (119)	26.7% (139)	25.9% (127)	18.9% (87)	16.1% (17)	26.1% (50)	(8, 38)=19.22, p<.001

Note: Brackets denote n values, F (degrees of freedom between groups, degrees of freedom within groups).

The findings suggest that self-learning habits are influenced by the online teaching method. For instance, humanities comprise philosophy, history, literature, archaeology, and so on and chiefly use the philological research method, which leads some to believe that on-demand classes are easier to implement in the humanities than in other specializations.[3] On-demand classes require faculty members to conduct more class material preparation before class and clearly convey the class procedures for making up work to students who are not physically present. This is because faculty members must present tasks to students in each class, then provide feedback for these tasks once they have been submitted by students. It is possible that this style of education, where such learning must be carried out, might promote self-learning outside of class time for humanities students.

The social sciences and health sciences students who mostly attended live classes had 16–21 hours more self-learning outside of class hours than in other online education forms. Multiple ANOVA comparisons using Tukey were also performed to analyze the influence of online education forms by specialization on self-learning outside of class time. The results showed a significant

[3] The on-demand class implementation rate was the highest in the humanities: all: 28.9%, 890 students; humanities: 45.1%, 204 students; social sciences: 28.1%, 131 students; physical sciences: 25.2%, 117 students; engineering: 25.3%, 132 students; agriculture: 23.1%, 114 students; health sciences: 21.3%, 98 students; home economics: 30.9%, 32 students; fine arts: 32.3%, 62 students.

difference in social sciences and humanities, health sciences, and humanities for students who studied self-learning outside of class for 16–21 hours per week. Therefore, it was reconfirmed that many students in the social sciences and health sciences who attended on-demand classes spent 16–21 hours more self-learning outside class per week. The "social sciences" consist of specializations such as economics, law, pedagogy, and sociology. Compared to the humanities, they more often apply the empirical method and practical training, as in legal studies, teaching, nursing, and social research; the live-class implementation rate was high: All: 36.3%, 1143 students; humanities: 20.9%, 94 students; social sciences: 40.2%, 188 students; physical sciences: 35.2%, 163 students; engineering: 36.3%, 189 students; agriculture: 37.1%, 183 students; health sciences: 46.9% ,217 students; home economics: 37.2%, 38 students; fine arts: 37.2%, 71 students. The health sciences also used clinical teaching and had a high live-class implementation rate. Given the characteristics of this specialization, live classes with a two-way format, including faculty and student interaction allowed students to work together to cultivate their education and training, resulting in greater self-learning outside class.

In the physical sciences, engineering, agriculture, and fine arts, the students who mostly attended hybrid classes had 11–21 hours more self-learning outside of class times than those in other types of online education. Multiple ANOVA comparisons using Tukey were also performed to analyze the influence of online education forms by specialization on self-learning outside of class time. The results showed a significant difference in physical sciences, engineering, agriculture, health sciences, and humanities for students who studied self-learning outside of class for 11–21 hours per week. Thus, it was reconfirmed that many students in the physical sciences, engineering, agriculture, and health sciences who attended on-demand classes spent 16–21 hours or more self-learning outside class every week. The physical sciences, engineering, agriculture, and fine arts resemble the social sciences and health sciences in having classes requiring blackboard writing and the university's laboratory equipment. However, one difference between the social sciences and health sciences was that the latter involved many classes requiring the use of laboratory equipment, so the students had to physically commute to the university. The implementation rate for hybrid classes increased: All: 34.7%, 1119 students; humanities: 34.0%, 154 students; social sciences: 31.7%, 148 students; physical sciences: 39.6%, 183 students; engineering: 38.4%, 201 students; agriculture: 39.8%, 195 students; health sciences: 31.8%, 147 students; home economics: 31.9%, 33 students; fine arts: 30.5%, 58 students. Hybrid classes included characteristics of both on-demand classes and live classes; thus, many educators believe that they promote student self-learning outside class.

Relationships between class experiences and online education forms

This section describes our examination of the class experiences reflected in the different forms of online education. Table 8 showed the influence of class experiences common to each respective online education form. For live classes, "The faculty possesses sufficient knowledge concerning the class

content," "The faculty proactively participates in class administration," "Appropriate feedback regarding tasks and tests are conducted by the faculty," "The class teaching materials logical and deepen student understanding," are influential in all specializations. It is important for faculty to have sufficient knowledge about the classes in all forms of online education, not just live classes. The results of this analysis suggest that the faculty who conducted detailed and thorough class preparation for their classes were important for driving live classes forward, as was maintaining interactivity with the students in the class.

