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Reciprocal Relationship Between Motivation and Engagement in Out-of-Class Learning Among Japanese Undergraduates

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Abstract

This study aimed to examine the reciprocal relationship between motivation and engagement in out-of-class learning among Japanese undergraduates by using a cross-lagged panel model. Two online surveys were conducted with 293 university students in Japan. This study measured motivation and engagement with regard to out-of-class tasks (homework) for compulsory classes relating to the university students' major subjects. Hypothesis 1 posited that there would be a positive reciprocal relationship between intrinsic/identified regulation and engagement in out-of-class learning. Hypothesis 2 posited that there would be a negative or no reciprocal relationships between introjected/external regulation and engagement in out-of-class learning. The results of the cross-lagged panel model partially supported each hypothesis. A positive reciprocal relationship between intrinsic regulation and emotional engagement was found. In addition, identified and introjected regulation in the first survey were positively correlated with behavioral engagement in the second survey. However, no relationship was observed between external regulation and engagement. Thus, intrinsic, identified, and introjected regulation were revealed as important factors in promoting engagement in out-of-class learning. Based on this study's findings, practical implications for education regarding motivation and engagement in out-of-class learning were proposed.

Keywords: motivation, engagement, university students, out-of-class tasks, self-determination theory

1. Introduction

1.1 Out-of-class Learning

Although out-of-class learning (homework) is important for learning at school, many learners are not fond of it (Moè et al., 2018). Goetz et al. (2012) measured various emotions regarding homework and class at school. They found that students tend to have a less positive and more negative emotions toward homework than for class. With such a prevailing emotional state, it is difficult for learners to actively engage in out-of-class learning. Therefore, it is important to clarify the learning process and consider support and intervention for out-of-class learning (Flunger et al., 2021).

Out-of-class learning is important for deepening the understanding of in-class learning and promoting academic achievement at school (Cooper et al., 2006; Trautwein & Lüdtke, 2009; Warton, 2001). Out-of-class learning differs from in-class learning in many ways (Katz et al., 2010). For example, while in-class learning is bound to the school, out-of-class learning competes with activities that learners perform in their leisure time. Moreover, unlike in-class learning, which takes place in an educational environment, out-of-class learning is conducted in an environment where there is little support for concentrating on a task. While in-class learning occurs under the supervision of a teacher, out-of-class learning is conducted without such supervision. There are two main types of out-of-class learning. The first involves out-of-class learning tasks (homework) that teachers assign to learners. The second includes learners working independently on tasks outside of class, other than the class tasks such as homework. In this study, we focused on the first type of out-of-class learning. This is because learners who engage in the second type of out-of-class learning are most likely to already possess autonomous motivation. By contrast, with the first type of out-of-class learning, it is likely relatively difficult to have a high level of autonomous motivation. As such, we focused on the out-of-class learning that teachers impose on learners.

In particular, Japanese learners are thought to be less active during out-of-class learning than students in other countries. For example, in the Program for International Student Assessment (PISA) 2003 and 2012, the average

time spent per week on homework for 15-year-old Japanese students was below the international average (The Organization for Economic Cooperation and Development [OECD], 2014). Tarumi (2017) compared data on 6th grade students in Japan, Hong Kong, and Shanghai, revealing that Japanese students spent the least amount of time studying at home per week. Furthermore, Kurokawa et al. (2018) highlighted that the out-of-class study time for Japanese university students is about half that of the international standard. Although most research on out-of-class learning has focused on students in primary and secondary education, out-of-class learning is also an important component for university students, as it leads to mastery of class content (Koban et al., 2020). Considering this, exploring methods to promote Japanese learners' out-of-class activities to enhance their understanding of in-class content and boost academic achievement are essential. To support their out-of-class learning, the factors that determine such learning should be examined.

1.2 Out-of-class Learning and Motivation

One of the most famous motivational theories is the self-determination theory (Deci & Ryan, 2002; Ryan & Deci, 2017, 2020). It states that the quality of motivation is classified according to the reasons for engaging in learning. The first motivating factor is intrinsic regulation based on the fun and interest evoked by the learning content. The second factor involves identified regulation based on the value (importance and utility) of the learning content. The third aspect includes introjected regulation based on internal rewards of self-esteem for success and avoidance of anxiety, shame, or guilt for failure. The fourth motivation involves external regulation based on obtaining rewards and avoiding punishment. These motivations can be arranged in one dimension according to the degree of autonomy, and this degree decreases in the order of intrinsic regulation, identified regulation, introjected regulation, and external regulation. Intrinsic and identified regulation are classified as autonomous motivation, and introjected and external regulation are classified as controlled motivation (e.g., Guay, 2022). Previous studies have shown that intrinsic and identified regulation particularly promote the use of metacognitive strategies, effort, positive emotions, interest in challenges, and academic achievement (e.g., Guay et al., 2000, 2008; Nishimura et al., 2011; Vansteenkiste et al., 2009). A meta-analysis by Howard et al. (2021) also revealed that intrinsic and identified regulation are positively associated with adaptive variables in learning (e.g., effort and positive emotions). At the same time, it has been shown that introjected regulation is associated with both adaptive and maladaptive variables (e.g., negative emotions such as anxiety), while external regulation is associated with maladaptive learning (Howard et al., 2021).

Previous studies have examined learners' motivation for out-of-class learning. For example, Katz et al. (2010) developed a scale to measure homework motivation based on the self-determination theory in elementary and middle school students, examining the relationship between teachers' support of students' psychological needs and motivation. The results showed that teachers supporting psychological needs is important for increasing students' autonomous motivation for homework, especially for those who express higher levels of needs. Katz et al. (2011) also examined the relationship between parents' motivation for helping with homework and homework motivation of elementary school students. This study showed that parents' autonomous motivation promotes behavior that supports the psychological needs of their children, thereby increasing the latter's autonomous motivation for homework. The relationship between motivation for out-of-class learning and out-of-class learning efforts and emotions has also been examined. Katz et al. (2014) showed that self-efficacy for homework suppresses procrastination by mediating autonomous motivation for homework in elementary school students. Katz et al. (2012) also showed that autonomous motivation for homework has a negative association with stress and negative emotions regarding homework, as well as a positive association with positive emotions. By contrast, controlled motivation for homework is positively associated with stress and negative emotions regarding homework. That is, individuals' motivation for out-of-class learning is key to preventing procrastination during out-of-class tasks, while instead promoting hard work, persistence, and proactiveness for learning.

