A Quantitative Investigation into Student Outcomes from Learning Assistant Engagement in Economics Class Hours

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Abstract

This paper employs an econometric method in estimating student outcomes from learning assistant (LA) engagement in economics class hours. Many US universities have already introduced an LA system into undergraduate courses, primarily in science, technology, engineering, and mathematics (STEM) disciplines. The author and his colleagues applied the LA model to an economics course at a Japanese university. We expected that LAs would also help economics students learn more readily and energize their in-class learning. Thus this paper investigates the effect of learning assistant support on the students in an introductory macroeconomics course. While circumventing collinearity problems between explanatory variables, the ordinary least squares estimation reveals that the LA model in economics fosters students' exam performance. Hence this paper provides one piece of evidence supporting the use of LAs not only in STEM education but also in economics.

Keywords: learning assistant, undergraduate education, economics education, variance inflation factors (VIFs)

1. Introduction

This paper investigates the learning assistant (LA) support of the students in an introductory macroeconomics course. Many instructors have recently transformed a traditional lecture into a new instructional format, such as a flipped classroom or online homework. LAs are one of the new approaches to undergraduate education. The Learning Assistant Alliance (2019) defines learning assistants as follows:

A Learning Assistant, or LA, is an undergraduate student who, through the guidance of course instructors and a special pedagogy course, facilitates discussions among groups of students in a variety of classroom settings that encourage student engagement and responsibility for learning. (p. 1)

The alliance has developed methods for implementing and assessing the LA model. In this regard, Otero et al. (2010) demonstrate that the LA model yields learning gains to students and LAs themselves and enhances LAs' future career prospects in teaching and research. Herrera et al. (2018) report that the LA model originated at the University of Colorado Boulder and has spread to over 75 institutions. As the use of the model expands across the US, many universities have already introduced LAs into undergraduate courses, primarily in science, technology, engineering, and mathematics (STEM) disciplines.

Economics is positioned near the STEM disciplines because it frequently uses mathematical tools to understand economic phenomena. Students sometimes find it challenging to understand economics—especially when it comes to the mathematical interpretation of human behavior. Therefore, the author and his colleagues expected that the engagement of LAs would help students learn more readily and energize their in-class learning. Thus in 2018, we initiated the use of LAs in teaching an introductory economics course. We have collected data for our new instructions to quantitatively gauge the extent to which LA support enhances students' achievement.

In Japan, the Ministry of Education, Culture, Sports, Science, and Technology (2000) argued that universities should provide an educational opportunity for seniors to assist in undergraduate education. This report, well known as the *Hironaka* report, made the first official statement declaring the importance of undergraduates' involvement in undergraduate education. As this paper describes, the LA model embodies the report's proposition.

The purpose of this paper is to investigate whether the LA model can afford a better understanding of economics for Japanese undergraduate students. In this way, this paper investigates two areas that are as yet relatively unexplored. First, the LA model has not yet spread widely in economics courses around the world, to our knowledge. Second, Japanese students do not have much experience with LAs in class. By discovering how LAs work out for them, we can help to meet the contemporary demand for undergraduate involvement in education.

In the remainder of this paper, we first introduce a literature review. Next, we describe our methodology concerning the data that we use and a theoretical specification. We then report and discuss our estimation results. Based on our evidence, we propose recommendations. Finally, we present conclusions derived from this study.

2. Literature Review

The past two decades have seen renewed interest in economics education at the undergraduate level. Mixon and Upadhyaya (2008) report that more papers about economics education have appeared in print since 2000 than before. A traditional outlet in this field had been the *Journal of Economic Education*. However, two new journals were launched in this field in 2002 and 2003, respectively: the *Journal of Economics and Finance Education* and the *International Review of Economics Education*. General-interest journals, such as the *American Economic Review*, also publish economics education research.

