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Exploring autonomy support and learning preference in higher education: introducing a flexible and personalized learning environment with technology

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Abstract
Learner autonomy is particularly important in higher education, where students are fully responsible for their own learning. Despite this, there is a lack of research on aspects of autonomy support in higher education compared with that of primary and secondary education. To address this gap, this study explored autonomy support and learning preference in higher education, introducing a flexible and individualized learning environment with technology after the COVID-19 pandemic. A survey was conducted among 849 Japanese university students to gather their perceptions about autonomous support, learning preferences (face-to-face or distance), use of learning strategies, and academic performance (grade point average). Correlations were identified between certain variables: for example, perceived autonomy support, class format preference, and grade point average. The scores of different scales were compared among the subject groups. Autonomy support provided by instructors included explaining the lesson's outline to students. A few teachers provided opportunities for students to select learning methods, teaching materials, and assignment content; yet, few instructors seemed to truly understand students' learning needs. Although many participants took face-to-face courses, students' learning preferences were evenly split between face-to-face and distance learning courses. Students who strongly preferred face-to-face learning performed well regardless of instructional format. Students with a little preference for distance education performed well, especially in distance education courses. Students with no preference performed the worst. This study suggests that a learning environment that provides students with options to suit their diverse learning preferences is beneficial and that introducing "hybrid-flexible" courses and feedback for students' learning strategies has the potential to promote learner autonomy in higher education.

Keywords Autonomy support · Learning preference · Learning strategy · Grade point average · HyFlex classes · Distance learning

1 Introduction

The rate of students entering higher education in Japan is increasing every year [1], which results in an increasing diversity of learners in terms of their learning autonomy and preferences. The traditional uniform educational model makes it difficult to accommodate such a wide range of individual differences [2]. One possible strategy for this educational challenge is to introduce a flexible and individualized learning environment that responds to students' learning preferences and

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requirements using digital technology [3–5]. To gain insights into how this may be successfully accomplished, students' perceived level of autonomy support from teachers, their learning preferences (face-to-face or distance), use of learning strategies, and their academic performance (grade point average) must be examined. This study aims to deepen the understanding of the interplay of these variables while introducing a flexible and personalized learning environment in the post-pandemic era.

1.1 Impact of the COVID-19 pandemic on Japanese higher education

In 2020, the COVID-19 pandemic impacted higher education in Japan. Similar to universities in other countries [6, 7], Japanese universities underwent radical changes in their learning environments, transitioning from face-to-face to distance learning. The use of educational technology in Japan was in line with that of other developed countries [8]. This created new barriers for some students who had no prior experience of distance learning and were suddenly required to take distance classes. Consequently, this brought about a loss of learning motivation and a desire from some students to resume face-to-face classes or leave university entirely. By the second half of 2020, hybrid/blended classes integrating face-to-face and distance learning increased. Among the hybrid instructional formats, hybrid-flexible (HyFlex) courses received particular attention; HyFlex courses are "class sessions that allow students to choose whether to attend classes face-to-face or online, synchronously or asynchronously" [9]. These courses combined a high degree of learning flexibility [10], which contributed to preventing the spread of infection in the classroom and guaranteeing learning opportunities for students living in remote areas [11, 12]. These changes in class format through the COVID-19 pandemic promoted students' awareness of the respective advantages of face-to-face and distance classes. As a result, new options were added to learning modalities, and they continue to be offered at Japanese universities, giving learners the opportunity—and creating the need—to learn more autonomously than before. The next section provides a review of previous literature on teachers' autonomy support and students' learning preferences in higher education, which are the key aspects of this study.

2 Literature review

2.1 Autonomy support in higher education: the self-determination theory

According to Self-determination Theory (SDT), one of the human motivational theories, humans have three innate psychological needs: autonomy, competence, and relatedness [13, 14]. When these needs are satisfied, humans are intrinsically motivated, and this fosters their well-being. Autonomy refers to the self's right in making choices or decision-making and regulation, a sense of initiative, and ownership of one's actions [15, 16]. Autonomy support indicates the attitudes and behaviors that satisfy the need for autonomy. It involves "an individual in a position of authority (e.g., an instructor) tak[ing] the other's (e.g., a student's) perspective, acknowledg[ing] the other's feelings, and provid[ing] the other with pertinent information and opportunities for choice, while minimizing the use of pressures and demands" [17, 18]. In educational settings, several autonomy-supportive behaviors by instructors were found. For instance, listening carefully to students' opinions, allowing students to learn in their own way, praising as informational feedback, offering encouragement, providing tips, and responding to students' questions are excellent methods [19]. Previous research has reported that autonomy support affects students' perceptions of competence and increases their interest and enjoyment while decreasing anxiety [17]. The fulfillment of the SDT's psychological requirements through autonomy support facilitates students' engagement and autonomous self-regulation in learning [20, 21]. Girelli et al. [22] found that autonomy-supportive behaviors from teachers mediate students' autonomous motivation and self-efficacy and positively influence academic outcomes. Hence, studies have shown the importance of transforming courses to support autonomy in higher education [7, 23] by providing students with learning goals, content, and method options and encouraging them to make choices and decisions. In addition, previous research has found that teachers' autonomy support promotes students' self-regulated learning (SRL) [24]. SRL is a learning process of planning, organizing, self-directing, self-monitoring, and self-evaluating, where learners facilitate learning achievements by intentionally using cognitive and metacognitive