The literature on motivation for out-of-class learning based on self-determination theory targets students in primary and secondary education. A few studies that have examined out-of-class learning among university students deal with other components of motivation (e.g., self-efficacy: Muljana et al., 2023). However, there are no studies that have examined motivation in terms of self-determination theory. As such, it is necessary to first develop a scale and then clarify the relationship between out-of-class learning motivation and learning efforts. When doing so, the factor structure of the scale should also be examined. In particular, the two-factor and four-factor structures of motivation should be compared. Katz et al. (2011), who developed a motivational scale for homework in elementary and middle school students, assumed a two-factor structure: autonomous motivation (composed of intrinsic and identified regulation) and controlled motivation (composed of introjected and external regulation); however, previous studies based on the self-determination theory have tended to use a four-factor structure for motivation that consists of intrinsic, identified, introjected, and external regulation. Moreover, it has been pointed

out that intrinsic and identified regulation, which are classified as autonomous motivation, show a different relationship with learning behavior. For example, Nishimura et al. (2011) conducted a longitudinal survey of middle school students and showed that identified regulation predicted the use of metacognitive strategies. By contrast, intrinsic regulations did not predict the use of metacognitive strategies. It was found that introjected and external regulation, which are classified as controlled motivation, also showed different associations with learning variables. As mentioned above, meta-analysis showed that external regulation was associated only with maladaptive learning, while introjected regulation was associated with both adaptive and maladaptive learning (Howard et al., 2021). This implies that the four motivations in learning are clearly differentiated, with each possibly exhibiting a unique association with out-of-class learning engagement. As such, as in Katz et al. (2011), we considered whether it is appropriate to discuss motivation by using four factors rather than two.

1.3 Reciprocal Relationship Between Motivation and Engagement

Engagement refers to the behavioral intensity and emotional quality of a learner's active involvement during learning a task (Reeve et al., 2004). Engagement has been identified as an important factor that directly determines academic achievement (Christenson et al., 2012; Meng & Zhang, 2023). As such, it is important to clarify the antecedents to promote learners' academic achievement. Several types of engagement have been envisaged. Skinner et al. (2009) developed a scale to measure behavioral and emotional engagement in class. Behavioral engagement is a concept that includes not only effort exertion and persistence but also mental effort, such as attention and concentration. Emotional engagement is a concept reflecting energized emotional states, such as enthusiasm, interest, and enjoyment. Previous studies have examined the relationship between motivation based on the self-determination theory and engagement. For example, Ito and Umemoto (2022) examined the relationship between interpersonal motivation and engagement in pair work among Japanese university students. According to the results, identified regulation showed a positive association with behavioral engagement, while intrinsic and identified regulation had positive associations with emotional engagement. In other words, motivation is an important driver of engagement.

In this study, we analyzed longitudinal data at two points using a cross-lagged panel model. By using this model, causal relationships and reciprocal relationships between variables can be considered (e.g., Lüdtke & Robitzsch, 2021). Motivation is considered to affect engagement; conversely, it can be assumed that engagement affects motivation. For example, Okada (2007) showed that teaching learning strategies to Japanese high school students increased their motivation. That is, it is conceivable that actively engaging in learning increases motivation. The analytical model of this study is shown in Figure 1. For Time 2 motivation, an autoregressive path from motivation in Time 1 and a cross-lagged effect path from engagement were assumed. For Time 2 engagement, a cross-lagged effect path from Time 1 motivation and an autoregressive path from engagement were assumed. In doing so, no cross-lagged effect path was assumed between the four motivations. Similarly, no cross-lagged effect path was assumed between the two engagements. This is because the purpose of this study was not to examine the relationships between four motivations, and the relationships between two engagements.

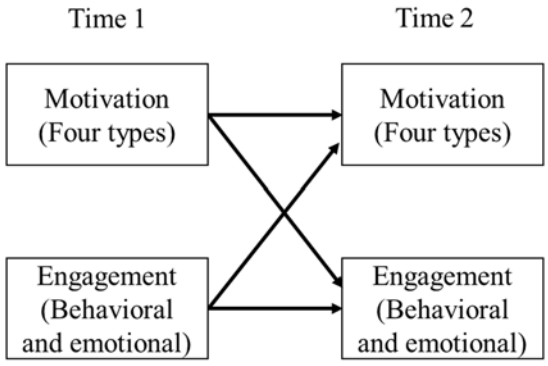

Figure 1. Overview of the analytical model in this study

1.4 Purpose and Hypotheses

The purpose of this study was to examine the reciprocal relationship between motivation and engagement in out-of-class learning among Japanese undergraduates by using a cross-lagged panel model. Hypothesis 1 posits that

there is a positive reciprocal relationship between intrinsic/identified regulation and engagement in out-of-class learning. Hypothesis 2 posits that there is a negative or no reciprocal relationship between introjected/external regulation and engagement in out-of-class learning.

Moreover, we examined whether the relationships between motivations and engagement for out-of-class learning change according to the type of out-of-class learning task. Previous studies on motivation for out-of-class learning have not considered the types of out-of-class learning tasks. As such, in this study, we used multi-group analysis to explore the relationships between motivations and engagement by considering the types of out-of-class learning tasks. There are various types of out-of-class learning tasks depending on the relevant country, school, and class. In this study, we assessed the content of out-of-class learning tasks through open-ended questions, categorizing the types after responses were obtained.

This study focused on out-of-class learning tasks in compulsory classes related to the university students' major subjects. This is because, for elective classes at Japanese universities, there are many cases wherein students are not assigned out-of-class tasks in the first place. Moreover, unlike middle and high school, universities have distinct faculties and academic disciplines; thus, it is the most important to enhance learners' expertise through compulsory classes related to their major subjects. We, therefore, examined the out-of-class learning process by focusing on out-of-class tasks in compulsory classes for university students.