Table 1

Previous Studies on Economics Education

	Attainment Measure	Method A	Method B	Conclusion	Institution	Country
Chevalier, Dolton, and Lührmann (2018)	z-score	quizzes in grade	quizzes recommended	A works better than B	University of London	UK
Pozo and Stull (2006)	score quantile	math learning in grade	math learning recommended	A works better than B	Western Michigan U	USA
Kajitani, Morimoto, and Suzuki (2020)	final exam score	ranking reported	ranking not reported	MIxed results	A Japanese university	Japan
Swoboda and Feiler (2016)	Test of Understanding in College Economics (TUCE)	blended learning	traditional learning	A works better than B	Carlton College	USA
Lee, Courtney, and Balassi (2010)	TUCE	online homework	traditional homework	No clear difference	Saint Mary's College of California	USA
Balaban, Gilleskie, and Tran (2016)	final exam score	flipped classroom	traditional classroom	A works better than B	U of North Carolina at Chapel Hill	USA
Arteaga (2018)	wage	less-required new coursework	more-required old coursework	B works better than A	Universidad de Los Andes	Colombia

Table 1 summarizes several papers about economics education. Chevalier et al. (2018) in the UK and Pozo and Stull (2006) in the US investigate learning outcomes associated with students' motivation. Both papers suggest that instructors should incorporate students' understanding of supplementary materials into their grading considerations rather than simply recommend them as an optional study. They also report that lower-performing students benefit more from the built-in grading policy. Related to students' incentive to study, Kajitani et al. (2020) examine the effect on students' final scores of disclosing their mid-term exam ranking. They report that students' knowing their ranking may motivate them to study for the final exam—depending on how well they performed in the mid-term exam. For students with a low score in the mid-term exam, the disclosure led to a higher final exam score. However, for students with a high score on the mid-term exam, the disclosure lowered the final exam score.

Swoboda and Feiler (2016) and Balaban et al. (2016) compare new learning styles such as blended learning and the flipped classroom, respectively, to traditional styles at US universities. Both argue that new approaches work better for students than traditional learning. On the other hand, the work of Lee et al. (2010) demonstrates no apparent difference in exam scores between online homework and traditional assignments. Apart from class teaching, Arteaga (2018) reveals that a curriculum transition toward less required coursework at a Colombian university reduced graduates' earnings.

In sum, researchers in various countries have shed light on different aspects of economics education. Roughly speaking, new approaches (i.e., Method A in Table 1) help students understand economics better than traditional ones (i.e., Method B in Table 1). However, new practices do not always prove superior.

Evidence-based suggestions valuing LAs' roles in universities arise from research in the STEM field (Herrera et al., 2018; Knight et al., 2015; Otero et al., 2010; Thompson et al., 2020). In general, we are not sure whether support staff in schools help students understand the content they must learn. For example, in the UK, Blatchford et al. (2009) collect data from elementary and secondary schools and conclude that the involvement of support staff makes a slight improvement in pupils' learning. On the other hand, we are not familiar with how LAs influence students in teaching economics. However, we expect that LAs will have an indispensable role in economics teaching because LAs are increasingly common in teaching the STEM disciplines. Hence it is worth examining

how they work in economics instruction.

3. Methodology

Data

We studied an introductory macroeconomics course taught by the author at Seikei University in Japan during the 2018 fall semester. About 7500 undergraduates attend the private university, located in a suburb of Tokyo. The macroeconomics course was compulsory for first-year economics students, with limited courses accepted as compensation for a failing grade. We introduced the LA model into this course, and three LAs attended the class regularly. Following procedures recommended by Otero et al. (2010) and the 2018 version of the Learning Assistant Alliance (2019), we held a weekly content preparation meeting between LAs and faculty members, where we reflected on the past week, examined the following week's materials, and proposed a question-solving time appropriate to students. Before this semester, LAs took a 10-week pedagogy course as one of the LA model's significant activities.