strategies [25, 26]. Supporting and facilitating SRL positively impacts cognitive, behavioral, and affective engagement and learning performance in ICT-based course design [27]. Okada [28] investigated the effect of autonomy support on the intrinsic motivation, metacognition, and subjective learning performance of students taking an online course at Japanese universities. The results showed that autonomy support was associated with academic performance and that this relationship was mediated by intrinsic motivation. Autonomy support was also associated with metacognition, but metacognition showed no mediating effect on academic performance. These results provide new insights into the causal relationship between autonomy support and metacognition.

However, most studies deal with scores (sum or mean of item scores) from a one-dimensional perceived autonomy support scale [29], and there is little literature that examines the specifics of autonomy support (items on the scale). In addition, the number of such studies is even more limited compared with those that have focused on primary and secondary education. This may be because of less focus on autonomy support in higher education, as it is assumed that students have a certain degree of autonomy owing to their learning experiences in primary and secondary education. Nonetheless, in the universal access phase [30], Japanese universities also enroll students from diverse backgrounds with various characteristics and varying degrees of autonomy. Therefore, it is crucial to examine the extent to which autonomy is currently supported in Japanese higher education systems in order to provide guidelines for creating learning environments that promote learner autonomy.

2.2 Relationship between learning preference and academic performance

University students come from various backgrounds and have diverse preferences and needs, which may influence their autonomy and behavior in learning [31]. Learning preference refers to one's choice of specific learning situations or environments over another [32], such as face-to-face or distance class format. It is assumed that learning preferences are context-dependent and flexible, and related to one's own choice and motivation for learning (i.e., autonomy) [33]. Several previous studies have examined the relationship between preference/choice for face-to-face versus distance class formats and academic performance. For instance, Bassili [34] showed that students without an interest in learning with friends or a tendency to monitor their learning (i.e., lacking metacognitive strategies) were more likely to take online classes. However, regardless of the choice of format (face-to-face or distance class), no difference was reported in their performance [34]. Another study showed that students with higher multimedia comprehension skills perform better in online classes than in traditional lecture classes in certain subjects [35]. Further, studies that have examined this performance by considering several factors (e.g., subject area, grade point average (GPA), gender, and race) have observed that male and Black students with low GPAs who took online classes performed worse than those who took face-to-face classes in subjects that require a high degree of demonstration, practice, and intensive instructor—student interaction [36]. The relationship between the preferred learning format and use of learning strategies and academic performance varies in different educational contexts and cultures. Therefore, a systematic cross-sectional survey among Japanese college students is needed.

The aim of this study was to investigate autonomy support and learning preference against the background of learning strategies and GPA to find a rationale for the introduction of a flexible and individualized learning environment with technology in higher education after the COVID-19 pandemic. This study intends to understand the relationship between perceptions of autonomy support, preference for learning formats, use of learning strategies, and academic performance (GPA) among college students and focuses on the potential of autonomy support through HyFlex course design. The following two research questions (RQs), each containing two sub-questions, were explored:

RQ1: Autonomy support.

RQ 1–1: To what extent do Japanese university students sense autonomy support from their instructors?

RQ 1–2: Are there differences in the perceptions of autonomy support according to academic year and GPA?

RQ2: Learning preference.

RQ 2–1: What percentage of students prefer each learning format?

RQ 2–2: Are differences in learning format preference related to students' perceptions of autonomy support, use of learning strategies, or GPA?