2. Material and Methods

2.1 Participants and Procedure

At private university A in the Kansai region of Japan, we conducted a longitudinal online survey at two points with a one-month interval. The two surveys were conducted in the middle of the semester, which is more than a month after the start of the semester, and before final exams or grading. A total of 293 university students taking compulsory classes that require out-of-class study (homework) were included in the analysis (11 first-year students, 195 second-year students, 73 third-year students, and 14 fourth-year students; 215 women, 76 men (Note 1), and 2 who did not respond). There were 265 participants who participated in the first survey (T1), of whom 131 also participated in the second survey (T2; Note 2). Twenty-eight participants only took part in T2. All belonged to foreign language and international faculties. The survey was conducted during non-compulsory classes related to the participants' major subjects. We pasted a link to the survey page in Google Forms into the class's learning management system and asked the participants to complete the survey during class.

At the top of the survey page, it was stated that there are no right or wrong answers to the questionnaire, the participants do not have to answer any questions that they do not want to answer or that are difficult to answer, the questionnaire has no bearing on their grades, and the questionnaire is anonymous. The same content was explained orally to the participants during class. After they were given information regarding the research study, they provided informed consent for their participation. Participants did not receive any reward for participating. This study was conducted according to the code of ethics and conduct of the Japanese Psychological Association.

2.2 Measures

2.2.1 Survey 1 (T1)

1) Out-of-class tasks for compulsory classes (three items)

In the first item, we asked the participants if there were any compulsory classes related to the major subjects they were currently taking with required out-of-class tasks (homework), giving two options: "Yes" or "No." If the answer was "Yes," the specific class name was to be written in the second item (if the answer was "No," the survey would end). In the third item, we asked the students to specify the content of the out-of-class tasks (homework) required for their class.

Using free-text descriptions of out-of-class tasks in the third item, we did an exploratory categorization of task types. As a result, we could divide them into two types. The first was tasks based on convergent thinking (TCT) because they were mainly related to correctly understanding learning content, such as solving problems in textbooks and reference books, reviewing the content of classes, and summarizing the content of textbooks. Convergent thinking is regarded as a process of generating one possible solution to a particular problem (e.g., Colzato et al., 2012). The second included tasks based on divergent thinking (TDT), which involves creative tasks that mainly generate various ideas, such as translating foreign languages into Japanese, writing essays, and preparing presentations. Divergent thinking is thought to represent a style of thinking that allows many new ideas to be generated in a context where more than one solution is correct (e.g., Colzato et al., 2012). When dividing participants' free-text descriptions into types, the first author of this paper worked alone, followed by independent confirmation by the second author. Descriptions on which two authors had differing opinions were categorized

after discussion. TCTs were described by 140 participants. TDTs were described by 111 participants. Forty-two participants did not give an answer or did not specify tasks; therefore, they were excluded from the two-way analysis of variance and multi-group analysis.

2) The out-of-class learning motivation scale (20 items)

With permission from the original authors, we translated Katz et al.'s (2011) motivation scale for homework into Japanese. This scale consists of two subscales: autonomous motivation, which consists of intrinsic and identified regulation, and controlled motivation, which consists of introjected and external regulation. After we translated the items, educational psychologists specializing in learning motivation independently checked whether there were any problems with the translation, and the content validity of the scale was confirmed. Moreover, "homework" in all items of the original scale was revised to "out-of-class learning" to match the university context.

There were 11 items to measure autonomous motivation (five for intrinsic regulation and six for identified regulation). Regarding controlled motivation, there were some items suited for elementary and middle school students that were not appropriate for university students (e.g., I do homework so that my parents don't punish me). As such, based on the items of Katz (2011), we created items with reference to the conceptual definition of the self-determination theory (Ryan & Deci, 2017), the learning motivation scale based on the self-determination theory by Ryan and Connell (1989), and a learning motivation scale based on the self-determination theory for Japanese university students (Okada & Nakaya, 2006; five items for introjected regulation, four for external regulation). All the items are shown in Table 1. The instructions stated, "Tell us about your learning in your current out-of-class tasks (homework) in the compulsory classes you just described above. What are the reasons for your learning with regard to these out-of-class tasks (homework)?" Participants were asked to choose their responses from five options, ranging from "Very true (5)" to "Not at all true (1)."

3) Out-of-class learning engagement (eight items)

We modified Skinner et al.'s (2009) behavioral engagement and emotional engagement scale to fit the context of out-of-class learning. An example of the items for behavioral engagement (three items) is "I work as hard as I can on out-of-class (homework)." An example of the items for emotional engagement (five items) is "It's fun to learn new things in out-of-class (homework)." The instructions stated, "Tell us about your approaches to learning in your current out-of-class tasks (homework) in the compulsory classes you just described above". Participants were asked to choose their responses from five options, ranging from "Very true (5)" to "Not at all true (1)."

2.2.2 Survey 2 (T2)

1) Out-of-class tasks in compulsory classes (four items)

In the first item, participants were asked whether they had participated in the T1 survey conducted a month ago, with two options: "Yes" or "No." Participants who answered "Yes" proceeded to answer the scale items below. Participants who answered "No" proceeded to answer three questions related to out-of-class tasks in compulsory classes similar to those in T1.

2) The out-of-class learning motivation scale (20 items)

The scale items were the same as for T1. The instructions stated, "Tell us about your learning in your current out-of-class tasks (homework) in the compulsory classes from the first survey (or the compulsory classes you just described above). What are the reasons for your learning with regard to these out-of-class tasks (homework)?"

3) Out-of-class learning engagement (eight items)

The scale items were the same as for T1. The instructions stated, "Tell us about your approaches to learning in your current out-of-class tasks (homework) in the compulsory classes from the first survey (or the compulsory classes you just described.)"

3. Results

3.1 Scale Structure

Confirmatory factor analysis (maximum likelihood method) was performed by structural equation modeling on the out-of-class learning motivation scale. This was done to compare two models. The first model assumes a four-factor structure: intrinsic regulation, identified regulation, introjected regulation, and external regulation. The second model assumes a two-factor structure: autonomous motivation consisting of intrinsic and identified regulation and controlled motivation consisting of introjected and external regulation. During the analysis, covariance was assumed between factors. Missing values were processed by the full information maximum likelihood estimation method.