Table 8. Relationship between class experience and online education forms during the COVID-19 pandemic

	On-demand Classes								
	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts
The faculty possesses sufficient knowledge concerning the class content	43.9% (1386)	42.3% (191)	42.9% (200)	43.6% (202)	44.5% (232)	45.1% (222)	45.6% (211)	43.9% (45)	43.5% (83)
The faculty proactively participates in class administration	10.4% (632)	10.2% (73)	11.3% (108)	9.8% (77)	12.3% (164)	11.3% (82)	10.1% (91)	9.2% (17)	9.1% (20)
Appropriate feedback regarding tasks and tests are conducted by the faculty	17.8% (1032)	15.2% (109)	16.3% (156)	15.9% (125)	18.3% (245)	19.1% (140)	20.1% (181)	19.2% (36)	18.3% (40)
The class teaching materials logical and deepen student understanding	20.4% (1231)	19.2% (138)	18.4% (176)	20.1% (158)	22.3% (299)	23.1% (169)	24.1% (217)	18.3% (34)	18.1% (40)
Adequate explanation is carried out regarding class objectives and procedures	44.4% (1401)	43.2% (195)	43.6% (204)	43.9% (203)	45.1% (235)	45.4% (223)	46.1% (213)	44.1% (45)	43.7% (83)

	Live Classes								
	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts
The faculty possesses sufficient knowledge concerning the class content	45.8% (1446)	44.3% (200)	44.6% (208)	45.9% (213)	47.1% (246)	45.9% (226)	47.2% (218)	45.2% (47)	46.3% (88)
The faculty proactively participates in class administration	44.9% (1405)	43.4% (196)	44.5% (208)	46.7% (216)	46.9% (245)	45.1% (211)	45.5% (201)	44.3% (46)	42.9% (82)
Appropriate feedback regarding tasks and tests are conducted by the faculty	44.2% (1397)	42.6% (193)	43.2% (202)	45.2% (209)	45.3% (236)	44.9% (221)	45.1% (208)	43.2% (44)	44.1% (84)
The class teaching materials logical and deepen student understanding	44.5% (1409)	42.9% (194)	43.9% (205)	45.9% (213)	45.7% (239)	44.9% (221)	45.3% (209)	43.9% (45)	43.2% (83)
Adequate explanation is carried out regarding class objectives and procedures	22.3% (1322)	20.1% (144)	22.3% (213)	24.5% (193)	23.1% (309)	22.1% (162)	23.8% (214)	22.1% (42)	20.3% (45)

	Hybrid Classes								
	All	Humanities	Social Sciences	Physical Sciences	Engineering	Agriculture	Health Sciences	Home Economics	Fine Arts
The faculty possesses sufficient knowledge concerning the class content	44.5% (1404)	43.9% (198)	44.1% (206)	44.9% (208)	44.9% (234)	44.7% (220)	45.1% (208)	44.2% (46)	44.1% (84)
The faculty proactively participates in class administration	28.4% (1645)	25.2% (181)	26.3% (252)	27.2% (215)	28.9% (387)	30.1% (220)	29.8% (268)	30.1% (57)	29.2% (65)
Appropriate feedback regarding tasks and tests are conducted by the faculty	26.6% (1491)	21.3% (153)	21.5% (206)	23.2% (183)	24.1% (323)	31.2% (229)	30.1% (271)	31.3% (59)	30.1% (67)
The class teaching materials logical and deepen student understanding	20.1% (1186)	20.1% (144)	20.3% (194)	20.5% (162)	20.7% (277)	20.3% (149)	20.1% (181)	19.4% (37)	19.1% (42)
Adequate explanation is carried out regarding class objectives and procedures	44.2% (1396)	43.7% (198)	43.8% (205)	44.6% (206)	44.7% (233)	44.5% (219)	44.7% (207)	43.9% (45)	43.7% (83)

Note: The values in this table included totals of the affirmative assessments "useful" and "somewhat useful."

For on-demand classes, "The faculty possesses sufficient knowledge concerning the class content," "Adequate explanation is carried out regarding class objectives and procedures," continue to be influential in all specializations. As mentioned before, it is important that faculty have sufficient knowledge about the class in all online education, not limited to on-demand classes. As on-demand classes require pre-class material preparation, clear class procedures, and progress through the class to make up for students not being physically present, these are likely to be effective.