Table 1 Demographics of participants

Baseline characteristics	*n*	%
Academic year		
1st	206	24.3
2nd	223	26.3
3rd	214	25.2
4th	206	24.3
Gender		
Male	236	27.8
Female	611	72.0
Non-binary	2	0.2
Major		
Social science	263	31.0
Humanities	204	24.0
Healthcare	126	14.8
Technology	83	9.8
Natural science	54	6.4
Education	51	6.0
Others	68	8.0

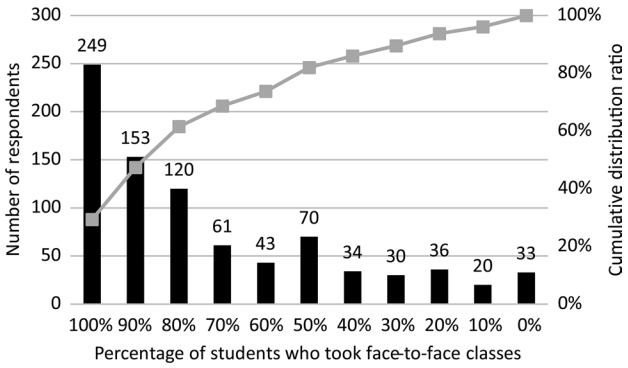

Fig. 1 Distribution of the percentage of students who took face-to-face classes. The x-axis represents the percentage of face-to-face classes among the total number of classes. For example, 100% on the x-axis indicates that no distance classes were taken. The line graph shows the cumulative distribution ratio

3 Methods

3.1 Participants

As shown in Table 1, the respondents comprised 206 first-year students, 223 second-year students, 214 third-year students, and 206 fourth-year students. They were aged 18–25 years, with a mean of 20.4 and a standard deviation of 1.42. In terms of gender, 236 were male (27.8%), 611 were female (72.0%), and 2 were non-binary (0.2%). More than half of the participants studied social sciences and humanities; in particular, 263 (31%) studied social sciences (e.g., politics, economics, management, welfare) and 204 (24%) humanities (e.g., literature, philosophy, art). According to the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) [1], women accounted for 44.1% of all college students in recent years, significantly lower than the percentage of women sampled in this study. In addition, more study participants had a major in the humanities (24.0%) than in the MEXT data (17.1%). The proportion of women is higher in the humanities (66.3%) than in other subjects, which could partly explain the high percentage of female participants.

According to the class format, 249 (29.3%) students took only face-to-face classes, while 33 students (3.9%) took only online classes (Fig. 1). Herein, the definition of "online class" includes asynchronous and synchronous classes.

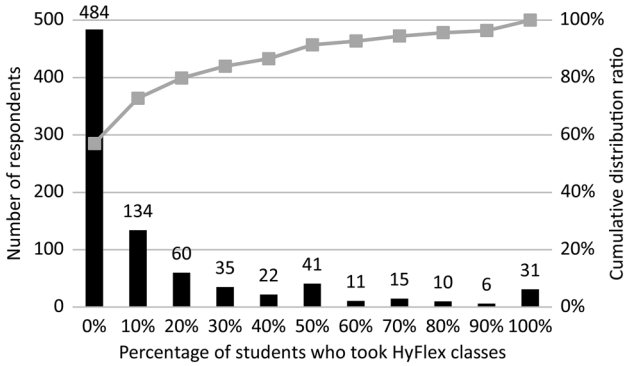

Fig. 2 Distribution of the percentage of students who took HyFlex classes. The x-axis represents the percentage of HyFlex classes among the total number of classes. The line graph shows the cumulative distribution ratio

Regarding the introduction of HyFlex courses, 31 students (3.7%) took HyFlex courses exclusively, while 484 students (57.0%) did not take any HyFlex courses during the spring semester. The specific course format was determined by the faculty (Fig. 2).

3.2 Instruments

3.2.1 Perceived autonomy support scale

Students' perception of autonomy support is an indicator that can be used to predict the degree of autonomy support provided by the instructors. This study referred to the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE) proposed by Tilga et al. [37] to measure students' perceptions of autonomy support by instructors. The scale measures the perception of autonomy support by physical education teachers for students aged 12–15 years and comprises 15 three-factorial items derived from an exploratory factor analysis (EFA) and a confirmatory factor analysis. The Raykov's composite reliability coefficients of this scale ranged from 0.70 to 0.87. The three factors correspond to the three components of autonomy support proposed by Stefanou et al. [38]: cognitive, procedural, and organizational. Cognitive autonomy support refers to teachers' actions, such as asking students to express their opinions. Procedural autonomy support includes actions that motivate students to learn, such as selecting learning content and communicating the practical value of what is learned in class to students. Organizational autonomy support allows students to curate their learning environments, including group work members and seat positions [38].

Because the MD-PASS-PE was developed to apply to physical subjects, the wording of this scale was modified for Japanese student participants to ensure its applicability to all courses: The original phrase "PE teacher," common to all the items, was changed to "teachers." In addition, items that are particularly relevant to the nature of the physical education subject were reworded so that the meaning of the original text was not compromised; for example, "My PE teacher allows me to choose sport equipment" was modified to "Teachers allow me to choose the learning materials" (AS15), and "My PE teacher allows me to choose the exercise place" was modified to "Teachers allow me to choose where I study" (AS14). The other modified scale comprised the following items: "Teachers provide an overview of what will be covered in class at the start of the class" (AS10) and "Teachers understand my learning requirements" (AS1; see Appendix Table 5). The response to the question "In the courses you took in the 2022 spring semester (first and second quarters), how many of your teachers exhibited the following behaviors and attitudes?" was measured on a five-point Likert scale (1: none at all to 5: many). In preparing the scale, the translation from English into Japanese and from Japanese into English and the proofreading were carried out by an academic translation agency. The author and translator checked each result to ensure an equivalence between the languages.