We started by analyzing the T1 data. When all 20 items were analyzed using Model 1, the factor loadings of two items (one for introjected regulation and one for external regulation) were .50 or less. When they were deleted and we redid the analysis with 18 items, the goodness of fit was: $\chi^2(129)=380.813$, $p<.001$, comparative fit index; CFI=.896, root mean square error of approximation; RMSEA=.086 [90% confidence interval; CI .076-.096], standardized root mean squared residual; SRMR=.078, Akaike information criterion; AIC=12299.124. The 18 items were analyzed in Model 2 and the goodness of fit was: $\chi^2(134)=694.800$, $p<.001$, CFI=.767, RMSEA=.126 [90% CI .117–.135], SRMR=.120, AIC= 12604.301. Next, we analyzed the T2 data. The same 18 items as for T1 were analyzed in Model 1 and the goodness of fit was: $\chi^2(129)=329.212$, $p<.001$, CFI=.869, RMSEA=.099 [90% CI .086–.112], SRMR=.081, AIC= 7376.537. When the 18 items were analyzed in Model 2, the goodness of fit was: $\chi^2(134)=487.220$, $p<.001$, CFI=.769, RMSEA=.129 [90% CI .117–.142], SRMR=.102, AIC= 7525.545. Since Model 1 showed a better fit for both T1 and T2, we adopted Model 1 (four-factor structure) for this study. Table 1 shows the items and factor loadings of Model 1 for T1 and T2.

Table 1. Results of confirmatory factor analysis on out-of-class learning motivation scales at T1 and T2

	T1	T2
Intrinsic regulation		
I do out-of-class tasks because they are interesting to me.	.80	.79
I do out-of-class tasks because I love to learn.	.77	.81
I do my out-of-class tasks because they are fun.	.82	.80
I do out-of-class tasks because they are challenging to me.	.75	.82
I do out-of-class tasks because I feel good when I do them.	.63	.64
Identified regulation		
I do out-of-class tasks in order to learn and make progress.	.69	.69
I do out-of-class tasks because they can help me in the future.	.84	.77
I do my out-of-class tasks because I understand that they help me succeed in school.	.55	.74
I do out-of-class tasks because of the value and contribution of the out-of-class tasks to my learning.	.86	.85
I do out-of-class tasks because I think it is important to do out-of-class tasks.	.72	.78
I do out-of-class tasks in order to improve my understanding in this subject.	.84	.82
Introjected regulation		
I do my out-of-class tasks because I want to get a better grade than my friends.	.58	.57
I do my out-of-class tasks because I would feel ashamed if people around me will find out I didn't do them.	.61	.69
I do out-of-class tasks because I want people around me to think I'm a good student.	.79	.75
I do my out-of-class tasks because I would feel guilty if I didn't do them.	.54	.60
External regulation		
I do out-of-class tasks because that's the rule.	.79	.81
I do out-of-class tasks so that the teacher doesn't yell at me.	.52	.53
I do out-of-class tasks because that's what I'm supposed to do.	.84	.78

Note. Coefficients indicate factor loadings.

For out-of-class learning engagement, we conducted a confirmatory factor analysis (maximum likelihood method) assuming a two-factor structure of behavioral engagement and emotional engagement. The goodness of fit of the model for T1 was: $\chi^2(19)=82.664$, $p<.001$, CFI=.933, RMSEA=.113 [90% CI .088–.138], SRMR=.052. The goodness of fit of the model for T2 was: $\chi^2(19)=82.624$, $p<.001$, CFI=.909, RMSEA=.146 [90% CI .114–.178], SRMR=.060. The factor loadings for all items were greater than or equal to .62.

For each subscale, α coefficients were calculated to confirm internal consistency (Table 2). In addition to the overall analysis, α coefficients were calculated for TCT and TDT, respectively. The results showed that all α coefficients were greater than or equal to .70. As such, each variable was constructed using the additive average of the item scores. Table 2 shows the means, standard deviations, α coefficients, and sample sizes for each variable both overall and for each task.

Table 2. Means, standard deviations, α coefficients, and sample sizes for each variable

	All				TCT				TDT			
	Mean	*SD*	*α*	*N*	*Mean*	*SD*	*α*	*N*	*Mean*	*SD*	*α*	*N*
Intrinsic regulation T1	2.78	0.89	.86	261	2.65	0.88	.86	125	2.87	0.84	.85	98
Identified regulation T1	3.61	0.86	.88	260	3.54	0.92	.91	125	3.71	0.79	.86	96
Introjected regulation T1	3.26	0.86	.71	261	3.20	0.86	.71	124	3.29	0.84	.68	99
External regulation T1	3.95	0.86	.74	263	3.90	0.87	.72	125	4.05	0.85	.75	99
Behavioral engagement T1	3.57	0.83	.78	263	3.43	0.88	.81	126	3.71	0.74	.72	98
Emotional engagement T1	2.95	0.85	.85	259	2.78	0.85	.86	124	3.08	0.75	.81	96
Intrinsic regulation T2	2.86	0.91	.88	159	2.68	0.92	.90	74	2.99	0.91	.86	64
Identified regulation T2	3.59	0.86	.90	153	3.48	0.97	.93	72	3.69	0.77	.86	60
Introjected regulation T2	3.20	0.94	.74	158	3.02	0.96	.76	74	3.30	0.93	.72	63
External regulation T2	3.86	0.84	.72	159	3.81	0.86	.73	74	3.91	0.85	.74	64
Behavioral engagement T2	3.54	0.92	.85	159	3.35	0.99	.86	74	3.76	0.83	.82	64
Emotional engagement T2	3.01	0.87	.87	158	2.79	0.87	.87	74	3.17	0.86	.85	63

Note. TCT, tasks based on convergent thinking; TDT, tasks based on divergent thinking.