Table 2 illustrates the timeline of the course during the semester. In Weeks 1 and 2, 123 out of 128 students consented to the use of their data for this research. From Week 1 to Week 7, we performed quizzes using traditional answer sheets. However, from Week 8 to Week 14 we conducted quizzes using answer sheets with an LA-support format. Although LAs were ready to support students even when taking quizzes using traditional answer sheets, students rarely asked the LAs for help. To encourage them to use LA support, the instructor revised the answer sheet to an LA-support format. Therefore, we can regard the first seven weeks as a traditional class because of traditional answer sheets and the second seven weeks as an LA-supported class. Whether the answer sheet was traditional or LA-supported, the quiz took place for about 15 minutes in the middle of the 90-minute class. Before and after the quiz, the lecture went on.

Table 2

Timeline of the Course

Week	Schedule	Traditional quiz	LA confirmation quiz
1	collecting consents	✓	
2	collecting consents	✓	
3		✓	
4		✓	
5	test 1	✓	
6		✓	
7		✓	
8	test 2		✓
9			✓
10			✓
11	test 3		✓
12			✓
13			✓
14	test 4		✓
15			
16	final exam		

Figure 1 shows a sample of the revised sheet. The first question (Q1) concerns a basic concept. Those that follow (Q2 and Q3) include questions for which the student's understanding of the first (Q1's) answer serves as a scaffold. The instructor inserted a space for the LA to confirm the student's answer to the first question. Students may raise their hands if they want an LA to check their answers. When the LA confirms that the answer is correct, he or she signs in the space provided. In other words, no signature means that the student either had a wrong answer or did not request the LA's help. In this way, we could track which students used LAs and which did not. These trackable data allow us to distinguish the learning effect between LA users and non-LA users within the LA-supported class.

A researcher may want to compare classes with and without LAs as treatment and control groups, respectively. In this case, the researcher would compare the average class performance with that of the counterpart. However, for fair and equitable treatment, it is problematic to assign LAs to one class but not to another class. Therefore, this paper compares the weeks of using traditional answer sheets with those of using the LA-support format. Also, it traces individual performance by using
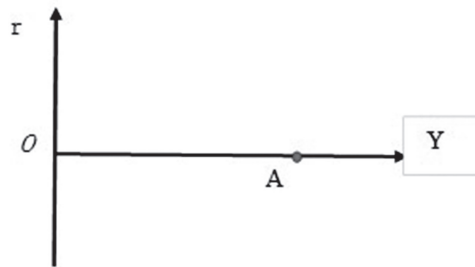
individual records of how many times the student used LA support. However, as described in the following subsection, we must avoid collinearity problems that could arise from mutually dependent data to make up for not dividing the students in advance into treatment and control groups.

Figure 1

*Sample of the Answer Sheet with an LA-Support Format*

In-Class Quiz
Q1 :

Raise your hand if you want an LA to confirm your Q1 answer as scaffolding for solving the following question. Note that the LA's confirmation does not mean you obtained marks, because your instructor officially grades your answer.

Regarding the Q1 answer, a confirming LA's initial signature : _____

Q2 :   (mathematical procedure)

$r =$

Q3.
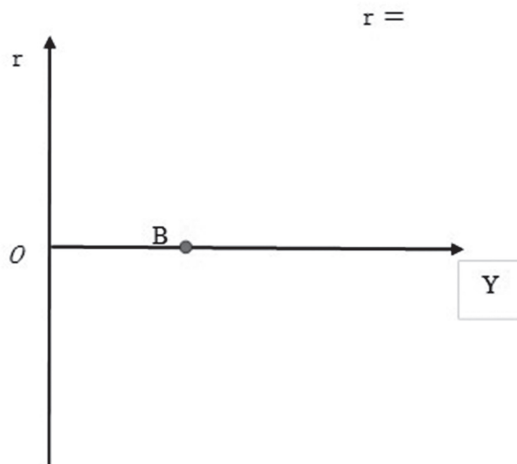
At the end of the semester, we had a 50-minute final exam covering all content presented from the first week to the concluding week. We also had four short-time (about 15-minute) tests (tests 1, 2, 3, and 4) in the period of the course. A short-time test covered the contents treated during the preceding few weeks. Hence, we regard the final exam as an appropriate output measure. In class, students absent from the final exam have zero points or a make-up exam. In this study, however, we designated those absent students' scores as "data unavailable." Therefore, observations reflect the number of students who attended the final exam.