3.2.2 Use of the learning strategy scale

To investigate the use of learning strategies, this study referred to the Motivated Strategies for Learning Questionnaire (MSLQ) proposed by Pintrich et al. [39]. The MSLQ scale has been widely used in SRL research [40–44]. It includes sections on motivation and learning strategies; the learning strategies section further includes cognitive, metacognitive, and resource management strategy subscales that maintain 50 items. Cronbach's alpha of this scale ranged from 0.52 to 0.80. The MSLQ was developed in the United States and is a traditional scale; therefore, using an exact translation in the Japanese college context could confuse respondents when interpreting the questionnaire items. Therefore, in this study, a 19-item scale for the use of learning strategies was developed on the basis of the original MSLQ scale. Of the 19 items, 18 were modified with reference to the MSLQ so as not to impair the meaning of the original text as much as possible. The modified scale contained 18 items such as "I memorize keywords to remind myself of important concepts learned in class" (LS3), "I create diagrams and tables to understand and organize the content learned in class" (LS8), "I change how I learn if I have difficulty understanding what I am learning" (LS11), and "When studying, I set and work toward personal goals" (LS14). The remaining item was created independently by the author: "I consider whether the learning method is right for me" (LS16; see Appendix Table 5). Responses to the question "Regarding your learning methods, in terms of the courses you took in the 2022 spring semester (first and second quarters), how often did you use the following methods?" were measured on a five-point Likert scale (1: not at all to 5: very often). In preparing the scale, the translation and checking were conducted by an academic translator and the author.

3.2.3 Class format preference

The class format preference was measured on a seven-point Likert scale, where "1"="face-to-face suits me extremely well," "4"="I do not have a preference for either," and "7"="online suits me extremely well."

3.2.4 Academic performance

GPA was used as a variable for academic performance. Respondents were asked to indicate their GPAs for the spring 2022 semester (first and second quarters). Since the questions required respondents to rely on just their memory for this information, they were asked to provide whole numbers instead of decimals. Thus, GPA scores of [0, 1], [1, 2], [2, 3], and [3, 4] were represented as 1, 2, 3, and 4 points, respectively.

3.3 Data collection

A questionnaire was distributed to first- to fourth-year students at Japanese universities. The questionnaire was anonymized via a web form in collaboration with a private research company that specializes in online surveys and has millions of registered survey respondents in Japan. A screening process was conducted prior to the survey, and only college students were selected. After that, the forms were distributed through online push notifications. The participants answered the questionnaire voluntarily after giving their informed consent to participate in the survey and to have their results used for this research. They were appropriately compensated for their participation. The survey was administered during the summer break of 2022 (after students' GPAs were determined) to avoid response bias due to declining memory, as the questionnaire asked about students' perceptions and impressions of the courses they had taken during the spring 2022 semester (first and second quarters). The sampling process continued until the target number of 200 students per year was reached (excluding linear responses). The target number exceeded (849 students), and the survey was completed in 3 days.

3.4 Data analysis

IBM SPSS Statistics (ver. 29) was used for data analysis. First, an EFA was performed to estimate the factor structure of the scales. Internal consistency reliability coefficients, means, standard deviations, and ranges for the scale values were then determined. A correlation analysis was then carried out to evaluate the relationship between the individual variables. Then, a one-way analysis of variance (ANOVA) was conducted to estimate the effect of each variable (factor). When a simple main effect of the factor was confirmed, a Tukey's honestly significant difference (HSD) test (post-hoc test) was performed to test for statistically significant differences between levels (mean scores) in the factors. The statistical significance threshold was set at < 0.05.