Next, correlation analyses were performed to examine the associations between the variables. In addition to the overall analysis, correlation analyses were performed for TCT and TDT, respectively (Tables A1, A2, and A3). First, we confirmed the simplex structure of the four motivations. Simplex structure in the self-determination theory means that the correlations between motivations assumed to be conceptually adjacent in terms of autonomy become stronger, while the correlations between motivations assumed to be conceptually separated become weaker (Ryan & Connell, 1989). For example, it is assumed that the correlation between intrinsic regulation and identified regulation will be stronger than the correlation between intrinsic regulation and introjected regulation. There was no significant positive correlation between identified and introjected regulation for TDT in T2, but we, otherwise, found expected correlations. This supports the validity of the out-of-class learning motivation scale used in this study. There was also a high positive correlation between T1 motivations and similar motivations in T2. For example, the correlation between intrinsic regulation in T1 and that in T2 was .64 (p<.001) for all, .67 (p<.001) for TCT, and .69 (p<.001) for TDT. This supports the motivation scale's test-retest reliability. Furthermore, when the relationship between motivation and engagement was examined, intrinsic regulation, identified regulation, and introjected regulation showed relatively strong positive correlations with engagement.

3.2 Examining Mean Differences

To examine the mean value differences, we performed a two-way mixed model analysis of variance for each variable, with the time period (T1 and T2) and task type (TCT and TDT) as independent variables. For intrinsic regulation, neither the main effects nor the interactions were significant (main effect of time: F (1, 109)=3.09, p=.081, η_P^2=.019; main effect of task: F (1, 109)=2.84, p=.095, η_P^2=.016; interaction effect: F (1, 109)=1.30, p=.256, η_P^2=.003). For identified regulation, neither the main effects nor the interactions were significant (main effect of time: F (1, 103)=0.57, p=.451, η_P^2=.000; main effect of task: F (1, 103)=0.63, p=.428, η_P^2=.000; interaction effect: F (1, 103)=0.23, p=.631, η_P^2=.000). For introjected regulation, neither the main effects nor the interactions were significant (main effect of time: F (1, 108)=2.65, p=.106, η_P^2=.015; main effect of task: F (1, 108)=0.12, p=.730, η_P^2=.000; interaction effect: F (1, 108)=0.41, p=.526, η_P^2=.000). For external regulation, only the main effect of time was significant (main effect of time: F (1, 110)=4.31, p=.040, η_P^2=.029; main effect of task: F (1, 110)=0.21, p=.645, η_P^2=.000; interaction effect: F (1, 110)=0.27, p=.605, η_P^2=.000). Multiple comparisons (Holm) showed a decrease in external regulation from T1 to T2.

For behavioral engagement, only the main effect of task was significant (main effect of time: F (1, 110)=0.11, p=.738, η_P^2=.000; main effect of task: F (1, 110)=7.30, p=.008, η_P^2=.053; interaction effect: F (1, 110)=0.00, p=.952, η_P^2=.000). Multiple comparisons (Holm) showed that behavioral engagement was higher in TDT than in TCT. For emotional engagement, only the main effect of task was significant (main effect of time: F (1, 108)=1.17, p=.281, η_P^2=.002; main effect of task: F (1, 108)=4.18, p=.043, η_P^2=.028; interaction effect: F (1, 108)=0.29, p=.589, η_P^2=.000). Multiple comparisons (Holm) showed that emotional engagement was higher in TDT than in TCT.

3.3 Examining the Reciprocal Relationship Between Motivation and Engagement in Out-of-class Learning

We examined the relationship between motivation and engagement in out-of-class learning. First, we created a cross-lagged panel model as shown in Figure 1. Since associations between the four types of engagement and between the two types of engagement are beyond the scope of this study, we did not set cross-lagged effect paths

between the four types of motivation and between the two types of engagement. For this model, we performed multi-group analysis by structural equation modeling with task type (TCT and TDT) as a moderator variable. In this study, we compared two models. The first is a model that freely estimates the values of each group. The second model places equality constraints on the path coefficients of each group. If Model 1 shows a better fit, it means that the relationships between the independent and dependent variables differ depending on the group. By contrast, if Model 2 shows a better fit, it means that the relationships between the variables are the same, regardless of group. In the analysis, covariance was assumed between all independent variables. We also assumed covariance between all dependent variable errors. Missing values were processed by the full information maximum likelihood estimation method.

The goodness of fit of Model 1 was: χ^2 (28)=32.121, p=.270, CFI=.997, RMSEA=.034 [90% CI .000–.080], SRMR=.047, AIC= 4208.195, while the goodness of fit of Model 2 was: χ^2 (50)=52.701, p=.370, CFI=.998, RMSEA=.021 [90% CI .000–.062], SRMR=.059, AIC= 4184.945. Model 2 showed a better fit than Model 1. Moreover, when the difference in chi-square values was tested to compare the two models, it was not significant ($\Delta\chi^2$ (22)=20.58, p=.547). This indicates that a more constrained model (Model 2) is preferred. Therefore, Model 2 was adopted for this study. This means that the relationship between motivation and engagement for out-of-class learning was not moderated by task.

The analysis results for Model 2 are shown in Table A4. Intrinsic regulation in T2 showed a positive association with emotional engagement in T1. Behavioral engagement in T2 showed positive associations with identified regulation in T1 and introjected regulation in T1. Emotional engagement in T2 showed a positive association with intrinsic regulation in T1.

4. Discussion

4.1 The Relationship Between Motivation and Engagement in Out-of-class Learning

Our analysis using a cross-lagged panel model clarified the relationship between motivation and engagement in out-of-class learning. The results partially supported the study hypotheses.

A positive relationship between intrinsic regulation and emotional engagement was found, partially supporting Hypothesis 1. First, we found a positive effect of T1 intrinsic regulation on T2 emotional engagement. Intrinsic regulation, which is classified as autonomous motivation, includes emotional components such as enjoyment and interest in learning content (Deci & Ryan, 2002). This was likely the reason for the positive associations, especially with emotional engagement. A meta-analysis of previous studies also showed a strong positive association between intrinsic regulation and positive emotions (Howard et al., 2021), which is consistent with the results of this study. In other words, learners who engage in out-of-class learning because they enjoy or like it are more likely to experience positive emotions during out-of-class learning. Moreover, we found that T1 emotional engagement had a positive impact on T2 intrinsic regulation. That is, learners who immerse themselves in out-of-class learning and experience positive emotions later engage in such learning because they find it enjoyable or fun. Combined with the above results, intrinsic regulation and emotional engagement are interrelated in time, constituting a positive spiral. These reciprocal relationships cannot be clarified from cross-sectional data. As such, the findings of this study clarified by the cross-lagged panel model for longitudinal data, are important.