Theoretical Methodology

Here we specify our basic equation based on the education production function, in which output is student content understanding and inputs are their ability, efforts, and exogenous characteristics (Balaban et al., 2016; Hanushek, 2020).

For student i,

final test's z-score $_i$

$= \beta_1$ the number of traditional quiz submissions $_i$

$+ \beta_2$ the number of LA-format quiz submissions $_i$

$+ \beta_3$ the number of LA confirmations $_i$

$+ \sum_{j>3} \beta_j$ student i's individual factor j

$+$ constant $+$ residual. （1）

We employ ordinary least squares regression to estimate the parameters of Equation 1.

As stated in the preceding subsection, the final test covered all contents taught in the entire semester. Therefore, the final test score represents the output from inputs for an individual student. For student i, we converted the test score to a z-score, following Chevalier et al. (2018). Thus student i's z-score is calculated by subtracting the examination average from the student's raw score and dividing the difference by the standard deviation.

For student i, submitting traditional quizzes is equal to attending the class when conducting the traditional quiz. Similarly, for student i, submitting an LA-format quiz is equal to attending the class when conducting LA-format quizzes. The course attendance was almost compulsory, as described in the preceding subsection. Therefore, absence from the class is mainly caused by exogenous factors such as illness or casual incidents, although the lack of diligent effort accounts for some students' absences. Hence, we

presume that the number of quiz submissions depends on exogenous factors. We can conclude that LA-format quizzes function better than traditional quizzes if the estimates of β_1 and β_2 are close to zero and greater than zero, respectively. The first research question is whether the estimates of β_1 and β_2 satisfy the condition

The number of LA confirmations indicates student i's effort realization made possible by the LA model. We can conclude that LA involvement enhances student performance if the estimate of β_3 is greater than zero. The second research question is whether the estimate of β_3 comes out as expected. The quiz-solving condition allows the students who received LA confirmations to help neighboring students. In this sense, β_3 represents the direct effect of the LA on a student leading a small study group on the spot. On the other hand, β_2 demonstrates the indirect effect of LA confirmations on those who benefited from LA support but did not directly obtain LA support.

Regarding exogenous characteristics, student i's individual factors include hometown location, entrance examination type, gender, birth year, and club affiliation. We obtained approval to use the data from the Seikei University's Faculty Development Committee for individual factors. Table 3 describes the variables that we use in this paper and reports the descriptive statistics.

In performing regression analysis, we should note the possibility of collinearity problems in the estimation. If a correlation between explanatory variables is sufficiently strong, the coefficient standard errors become so needlessly large as to make significant test results inconclusive (Belsley et al., 1980). Hence we test for the collinearity between one explanatory variable and others, using variance inflation factors (VIFs). A high value of VIF indicates that the explanatory variable for the estimated coefficient excessively increases its standard errors due to collinearity with other explanatory variables. As a theoretical argument, O'Brien (2007) suggests that researchers eliminate one or more explanatory variables from the regression when the VIF is greater than 10. In investigating education data, Entrich (2021) uses the VIF of 10 as the threshold point above which the collinearity problem occurs. Therefore we adopt their criterion (i.e., the VIF of 10) for diagnosing collinearity between explanatory variables.