For hybrid classes, "The faculty possesses sufficient knowledge concerning the class content," "Adequate explanation is carried out regarding class objectives and procedures," are affected in all specializations. The hybrid classes had a mix of features of both live and on-demand classes, and the attitude that the faculty took when facing the class was essential, as was clarity concerning class configuration; these kinds of class experiences are thought to be particularly valuable here.

Primary factors regulating self-learning outside class during the COVID-19 pandemic and examination of effective class experiences affecting online education forms

Table 9. Primary factors regulating self-learning outside class during the COVID-19 pandemic

	All Standardized Coefficient (β)	Humanities Standardized Coefficient (β)	Social Sciences Standardized Coefficient (β)	Physical Sciences Standardized Coefficient (β)	Engineering Standardized Coefficient (β)
Learning Circumstances prior to COVID-19 Pandemic					
Academic Performance	0.17	0.13	0.14	0.18	0.19
Short-period Learners	-0.27 **	-0.24 **	-0.25 **	-0.28 **	-0.29 **
Mid-period Learners	0.25 *	0.26 *	0.27 *	0.29 *	0.31 **
Long-period Learners	0.32 **	0.31 **	0.33 **	0.35 **	0.36 **
Current State of Learning during COVID-19 Pandemic					
Part-time Work Hours within University	0.14	0.15	0.11	0.12	0.15
Part-time Work Hours outside University	-0.25 **	-0.23 **	-0.24 **	-0.26 **	-0.27 **
Parental Involvement	0.12	0.12	0.12	0.13	0.14
Peer Support	0.13	0.13	0.12	0.14	0.15
Online Education Forms during COVID-19 Pandemic					
On-demand Classes	0.27 **	0.32 **	0.25	0.27	0.28
Live Classes	0.27	0.25	0.36 **	0.28	0.28
Hybrid Classes	0.31	0.27	0.26	0.36 **	0.37 **
Class Experiences					
The faculty possesses sufficient knowledge concerning the class content	0.38	0.34	0.35	0.36	0.37
The faculty proactively participates in class administration	0.33	0.31	0.32	0.33	0.34
Appropriate feedback regarding tasks and tests are conducted by the faculty	0.32	0.29	0.29	0.31	0.32
The class teaching materials logical and deepen student understanding	0.31	0.31	0.32	0.33	0.34
Adequate explanation is carried out regarding class objectives and procedures	0.29	0.28	0.29	0.31	0.32
Adjusted Coefficient of Determination	0.36	0.34	0.36	0.37	0.38
F Value	5.365 **	5.231 **	5.365 **	5.429 **	5.562 **

	Agriculture Standardized Coefficient (β)	Health Sciences Standardized Coefficient (β)	Home Economics Standardized Coefficient (β)	Fine Arts Standardized Coefficient (β)
Learning Circumstances prior to COVID-19 Pandemic				
Academic Performance	0.21	0.23	0.11	0.12
Short-period Learners	-0.27 **	-0.31 **	-0.21 **	-0.19 **
Mid-period Learners	0.29 *	0.33 *	0.22 *	0.21 *
Long-period Learners	0.34 **	0.39 **	0.23 **	0.22 **
Current State of Learning during COVID-19 Pandemic				
Part-time Work Hours within University	0.13	0.16	0.12	0.11
Part-time Work Hours outside University	-0.25 **	-0.28 **	-0.21 **	-0.19 **
Parental Involvement	0.13	0.09	0.08	0.11
Peer Support	0.13	0.15	0.14	0.11
Online Education Forms during COVID-19 Pandemic				
On-demand Classes	0.26	0.29	0.25	0.22
Live Classes	0.27	0.39 **	0.21	0.19
Hybrid Classes	0.38 **	0.38	0.29	0.33 **
Class Experiences				
The faculty possesses sufficient knowledge concerning the class content	0.37	0.39	0.35	0.33
The faculty proactively participates in class administration	0.33	0.34	0.33	0.31
Appropriate feedback regarding tasks and tests are conducted by the faculty	0.31	0.34	0.29	0.29
The class teaching materials logical and deepen student understanding	0.29	0.32	0.28	0.27
Adequate explanation is carried out regarding class objectives and procedures	0.28	0.31	0.26	0.25
Adjusted Coefficient of Determination	0.39	0.39	0.32	0.31
F Value	5.672 **	5.672 **	4.879 **	4.729 **

Note: *$p < 0.05$, **$p < 0.01$. The standard value is nonlearners.