Table 2 Scale reliability analysis

Scale name	No. of items	Cronbach's alpha	McDonald's omega	Mean	Standard deviation	Score range
Perceived autonomy support	15	0.937	0.937	44.8	11.1	[15, 75]
Use of learning strategies	19	0.941	0.941	57.6	13.4	[19, 95]

Table 3 Correlation coefficients between variables

	1	2	3	4
1. Academic year				
2. Perceived autonomy support	0.104[b]			
3. Use of learning strategies	0.012	0.573[b]		
4. Class format preference	− 0.038	− 0.198[b]	− 0.225[b]	
5. GPA	0.050	0.152[b]	0.182[b]	− 0.069[a]

[a]$p < 0.05$

[b]$p < 0.01$

4 Results

4.1 Exploratory factor analysis of the scales

The scales on perceived autonomy support and use of learning strategies were modified; therefore, factorial validity was confirmed by EFA. Based on the results of a scree plot and a parallel analysis for both scales, the interpretation of a one-factorial solution was considered reasonable. Using a one-factor model, the factor loadings for the items of each scale ranged from 0.627 to 0.785 for perceived autonomy support and from 0.535 to 0.764 for use of learning strategies. Cronbach's alpha and McDonald's omega showed high internal consistencies, with values of 0.937 for perceived autonomy support and 0.941 for learning strategy use (Table 2). Therefore, the analysis was conducted using the summed scores of all items of each scale.

4.2 Correlation coefficients between key variables

Table 3 presents the correlation coefficients between the variables. There was no statistically significant relationship between academic year and the other variables except for perceived autonomy support. Statistically significant positive correlations were observed between academic year and perceived autonomy support ($r = 0.104$, $p < 0.01$). In addition, statistically significant positive correlations existed between GPA and perceived autonomy support ($r = 0.152$, $p < 0.01$) as well as use of learning strategies ($r = 0.182$, $p < 0.01$). However, these correlations were low. A moderately statistically significant positive correlation was observed between perceived autonomy support and use of learning strategies ($r = 0.573$, $p < 0.01$). Contrastingly, statistically significant *negative* correlations were observed between the class format preference and perceived autonomy support ($r = -0.198$, $p < 0.01$), use of learning strategies ($r = -0.225$, $p < 0.01$), and GPA ($r = -0.069$, $p < 0.05$). This meant that the greater the students' preferences for online learning, the lower their scores. However, the correlation was low, suggesting that it was largely negligible, especially in terms of GPA.

4.3 Analysis of effects among key variables

Further analysis was conducted on the effects between the variables for which the correlation coefficients were significant. An ANOVA was conducted on the score for perceived autonomy support, with academic year as a factor. The results showed an effect between the academic years ($F = 4.21$, $p < 0.01$). Multiple comparisons using Tukey's

HSD test revealed significant differences between the first- and fourth-year students ($p < 0.05$) and second- and fourth-year students ($p < 0.01$).

The ANOVA results on the scores for perceived autonomy support and use of learning strategies, with GPA as a factor, revealed significant differences between perceived autonomy support ($F = 6.77$, $p < 0.001$) and use of learning strategies ($F = 9.74$, $p < 0.001$). Multiple comparisons using Tukey's HSD test revealed significant differences between scores 2 and 4 ($p < 0.001$) for perceived autonomy support and scores 1 and 4 ($p < 0.05$), scores 2 and 4 ($p < 0.001$), and scores 3 and 4 ($p < 0.01$) for use of learning strategies.

An ANOVA was conducted on the scores for perceived autonomy support and use of learning strategies, with class format preference as a factor. Significant differences were observed between perceived autonomy support ($F = 7.50$, $p < 0.001$) and use of learning strategies ($F = 8.93$, $p < 0.001$). The results of multiple comparisons using Tukey's HSD test showed that, similar to both scales, the scores for the items "1: face-to-face suits me extremely well," "2: face-to-face suits me very well," and "3: face-to-face suits me well" were significantly higher than that for "7: online suits me extremely well." ($p < 0.05$).

The mean scores of participants who responded to items on each of the two scales were compared (Appendix Table 5). Regarding the mean scores of all respondents for the 15 items of perceived autonomy support, AS10 had the highest score (3.38), whereas AS15 had the lowest score (2.70). The items with an average score of less than 3.00 are marked with an asterisk in Appendix Table 5, and there was a notable lack of awareness of the options offered. Regarding the mean scores of all respondents for the 19 items on the use of learning strategies, LS4 had the highest score (3.21), while LS1 had the lowest score (2.63). As indicated in Appendix Table 5 with an asterisk, low use of specific cognitive or metacognitive strategies was observed for each item.

Table 4 shows the relationship between learning preferences and mean GPA by type of class format. Students who attended only face-to-face classes (I) had the highest score for preference "1" (GPA (M) = 3.52) and the lowest for "4" (GPA (M) = 3.03). Students who participated equally in face-to-face and online classes (II) performed the best in "1" (GPA (M) = 4) and the worst in "6" (GPA (M) = 3.18). Students who attended only online classes (III) reported high scores in "1" and "5" (GPA (M) = 4.00) and the lowest in "4" (GPA (M) = 2). No statistical tests were performed for these comparisons because of the small sample size. The results of an ANOVA for students' mean GPAs that exclude the factor of the type of class attended (IV), with class format preference as a factor, revealed an effect of the factor ($F = 3.24$, $p < 0.01$). Therefore, multiple comparisons using Tukey's HSD were conducted, and significant differences were observed between "1" (3.47 points) and "4" (3.15 points; $p < 0.05$) and "4" and "5" (3.49 points; $p < 0.01$) (Fig. 3). The score "7" for students who strongly preferred online learning was consistently average, regardless of the class format.