Table 3

Descriptive Statistics

Variable	Variable description for student i	Mean	SD.	Max.	Min.
Final	z-score of final exam	0.0000	1.0045	1.7796	-3.1490
Number of traditional quiz submissions	Described under "Variable"	6.1463	1.2590	7.0000	1.0000
Number of LA-format quiz submissions	Described under "Variable"	5.7398	1.8370	7.0000	0.0000
Number of LA confirmations	Described under "Variable"	2.8049	1.9019	7.0000	0.0000
Number of LA confirmations with perfect answers	Described under "Variable"	2.6585	1.8145	7.0000	0.0000
Number of LA confirmations with imperfect answers	Described under "Variable"	0.1463	0.4185	2.0000	0.0000
Number of no LA confirmations with perfect answers	Described under "Variable"	2.0081	1.6669	7.0000	0.0000
Number of no LA confirmations with imperfect answers	Described under "Variable"	0.9268	1.0494	5.0000	0.0000
(Individual factor)					
Entrance exam type 1	=1 if the student had passed entrance exam type 1, =0 otherwise.	0.3496	0.4788	1.0000	0.0000
Entrance exam type 2	=1 if the student had passed entrance exam type 2, =0 otherwise.	0.0488	0.2163	1.0000	0.0000
Entrance exam type 3	=1 if the student had passed entrance exam type 3, =0 otherwise.	0.0325	0.1781	1.0000	0.0000
Entrance exam type 4	=1 if the student had passed entrance exam type 4, =0 otherwise.	0.1301	0.3378	1.0000	0.0000
Entrance exam type 5	=1 if the student had passed entrance exam type 5, =0 otherwise.	0.2520	0.4360	1.0000	0.0000
Hometown location	=1 if the student comes from outside the area of Tokyo and its vicinities (i.e., Kanagawa, Saitama, and Chiba prefectures), =0 otherwise.	0.1545	0.3629	1.0000	0.0000
Club affiliation	The number of clubs to which the student belongs.	1.7642	1.255	6.0000	0.0000
Gender	=1 if the student is a female, =0 otherwise.	0.4146	0.4947	1.0000	0.0000
Birth year	=1 if the student is older than 18, =0 otherwise.	0.1301	0.3378	1.0000	0.0000

4. Results and Discussion

Basic Estimations

Results. Table 4 presents ordinary least squares estimates based on Equation 1. Robust standard errors are in parentheses. P-values are in brackets. Values in angle brackets report the VIFs for the estimated coefficients. Column 1 presents the estimation of the parameters of Equation 1 that excludes the number of LA confirmations from the explanatory variables. The estimated coefficient of β_1 is 0.1423, with a p-value of 0.1188. The effect of traditional quizzes on the final exam is statistically insignificant from zero at the 10% level. Because the p-value is slightly greater than 0.1, we cannot say that using the traditional answer sheet does not shape learning outcomes.

Table 4

Basic Estimations

	Column number	1	2
	Estimation name	Basic 1	Basic 2
Coef.	Explanatory variables ╲ Dependent variable	final	final
β_1	Number of traditional quiz submissions	0.1423 (　0.0905　) [　0.1188　] <　1.4020　>	0.1055 (　0.0896　) [　0.2419　] <　1.4052　>
β_2	Number of LA-format quiz submissions	0.2839 (　0.0770　) [　0.0004　] <　1.3371　>	0.2375 (　0.0817　) [　0.0045　] <　1.4566　>
β_3	Number of LA confirmations		0.0870 (　0.0411　) [　0.0368　] <　1.3592　>
	R-squared	0.3617	0.3819
	Obs.	111	111

Note: Robust standard errors are in parentheses. P-values are in brackets. Variance inflation factors (VIFs) are in angle brackets. The regressions control for constant and individual factors: Hometown location, entrance examination type, gender, birth year, and club affiliation.

On the other hand, the estimated coefficient of β_2 is 0.2839, with a p-value of 0.0004. The effect of the LA-format quiz on the final exam is statistically significantly different from zero at 1%. Both estimates are positive, but the p-value for β_2 is much lower than that for β_1. The LA-format quiz makes a greater contribution to students' understanding than the traditional quiz does. In Column 1, VIFs for β_1 and β_2 range from 1.0 to 2.0, far below 10.0. Thus we can conclude that there is no collinearity problem, and the corresponding standard errors do not needlessly inflate.