This section describes the effective class experiences affecting each respective online education form, considering the primary factors regulating self-learning outside of class time during the COVID-19 pandemic by all the fields of specialization and each specialization. Table 9 shows the results of multiple regression analysis. The class experiences incorporated in this survey are those about the conditions and ideas for deepening learning. In other words, they are variables “on the education provider side”. Therefore, Table 9 shows the results of uncontrolled multiple regression analysis and Table 10 shows the results of controlled. From Table 9, regarding factors common to all the fields of specializations, statistically significant results could not be obtained for GPA relating to learning circumstances prior to the COVID-19 pandemic or parental involvement and peer support relating to the current state of learning during the COVID-19 pandemic. Additionally, through all the fields of specialization, the shorter students’ self-study was before the COVID-19 pandemic, the less time they spent on self-learning outside class time during the COVID-19 pandemic. Conversely, the students who were mid- or long-period learners before the COVID-19 pandemic spent more time self-learning outside class. The results showed the importance of acquired learning habits compared to simply having been a learner prior to the COVID-19 pandemic.

Regarding students’ current learning circumstances during the COVID-19 pandemic, for all fields of specialization, the more hours students enrolled in university worked at part-time non university jobs, the shorter their self-learning outside class. On the other hand, we found no statistically

Table 10. Primary factors regulating self-learning outside class during the COVID-19 pandemic (controlled the class experiences)

	All Standardized Coefficient (β)	Humanities Standardized Coefficient (β)	Social Sciences Standardized Coefficient (β)	Physical Sciences Standardized Coefficient (β)	Engineering Standardized Coefficient (β)
Learning Circumstances prior to COVID-19 Pandemic					
Academic Performance	0.17	0.13	0.14	0.18	0.19
Short-period Learners	-0.27 **	-0.24 **	-0.25 **	-0.28 **	-0.29 **
Mid-period Learners	0.25 *	0.26 *	0.27 *	0.29 *	0.31 **
Long-period Learners	0.32 **	0.31 **	0.33 **	0.35 **	0.36 **
Current State of Learning during COVID-19 Pandemic					
Part-time Work Hours within University	0.14	0.15	0.11	0.12	0.15
Part-time Work Hours outside University	-0.25 **	-0.23 **	-0.24 **	-0.26 **	-0.27 **
Parental Involvement	0.12	0.12	0.12	0.13	0.14
Peer Support	0.13	0.13	0.12	0.14	0.15
Online Education Forms during COVID-19 Pandemic					
On-demand Classes	0.27 **	0.32 **	0.25	0.27	0.28
Live Classes	0.27	0.25	0.36 **	0.28	0.28
Hybrid Classes	0.31	0.27	0.26	0.36 **	0.37 **
Class Experiences					
The faculty possesses sufficient knowledge concerning the class content					
The faculty proactively participates in class administration					
Appropriate feedback regarding tasks and tests are conducted by the faculty					
The class teaching materials logical and deepen student understanding					
Adequate explanation is carried out regarding class objectives and procedures					
Adjusted Coefficient of Determination	0.35	0.33	0.35	0.36	0.37
F Value	5.355 **	5.211 **	5.355 **	5.419 **	5.552 **

	Agriculture Standardized Coefficient (β)	Health Sciences Standardized Coefficient (β)	Home Economics Standardized Coefficient (β)	Fine Arts Standardized Coefficient (β)
Learning Circumstances prior to COVID-19 Pandemic				
Academic Performance	0.21	0.23	0.11	0.12
Short-period Learners	-0.27 **	-0.31 **	-0.21 **	-0.19
Mid-period Learners	0.29 *	0.33 *	0.22 *	0.21
Long-period Learners	0.34 **	0.39 **	0.23 **	0.22
Current State of Learning during COVID-19 Pandemic				
Part-time Work Hours within University	0.13	0.16	0.12	0.11
Part-time Work Hours outside University	-0.25 **	-0.28 **	-0.21 **	-0.19
Parental Involvement	0.13	0.09	0.08	0.11
Peer Support	0.13	0.15	0.14	0.11
Online Education Forms during COVID-19 Pandemic				
On-demand Classes	0.26	0.29	0.25	0.22
Live Classes	0.27	0.39 **	0.21	0.19
Hybrid Classes	0.38 **	0.38	0.29	0.33
Class Experiences				
The faculty possesses sufficient knowledge concerning the class content				
The faculty proactively participates in class administration				
Appropriate feedback regarding tasks and tests are conducted by the faculty				
The class teaching materials logical and deepen student understanding				
Adequate explanation is carried out regarding class objectives and procedures				
Adjusted Coefficient of Determination	0.38	0.38	0.31	0.29
F Value	5.662 **	5.662 **	4.869 **	4.719 **

Note: *$p < 0.05$, **$p < 0.01$. The standard value is nonlearners.

significant results concerning working hours for part-time jobs within the university. Even when opportunities for part-time jobs external to the university decreased due to the shortened hours of operation under the COVID-19 pandemic, we found significant effects on student learning from the burden of longer work hours at part-time jobs outside the university.