Next, we found positive effects of T1 identified regulation and T1 introjected regulation on T2 behavioral engagement. The former result was in line with Hypothesis 1, but the latter result was different from Hypothesis 2. Identified regulation, classified as autonomous motivation, has been shown to have positive effects on learning, such as promoting the use of metacognitive strategies and encouraging learners to make effort (e.g., Howard et al., 2021; Nishimura et al., 2011). This study's results are consistent with those of previous studies. By internalizing the value of learning in a way that gives out-of-class learning importance, students can work hard and persistently on the out-of-class learning without giving up, despite encountering difficulties. Moreover, previous studies have shown that introjected regulation, which is classified as controlled motivation, is associated not only with negative variables but also with positive variables. For example, Howard et al. (2021) revealed a positive association between introjected regulation and effort by a meta-analysis. Even relatively low autonomous motivation, such as engaging in out-of-class learning because individuals want to show that they are superior to others or because they do not want to be embarrassed, may promote hard work and persistence in out-of-class learning. Conversely, T1 behavioral engagement was not found to have any effect on T2 identified regulation or T2 introjected regulation. This implies a causal relationship in which identified regulation and introjected regulation promote behavioral engagement. By using a cross-lagged panel model for the longitudinal data, we were able to clarify such a causal relationship. Among several types of engagement, behavioral engagement in particular has been shown to directly determine academic achievement (Ito & Umemoto, 2022; Reeve, 2013). Our findings clarify the factors that

influence behavioral engagement in out-of-class learning.

Finally, no relationship was observed between external regulation and engagement, which is consistent with Hypothesis 2. In other words, controlled instruction and environments that force students to engage in out-of-class learning that increases external regulation do not actually lead to active learning. In future research, examining the variables that are positively or negatively related to external regulation in out-of-class learning is recommended.

4.2 Differences in Out-of-class Learning by Task Type

Based on the free-text descriptions of the university students, this study divided out-of-class learning tasks into two types: TCT and TDT. TCT is a task that promotes a correct understanding of the learning content, such as solving problems in a textbook. TDT is a task that encourages various ideas, such as preparing presentations and writing essays. The results of the multi-group analysis showed that the relationships between motivation and engagement in out-of-class learning are not moderated by task type. That is, the relationships between motivation and engagement observed in this study apply to a variety of out-of-class learning tasks and may be universal. Analyses of variance were also performed to compare the means of the four types of motivation according to TCT and TDT, and no differences were found. Meanwhile, there were differences in mean out-of-class learning engagement depending on task type. Specifically, TDT had higher mean values in behavioral and emotional engagement than TCT. With TCT, where learners read textbooks or solve problems to understand the learning content, there tends to be a predetermined goal or solution, which means that the learners' free thinking and efforts are relatively restricted. However, with TDT, where learners creatively prepare presentations and write essays based on their various ideas, learners have the relative freedom to work as they wish. TDT is likely to increase effort, concentration, and positive emotions regarding the task. In future research, it would be important to examine factors and practical interventions that can increase behavioral and emotional engagement, especially in TCT, where engagement tends to be low.

4.3 The Out-of-Class Learning Motivation Scale

We examined the validity of the out-of-class learning motivation scale developed in this study. As a result of confirmatory factor analysis of the scale, the four-factor structure of intrinsic regulation, identified regulation, introjected regulation, and external regulation was found to have better fitness values than the two-factor structure of autonomous motivation and controlled motivation described by Katz et al. (2011). A similar trend was also observed in the T2 data. This indicated that the T1 results were reproduced with T2. This is evidence of the strong validity of the four-factor structure of this study's motivation scale. Furthermore, correlation analysis indicated a simplex structure for the four types of motivation. For example, intrinsic regulation showed a strong positive association with identified regulation, a moderate to weak positive association with introjected regulation, and no association with external regulation. This is consistent with the conceptual definition of self-determination theory and provides evidence of the constructive validity of our motivation scale.

Next, the cross-lagged panel model showed that intrinsic and identified regulation, which are classified as autonomous motivation, had different association with engagement. Intrinsic regulation showed a positive association with emotional engagement, while identified regulation showed a positive association with behavioral engagement. Moreover, introjected and external regulation, which are classified as controlled motivation, had different association with engagement. Introjected regulation showed positive association with behavioral engagement, while external regulation showed no association with any type of engagement. Each of the four motivation types exhibited unique associations with external variables. Moreover, as described above, average intrinsic regulation is below three points which is the midpoint of the five-point scale. By contrast, the average value for identified regulation is above 3.5 points on the five-point scale. That is, learners tend to find out-of-class learning less enjoyable or interesting but are more likely to think it is important or useful. Intrinsic and identified regulation are classified as autonomous motivation, but in terms of averages, we can observe different tendencies. Therefore, it is important to handle out-of-class learning motivation as four factors with regard to Japanese university students, rather than the two factors of autonomous motivation and controlled motivation as proposed by Katz et al. (2011).

We also examined the reliability of our out-of-class learning motivation scale. First, when we calculated the α coefficients for each of the four motivations, we found sufficient values for each. This provided evidence of internal consistency. The results of the correlation analysis of the T1 and T2 data showed strong positive associations between the same motivations. For example, the overall correlation between T1 intrinsic regulation and T2 intrinsic regulation was .64, the correlation between T1 identified regulation and T2 identified regulation was .70, the correlation between T1 introjected regulation and T2 introjected regulation was .70, and the correlation between T1 external regulation and T2 external regulation was .71. This is evidence of test-retest reliability. These

results confirm the validity and reliability of this study's motivation scale. However, to obtain robust results and interpretations in future studies, further detailed examination and confirmation of the validity and reliability of the scale are required.