Although many participants took part in face-to-face events (Fig. 1), the students' learning preferences were evenly distributed between face-to-face (373 students) and online (369 students).

5 Discussion

This study empirically examined the relationship among the variables of perceived autonomy support, class format preference, use of learning strategies, and GPA to explore the nature of autonomy support in Japanese higher education after the COVID-19 pandemic. It referred to the MD-PASS-PE, the most appropriate model to assume a three-factor structure [37] to measure students' perceptions of autonomy support. Furthermore, the study referenced the MSLQ scale to assess students' use of learning strategies. Previous research has been conducted on learning strategies assuming a nine-factor structure [39, 45]. After the EFA, it was considered appropriate to interpret the two scales modified for the present study using a single factor. A possible reason for this is that the questionnaire used a relatively small interval scale (five-point scale) and asked about the "entire" range of subjects taken by students rather than students' perceptions of a particular subject. This may have compensated for any response bias due to course differences and instructors' abilities to support skills. Since the reliability coefficients of both scales were extremely high, they exhibited high internal consistency and were used as unidimensional scales in the comparative analysis. To determine what kind of content was lacking in autonomy support, the items that fell below the assessment criteria (mean of less than 3.00) were identified.

Table 4 Comparison of mean GPA for type of classes attended with learning preference as a factor

		1: Face-to-face suits me extremely well	2: Face-to-face suits me very well	3: Face-to-face suits me well	4: I do not have a preference for either	5: Online suits me well	6: Online suits me very well	7: Online suits me extremely well
I. Only participated in face-to-face class	*M*	3.52↑	3.37	3.38	3.03↓	3.08	3.19	3.25
	n	46	43	47	37	24	32	20
II. Participated equally in face-to-face and online classes	*M*	4.00↑	3.70	3.50	3.36	3.70	3.18↓	3.23
	n	1	10	14	11	10	11	13
III. Only participated in online classes	*M*	4.00↑	n.a	3.50	2.00↓	4.00↑	3.60	3.31
	n	3	0	4	3	2	5	16
IV. All participants regardless of class formats (Corresponds to Fig. 3)	*M*	3.47	3.39	3.32	3.15↓	3.49↑	3.25	3.24
	Total	81	122	170	107	114	129	126

M Mean of GPA; ↑ Highest value; ↓ Lowest value

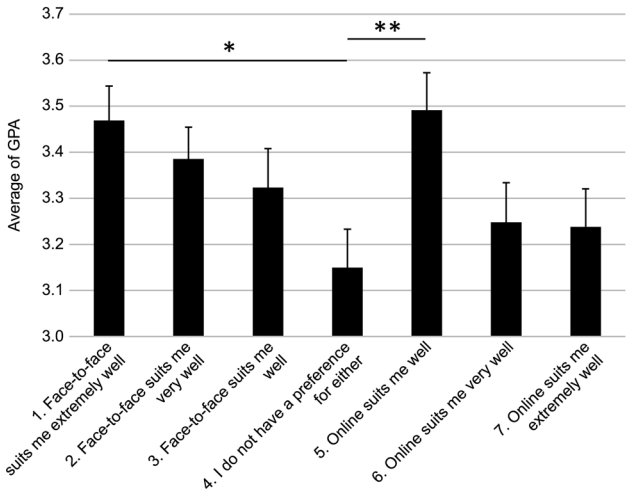

Fig. 3 Comparison of GPA averages according to learning preference. *$p < 0.05$, **$p < 0.01$; error bars show standard errors (SE)

To answer RQ1 (autonomy support), this study showed that perceived autonomy support increased in higher academic years. The reason for the increased perception was that students generally became closely involved with instructors as they transitioned from classroom studies to graduation research during their senior years. In contrast, students with lower GPAs had lower perceived autonomy support. This result was consistent with previous studies investigating the relationship between teachers' autonomy support and students' academic performance [17, 42]. Although causal relationships between the variables were not examined in the present study, students with low grades may not have had contact with the instructors—and were not involved— because they did not attend class. In addition, some students may have had difficulty recognizing the intentions behind their instructors' actions, even when the instructors advocated autonomy-supportive actions. In addition to autonomy support, providing students with "personalized" support focusing on their social and communication skills may be necessary in some situations.