Regarding the forms of online education during the COVID-19 pandemic, the effects differed by specialization. We found significant effects for on-demand classes in the humanities, live classes in the social sciences and health sciences, and hybrid classes in the physical sciences, engineering, agriculture, and fine arts. Thus, our hypothesis that "Students who mostly attend on-demand classes conduct more self-learning outside of class than students in other forms of education" was supported for the humanities. Moreover, regarding the class experience, it was clarified that the class experience did not affect self-learning outside class in all specialized fields. Therefore, no matter what class experience you have in online education, it does not directly encourage self-learning outside class.

Furthermore, Table 10 shows the results of controlled multiple regression analysis. The adjusted coefficient of determination has not changed significantly in all the fields of specializations. In other words, it shows that particularly, online education forms and students' learning circumstances prior to COVID-19 pandemic are more important.

Moreover, Table 11 shows the results of the logistic regression analysis of the class experience in online education and the online education forms. Our examination of the effect of class experiences and regulating respective online education forms revealed that each online education form had a influence was stronger when the students had these class experiences: (1) for live classes, "Appropriate feedback regarding tasks and tests being conducted by the faculty," "The faculty proactively participates in class administration," "The class teaching materials are logical and deepen

Table 11. Primary factors regulating online education forms

On-demand Classes	All Exp (B)	Humanities Exp (B)	Social Sciences Exp (B)	Physical Sciences Exp (B)	Engineering Exp (B)
Class Experiences					
The faculty possesses sufficient knowledge concerning the class content	1.79 **	1.76 **	1.77 *	1.82 **	1.83 **
The faculty proactively participates in class administration	1.45	1.44	1.45	1.47	1.51
Appropriate feedback regarding tasks and tests are conducted by the faculty	1.23	1.21	1.22	1.25	1.26
The class teaching materials logical and deepen student understanding	1.12	1.11	1.13	1.15	1.16
Adequate explanation is carried out regarding class objectives and procedures	1.95 **	1.91 **	1.92 **	1.98 *	1.98 **
Nagelkerke	0.34 **	0.32 **	0.31 **	0.37 **	0.35 **

	Agriculture Exp (B)	Health Sciences Exp (B)	Home Economics Exp (B)	Fine Arts Exp (B)
Class Experiences				
The faculty possesses sufficient knowledge concerning the class content	1.86 **	1.88 *	1.71 **	1.69 *
The faculty proactively participates in class administration	1.53	1.54	1.32	1.29
Appropriate feedback regarding tasks and tests are conducted by the faculty	1.27	1.29	1.19	1.15
The class teaching materials logical and deepen student understanding	1.17	1.19	1.01	1.01
Adequate explanation is carried out regarding class objectives and procedures	1.99 *	1.99 **	1.87 *	1.81 **
Nagelkerke	0.33 **	0.36 **	0.31 **	0.29 **

Live Classes	All Exp (B)	Humanities Exp (B)	Social Sciences Exp (B)	Physical Sciences Exp (B)	Engineering Exp (B)
Class Experiences					
The faculty possesses sufficient knowledge concerning the class content	1.85 **	1.78 **	1.98 **	1.99 **	1.97 **
The faculty proactively participates in class administration	1.91 **	1.67 **	1.88 *	1.91 **	1.92 **
Appropriate feedback regarding tasks and tests are conducted by the faculty	1.84 *	1.55 *	1.79 **	1.89 *	1.91 **
The class teaching materials logical and deepen student understanding	1.77 **	1.43 **	1.66 **	1.71 **	1.89 *
Adequate explanation is carried out regarding class objectives and procedures	1.21	1.11	1.21	1.22	1.25
Nagelkerke	0.32 **	0.31 **	0.29 **	0.36 **	0.34 **