4.4 Practical Implications

Based on this study's results, interventions with regard to identified and introjected regulation are recommended to promote behavioral engagement in out-of-class learning. However, introjected regulation has also been found to have negative effects on learning, with Howard et al. (2021) noting a positive association with anxiety. Thus, interventions should particularly focus on identified regulation. For example, it is thought that identified regulation can be promoted by carefully explaining the importance of out-of-class learning to learners and highlighting its usefulness for in-class learning and academic achievement at school.

When considering educational practice, the reciprocal relationship between intrinsic regulation and emotional engagement is significant. The average score of intrinsic regulation is below three points, which is the midpoint of a five-point scale. The out-of-class learning (homework) in this study is not something that learners opt to do themselves as it is unilaterally imposed on them by their teachers. Consequenlty, it may be difficult for learners to engage in out-of-class learning simply because it is fun or interesting (e.g., Goetz et al., 2012), thereby making it difficult to directly enhance intrinsic regulation through interventions. As such, intervening to facilitate emotional engagement may indirectly enhance intrinsic regulation. For example, suppressing negative emotions about learning by preparing tasks at a level of difficulty that is not too high for the learners, alongside assigning out-of-class tasks that are related to their interests and concerns, may make it easier for them to experience positive emotions when performing the tasks. These interventions, aimed at creating positive emotions during out-of-class learning, can indirectly support intrinsic regulation in subsequent out-of-class learning.

4.5 Limitations and Future Research Prospects

The following are the limitations of this study and avenues for future research: First, the results obtained in this study were based on a sample from one university. It is necessary to consider reproducibility and generalizability by using samples from other universities and faculties. Second, out-of-class learning may be influenced by exams, which mainly determine a student's grades in the class. However, this study did not measure information about exams (e.g., whether the compulsory classes taken by the participants had midterm or final exams.). Therefore, future studies should consider information about exams, such as type and timing. Moreover, it is necessary to clarify antecedent factors for supporting out-of-class learning motivation. For example, the self-determination theory shows that autonomy support promotes autonomous motivation. Autonomy support refers to what one person says and does to enhance the learner's internal perceived locus of causality, volition, and perceived choice during action (Su & Reeve, 2011). It is important to clarify whether autonomy support from teachers in class affects learners' motivation for out-of-class learning. Likewise, it is necessary to clarify how out-of-class engagements relate to in-class efforts and academic achievement (e.g., proficiency and performance such as test scores). For example, proactive efforts to perform out-of-class tasks may lead to a better understanding of what is learned in class, while improving exam scores. Conversely, in-class academic achievement may promote autonomous motivation for out-of-class learning. It is necessary to clarify the causal and reciprocal relationships between these variables through longitudinal surveys. There is little research on motivation that is based on the self-determination theory for university students' out-of-class learning. Therefore, it is first necessary to accumulate such research findings. It is also extremely important to develop and evaluate structured programs that support university students' motivation and engagement in out-of-class learning.

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Authors' contributions

Takatoyo Umemoto: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing-original draft, Writing-review & editing. Tsutomu Inagaki: Conceptualization, Methodology, Investigation, Writing-original draft, Writing-review & editing.

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Competing interests

The authors declare no conflicts of interest.

Informed consent

Obtained.

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Notes

Note 1. To examine differences in mean values due to gender, a *t*-test was conducted for each variable with gender as an independent variable. The mean difference in external regulation in T1 was marginally significant (t (260) = 1.86, p = .064), but no significant mean difference was revealed for the other variables (ts < 1.46, ps > .144). Therefore, we considered that there were no significant gender differences and did not refer to gender in the subsequent analyses.

Note 2. To examine the difference in mean values between students who participated in two surveys and those who participated only in the T1 survey, a *t*-test was conducted for each variable at T1. The results did not reveal significant differences (ts < 1.24, ps > .216). Therefore, it appears that the number of times that participants took part in the survey did not have a significant effect on the results.

Appendix A

Table A1. Overall correlation analysis results

		1		2		3		4		5		6		7		8		9		10		11	
1	Intrinsic regulation T1																						
2	Identified regulation T1	.71	***																				
3	Introjected regulation T1	.43	***	.55	***																		
4	External regulation T1	-.05		.23	***	.39	***																
5	Behavioral engagement T1	.50	***	.58	***	.42	***	.18	**														
6	Emotional engagement T1	.79	***	.69	***	.44	***	-.01		.63	***												
7	Intrinsic regulation T2	.64	***	.54	***	.35	***	.05		.53	***	.71	***										
8	Identified regulation T2	.49	***	.70	***	.40	***	.22	*	.55	***	.60	***	.69	***								
9	Introjected regulation T2	.29	**	.37	***	.70	***	.38	***	.41	***	.30	**	.38	***	.38	***						
10	External regulation T2	.04		.26	**	.39	***	.71	***	.20	*	.07		.04		.28	**	.49	***				
11	Behavioral engagement T2	.31	***	.51	***	.39	***	.18	*	.70	***	.50	***	.52	***	.65	***	.45	***	.26	**		
12	Emotional engagement T2	.61	***	.61	***	.37	***	.09		.60	***	.73	***	.82	***	.71	***	.39	***	.09		.64	***

Note. *p<.05, **p<.01, ***p<.001.

Table A2. Correlation analysis results for tasks based on convergent thinking

		1		2		3		4		5		6		7		8		9		10		11	
1	Intrinsic regulation T1																						
2	Identified regulation T1	.72	***																				
3	Introjected regulation T1	.48	***	.61	***																		
4	External regulation T1	-.14		.24	**	.38	***																
5	Behavioral engagement T1	.55	***	.60	***	.49	***	.17															
6	Emotional engagement T1	.86	***	.74	***	.53	***	.00		.68	***												
7	Intrinsic regulation T2	.67	***	.56	***	.35	**	.02		.57	***	.68	***										
8	Identified regulation T2	.57	***	.75	***	.46	***	.23		.52	***	.62	***	.73	***								
9	Introjected regulation T2	.30	*	.38	**	.62	***	.24		.45	***	.37	**	.49	***	.49	***						
10	External regulation T2	.06		.28	*	.38	**	.70	***	.14		.12		.15		.37	**	.44	***				
11	Behavioral engagement T2	.40	**	.55	***	.46	***	.16		.69	**	.55	***	.59	***	.63	***	.64	***	.28	*		
12	Emotional engagement T2	.67	***	.62	***	.34	**	.06		.64	***	.76	***	.85	***	.80	***	.52	***	.22		.68	***

Note. *p<.05, **p<.01, ***p<.001.