Perceived autonomy support and use of learning strategies were moderately correlated (Table 1). This result is consistent with previous studies that examined this relationship [24, 28, 42]. When focusing on the content of each of the two variables in this study, although autonomy-promoting attitudes, such as listening to students' opinions (AS3; 3.07 points), were not uncommon in lecturers' actions, the study found that students were less likely to ask for support from the lecturer (LS18; 2.69 points) than to use learning resources such as textbooks and the Internet (LS4; 3.21 points) or to request support from friends (LS19; 3.10 points). One possible reason for this is that the psychological and situational costs for Japanese students of asking a teacher are high (e.g., it is frowned upon to ask a teacher questions during a lecture). As mentioned earlier, the challenge is to give teachers more opportunities to interact with individual students, regardless of the teaching format. It might be possible to solve such problems with the help of a flipped classroom [46, 47]. In this system, students conduct a study and assess their comprehension in advance. Thereafter, during the class, students who have achieved a certain level of comprehension work on applied (developmental) tasks with cooperative learning [48], while teachers provide individual instruction to students who lack understanding.

The results indicate that Japanese universities are generally proactive in designing instruction by explaining the purpose and meaning of courses and outlining lessons (AS6, AS8, AS10; more than 3.00 points). This result may imply that theories of instructional design (e.g., Gagne's nine events of instruction) have penetrated Japanese higher education by promoting faculty development [49, 50]. On the other hand, the ability to select learning methods, teaching materials and task content and to understand students' learning needs is less common (AS1, AS11, AS13, AS15; less than 3.00 points). This trend may not be unique to the Japanese higher education system [24]. Providing choices is the crucial instructional method to improve learner autonomy because making a choice involves considering one's goals and preferences [15, 18, 51].

In answering RQ2 (learning preference), although after COVID-19, the implementation of classes shifted back to the face-to-face format (Figs. 1 and 2), it was observed that students' learning preferences were distributed equally between face-to-face and online classes. Students who preferred face-to-face showed good academic performance regardless of

instructional format and students with a slight preference for online learning also showed learning success, especially in online instruction. Students with an extreme preference for online classes had significantly lower perceptions of autonomy support and use of learning strategies compared with students who preferred face-to-face classes. This finding suggests that students who do not use learning strategies because they have little knowledge or skills in these strategies or because of barriers they may experience are more likely to prefer online learning. Nevertheless, these students' academic performance was not significantly affected. These results are partially consistent with the findings of Bassili [34], which compared the academic performance of students who took face-to-face or distance classes. Interestingly, the results showed that the students who responded "I do not have a preference for either" demonstrated the lowest performance. Although the reasons for this are unclear, a possible explanation is that the lack of orientation toward a specific learning preference may hinder motivation and the learning process.

As shown for the answer to RQ1, given the current situation in which students have limited opportunities to choose learning methods, materials, and assignments, these results indicate the need for changing teachers' awareness to promote a personalized learning environment that is sufficiently flexible to accommodate students' diverse learning preferences and requirements.

5.1 Implications and recommendations

The current findings offer insights into how autonomy support can best be realized in Japanese higher education after the COVID-19 pandemic. In the Japanese higher education system, where the diversity of the student body is becoming increasingly apparent, autonomy support within the HyFlex class system can be of great use [52]. The HyFlex learning style provides opportunities for students to choose their learning process and learn to take responsibility and control of their learning, which contributes to promoting learner autonomy and self-regulating skills [53]. Importantly, introducing HyFlex classes is expected to be an opportunity to raise awareness of providing options for both, teachers and students.

Successful online and hybrid learning requires certain self-regulation, self-discipline, and related metacognitive skills [36, 40, 54]. The respondents in the current study included a number of students who were taking distance or HyFlex classes (Figs. 1 and 2); however, the present study's findings indicate a low use of metacognitive strategies, such as setting learning goals for oneself (LS14; 2.90 points) or changing learning strategies when stuck in a learning situation (LS11; 2.93 points). If low-skill students prefer distance learning and opt for online courses in the HyFlex format, they are likely to have difficulty completing their studies. This is an example of how certain learning preferences do not always have a positive impact on learning success.

Thus, to enhance academic autonomy and learning effectiveness in the HyFlex format, it is important to provide instruction regarding various learning strategies and feedback on using them [55, 56]. Allowing students to understand effective learning strategies based on critical thinking about their preferences increases autonomy and improves SRL in a hybrid learning environment [57]. It may be necessary to conduct formative evaluations through quizzes or other methods within a course. Students could be given the opportunity to reflect on the effectiveness of different learning strategies in achieving their learning goals and be encouraged to change their choice of strategy depending on how effective the strategy is. In the process, questions such as "Is my preferred method effective for learning?" and "In what ways do you think you can achieve your learning goals?" may prove useful. It is important to acknowledge that students and instructors embark on a journey toward becoming expert learners. They should be given the time and space to implement the most effective method for their individual goals.