	Agriculture Exp (B)	Health Sciences Exp (B)	Home Economics Exp (B)	Fine Arts Exp (B)
Class Experiences				
The faculty possesses sufficient knowledge concerning the class content	1.98 *	1.99 **	1.61 **	1.59 **
The faculty proactively participates in class administration	1.93 **	1.95 *	1.59 **	1.51 *
Appropriate feedback regarding tasks and tests are conducted by the faculty	1.91 **	1.92 **	1.55 *	1.49 **
The class teaching materials logical and deepen student understanding	1.87 **	1.91 **	1.53 **	1.41 **
Adequate explanation is carried out regarding class objectives and procedures	1.28	1.29	1.21	1.19
Nagelkerke	0.32 **	0.35 **	0.29 **	0.28 **

Hybrid Classes	All Exp (B)	Humanities Exp (B)	Social Sciences Exp (B)	Physical Sciences Exp (B)	Engineering Exp (B)
Class Experiences					
The faculty possesses sufficient knowledge concerning the class content	1.85 **	1.79 **	1.81 **	1.84 **	1.91 **
The faculty proactively participates in class administration	1.74	1.69	1.71	1.73	1.73
Appropriate feedback regarding tasks and tests are conducted by the faculty	1.59	1.56	1.57	1.58	1.58
The faculty proactively participates in class administration	1.53	1.51	1.52	1.53	1.53
Adequate explanation is carried out regarding class objectives and procedures	1.91 **	1.91 **	1.92 **	1.93 **	1.95 **
Nagelkerke	0.35 **	0.34 **	0.36 **	0.31 **	0.29 **

	Agriculture Exp (B)	Health Sciences Exp (B)	Home Economics Exp (B)	Fine Arts Exp (B)
Class Experiences				
The faculty possesses sufficient knowledge concerning the class content	1.91 **	1.92 **	1.21 **	1.19 **
The faculty proactively participates in class administration	1.76	1.78	1.54	1.51
Appropriate feedback regarding tasks and tests are conducted by the faculty	1.59	1.61	1.47	1.42
The faculty proactively participates in class administration	1.55	1.57	1.41	1.38
Adequate explanation is carried out regarding class objectives and procedures	1.95 **	1.99 **	1.33 **	1.29 **
Nagelkerke	0.33 **	0.36 **	0.31 **	0.29 **

Note: *$p < 0.05$, **$p < 0.01$. The standard value is nonlearners.

student understanding," and "The faculty possesses sufficient knowledge concerning the class content"; (2) for on-demand classes, "The faculty possesses sufficient knowledge concerning the class content" and "Adequate explanation is carried out regarding class objectives and procedure"; and (3) for hybrid classes, "The faculty possesses sufficient knowledge concerning the class content" and "Adequate explanation is carried out regarding class objectives and procedure." Consequently, this study's hypothesis that "students with class experiences in which faculties adequately provide explanations on how to progress through class objectives will conduct more self-learning outside of class" was supported for both on-demand and hybrid classes. Therefore, it can be said that the class experience in online education does not directly influence self-learning outside of class, but the class experience indirectly influences though the online education forms.

Conclusion

By focusing on three types of online education, this study sought to determine the primary factors affecting students' self-learning undertaken outside of class during the COVID-19 pandemic. Additionally, we conducted a comprehensive examination of the effectiveness of a variety of class experiences within the three types of online education.

We found that the effectiveness of each form of online education depended on students' specialization. Humanities students who mostly attended on-demand classes spent more time self-learning outside of class. This finding supported the study's first hypothesis. Additionally, regarding the class experiences affecting online education common to all specializations, we found that in on-demand and hybrid classes, students with the class experience of "clarity concerning class configuration" showed greater self-learning outside of class time.

Currently, in the midst of the COVID-19 pandemic, many universities have found themselves in situations where they must conduct remote learning. However, many have realized that they must do so in an informed manner, responding to the characteristics of the specialization. We identified effective class methods for each of the online education forms, showing that these two elements should lead to student self-learning outside of class time being maximized.

It is important to conduct class improvements via university-wide faculty development (FD) related to online class methods. In addition, we need to establish opportunities throughout the university for class observation and to increase awareness among faculty concerning class improvements. We believe that the adoption of a "best teacher award" system with commendations for recipients—faculty members who conduct excellent classes—would be effective.

Study limitations

This study measured self-learning outside class through choice selection; according to Nakajima (2020), this could result in difficulties in comprehending learning time growth circumstances in the short term. When measuring learning time, the shorter the period, the more difficult it is to distinguish different categories of learner, making it challenging to precisely measuring increases or decreases in self-learning. Therefore, future studies should request that students record their day-to-day lives to allow precise measurements and analyses.

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