Table A3. Correlation analysis results for tasks based on divergent thinking

		1		2		3		4		5		6		7		8		9		10		11	
1	Intrinsic regulation T1																						
2	Identified regulation T1	.68	***																				
3	Introjected regulation T1	.22	*	.43	***																		
4	External regulation T1	.01		.25	*	.53	***																
5	Behavioral engagement T1	.46	***	.53	***	.30	**	.30	**														
6	Emotional engagement T1	.73	***	.66	***	.24	*	.06		.53	***												
7	Intrinsic regulation T2	.69	***	.56	***	.35	*	.23		.44	**	.73	***										
8	Identified regulation T2	.52	***	.73	***	.42	**	.36	*	.55	***	.67	***	.65	***								
9	Introjected regulation T2	.23		.35	*	.78	***	.59	***	.32	*	.15		.19		.20							
10	External regulation T2	-.06		.20		.49	**	.73	**	.23		-.03		-.06		.16		.61	**				
11	Behavioral engagement T2	.23		.52	***	.43	**	.38	**	.65	***	.40	**	.37	**	.64	***	.23		.27	*		
12	Emotional engagement T2	.63	***	.66	***	.37	**	.21		.50	***	.73	***	.74	***	.63	***	.14		-.04		.53	***

Note. *p<.05, **p<.01, ***p<.001.

Table A4. Multi-group analysis results for Model 2

Objective variable	Tasks based on convergent thinking								Tasks based on divergent thinking							
Explanatory variable	*B*	95%CI			*SE*	*β*	*p*		*B*	95%CI			*SE*	*β*	*p*	
Intrinsic regulation T2																
Intrinsic regulation T1	0.45	[	0.26	, 0.64]	0.10	.44	.000		0.45	[	0.26	, 0.64]	0.10	.46	.000	
Behavioral engagement T1	0.04	[	-0.09	, 0.18]	0.07	.04	.550		0.04	[	-0.09	, 0.18]	0.07	.04	.550	
Emotional engagement T1	0.29	[	0.07	, 0.51]	0.11	.27	.011		0.29	[	0.07	, 0.51]	0.11	.25	.011	
R^2						.50								.48		
Identified regulation T2																
Identified regulation T1	0.61	[	0.46	, 0.76]	0.08	.61	.000		0.61	[	0.46	, 0.76]	0.08	.63	.000	
Behavioral engagement T1	0.00	[	-0.14	, 0.14]	0.07	.00	.975		0.00	[	-0.14	, 0.14]	0.07	.00	.975	
Emotional engagement T1	0.12	[	-0.04	, 0.29]	0.09	.12	.147		0.12	[	-0.04	, 0.29]	0.09	.12	.147	
R^2						.50								.51		
Introjected regulation T2																
Introjected regulation T1	0.72	[	0.59	, 0.85]	0.07	.64	.000		0.72	[	0.59	, 0.85]	0.07	.69	.000	
Behavioral engagement T1	0.13	[	-0.03	, 0.30]	0.08	.12	.121		0.13	[	-0.03	, 0.30]	0.08	.11	.121	
Emotional engagement T1	-0.10	[	-0.25	, 0.06]	0.08	-.08	.235		-0.10	[	-0.25	, 0.06]	0.08	-.08	.235	
R^2						.43								.51		
External regulation T2																
External regulation T1	0.66	[	0.55	, 0.78]	0.06	.68	.000		0.66	[	0.55	, 0.78]	0.06	.68	.000	
Behavioral engagement T1	0.03	[	-0.13	, 0.20]	0.09	.04	.699		0.03	[	-0.13	, 0.20]	0.09	.03	.699	
Emotional engagement T1	0.01	[	-0.15	, 0.17]	0.08	.01	.933		0.01	[	-0.15	, 0.17]	0.08	.01	.933	
R^2						.47								.47		
Behavioral engagement T2																
Intrinsic regulation T1	-0.13	[	-0.31	, 0.05]	0.09	-.12	.163		-0.13	[	-0.31	, 0.05]	0.09	-.14	.163	
Identified regulation T1	0.31	[	0.13	, 0.50]	0.10	.30	.001		0.31	[	0.13	, 0.50]	0.10	.30	.001	
Introjected regulation T1	0.17	[	0.02	, 0.31]	0.08	.15	.028		0.17	[	0.02	, 0.31]	0.08	.17	.028	
External regulation T1	-0.02	[	-0.16	, 0.11]	0.07	-.02	.748		-0.02	[	-0.16	, 0.11]	0.07	-.02	.748	
Behavioral engagement T1	0.50	[	0.35	, 0.65]	0.08	.45	.000		0.50	[	0.35	, 0.65]	0.08	.46	.000	
R^2						.47								.44		
Emotional engagement T2																
Intrinsic regulation T1	0.20	[	0.02	, 0.37]	0.09	.21	.026		0.20	[	0.02	, 0.37]	0.09	.22	.026	
Identified regulation T1	0.13	[	-0.01	, 0.27]	0.07	.14	.072		0.13	[	-0.01	, 0.27]	0.07	.13	.072	
Introjected regulation T1	-0.01	[	-0.12	, 0.10]	0.06	-.01	.840		-0.01	[	-0.12	, 0.10]	0.06	-.01	.840	
External regulation T1	0.03	[	-0.07	, 0.13]	0.05	.03	.540		0.03	[	-0.07	, 0.13]	0.05	.03	.540	
Emotional engagement T1	0.44	[	0.26	, 0.62]	0.09	.44	.000		0.44	[	0.26	, 0.62]	0.09	.41	.000	
R^2						.55								.47		