6 Limitations

The study has limitations that may affect the validity and generalizability of the results. First, all the responses in this study's survey were subjective and based on students' perceptions; hence, they may differ from facts. A relatively large proportion of the participants were female, meaning that the results may include the effects of gender [36]. Many of the respondents participated in the instructor's designated teaching format (face-to-face), and the balance between

learning preferences and the implemented teaching format was not controlled. Second, the relationship between student motivation, a component of SDT and SRL, and the individual variables was not examined in this study [54, 58]. Thus, the details of students' motivation to choose a learning preference and autonomy support for learning outcomes through self-regulation remain unknown. Third, as this was a cross-sectional study limited to correlation and variance analyses, no causal relationships between the variables could be established, and the generalizability of the results cannot be guaranteed.

7 Conclusion and future research directions

This study has shown that the Japanese higher education system recognizes different learning preferences and requirements of learners. However, there is no provision for self-selection of learning methods and reflection on learning strategies. The study also suggests that an orientation toward learning preferences influences academic performance. It is therefore to be expected that there will be innovations in the practice of ICT-enhanced, autonomy-supportive course designs: namely, distance learning and HyFlex teaching practice. Further research on the effects of these course designs on students' autonomous motivation, self-regulation, and academic performance is needed, with a focus on students who prefer and choose online learning in HyFlex courses [59]. In addition, a practical study is expected to be conducted on integrating individualized and cooperative learning through HyFlex classes and flipped classroom teaching [60].

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Data availability The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate This study was approved by the Research Ethics Committee of the Fukuoka Institute of Technology (permission number, hm06-22) and conducted according to the committee guidelines. The participants voluntarily answered the questionnaire after providing their informed consent to participate in the survey and for the results to be used in the research.

Consent for publication Not applicable.

Competing interests The authors declare that they have no competing interests.

Appendix

See Table 5

Table 5 Comparison of mean scores for perceived autonomy support and use of learning strategies with learning preference as a factor

	Mean	Mini graph of the mean score (from left to right: "1" to "7")
Perceived autonomy support		
AS1. Teachers understand my learning requirements.*	2.83	
AS2. Teachers believe that I can learn better through classes.*	2.94	
AS3. Teachers let me express my opinion	3.07	
AS4. Teachers are interested in what students want to do	3.01	
AS5. Teachers respond and answer when I express my opinion	3.14	
AS6. Teachers explain the significance of learning the class content	3.17	
AS7. Teachers guide students to find solutions	3.02	
AS8. Teachers explain how the class content is useful	3.08	
AS9. Teachers give me tips on how to do better when I face a learning setback.*	2.96	
AS10. Teachers provide an overview of what will be covered in class at the start of the class	3.38	
AS11. Teachers allow me to learn in various ways.*	2.90	
AS12. Teachers recognize the various solutions proposed by students.*	2.97	
AS13. Teachers allow me to choose from various learning tasks.*	2.76	
AS14. Teachers allow me to choose where I study.*	2.87	
AS15. Teachers allow me to choose the learning materials.*	2.70	
Use of learning strategies		
LS1. I repeatedly recite the content used in class.*	2.63	
LS2. I read the textbook and my notes several times	3.04	
LS3. I memorize keywords to remind myself of important concepts learned in class	3.07	
LS4. I use various sources when learning, including textbooks, my notes, the Internet, and discussions with others	3.21	
LS5. When studying in class, I consider whether the knowledge gained can be applied in other classes	3.14	
LS6. When learning new content, I try to relate it to the knowledge I already have	3.20	

Table 5 (continued)

	Mean	Mini graph of the mean score (from left to right: "1" to "7")
LS7. I identify key points based on class materials and my notes	3.15	
LS8. I create diagrams and tables to understand and organize the content learned in class.*	2.80	
LS9. When studying, I summarize important concepts based on class materials and textbooks	3.02	
LS10. I go back and try to understand the basics when I do not understand what I am learning	3.18	
LS11. I change how I learn if I have difficulty understanding what I am learning.*	2.93	
LS12. When learning, I think about whether I have a good understanding of the content	3.16	
LS13. When studying, I am aware of what I do not understand well	3.10	
LS14. When studying, I set and work toward personal goals.*	2.90	
LS15. I review later if I did not understand well in class	3.08	
LS16. I consider whether the learning method is right for me	3.01	
LS17. I choose a place where I can concentrate on my assignments and study there	3.20	
LS18. I ask the teacher questions if I do not understand something when learning.*	2.69	
LS19. I ask a friend if I do not understand the class content	3.10	

Items marked with an asterisk (*) indicate that the average score for all the respondents was less than 3.00

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