Column 2 reports the estimation that includes the number of LA confirmations in the explanatory variables. The estimated coefficient of β_1 is 0.1055, with a p-value of 0.2419. On the other hand, the estimated coefficient of β_2 is 0.2375, with a p-value of 0.0045. As in Column 1, both estimates are positive, but the p-value for β_2 is much lower than that for β_1. The estimated coefficient of β_3 is 0.0870, with a p-value of 0.0368. The effect of LA confirmations on the final exam is statistically significant from zero at the 5% level. In Column 2, VIFs for β_1, β_2, and β_3 range from 1.0 to 2.0, far below 10.0. Thus we can conclude that there is no collinearity problem, and the corresponding standard errors do not needlessly inflate.

Discussion. The positive coefficient on the LA-format quiz ($\beta_2 > 0$), with a statistical significance, demonstrates that the use of LA-format quizzes enhances the students' final score regardless of LA confirmations obtained during the quiz hours. We assigned the weeks using traditional answer sheets to a traditional class and the weeks using LA-support format answers sheets to an LA-supported class. Therefore, our finding concurs with Herrera et al. (2018), who report that LA-supported physics courses produce higher posttest scores than traditional courses. Having the advantage over the traditional class, the LA-supported class either in physics or economics aligns with economics for both the flipped classroom (Balaban et al., 2016) and blended learning (Swoboda & Feiler, 2016).

Also, students who received LA confirmations achieve an additional increase in the final exam z-score ($\beta_3 > 0$). In specific terms, one confirmation raises the student's final exam z-score by 0.0870, which means an increase in the final exam row score of 1.54 points out of a possible 100. This estimate comes from multiplying 0.0870 by the final exam's standard deviation of 17.65.

Extended Estimations

Results. Even if the LA confirms the correctness of a student's answer, the instructor does not give them a perfect score in some cases, primarily because the student provides an insufficient explanation for the conclusive answer confirmed by LAs. On the other hand, many students can obtain the perfectly correct answer without LA confirmations. In terms of the basic question (Q1 in Figure1), including the conclusive portion that an LA may confirm, we can classify the answers into four cases: (1) a perfect answer with LA confirmation, (2) an imperfect answer with LA confirmation, (3) a perfect answer without LA confirmation, and (4) an imperfect answer without LA confirmation.

Figure 2 illustrates the total number of LA-format answer sheets for each case. The number of LA confirmations used in Column 2 of Table 4 is the sum of Cases (1) and (2), which amounts to be 345. The sum of Cases (3) and (4) is 361. Therefore the number of LA confirmations turns out to be approximately the same as the number of no LA confirmations. On the other hand, it is not surprising to observe that there are remarkably fewer instances of Case (2) than of Case (1), although Case (2) could happen sometimes. Most of the students confirmed by LAs could express correct induction to reach the conclusive answer, which an LA confirms. In the end, the difference between Cases (3) and (4) is not as significant as that between Cases (1) and (2).

Figure 2

Four Types of LA-Format Answers
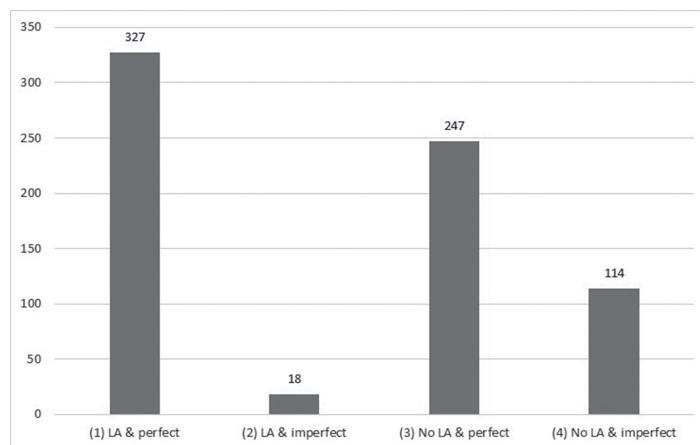
Note: The total number of LA-format answer sheets submitted in the semester.

Table 5 reports the regression in which each case for student i replaces the number of LA confirmations as the third regressor of Equation 1. Robust standard errors are in parentheses. P-values are in brackets. VIFs are in angle brackets. In each case, β_2 captures an average effect of the other three cases. The total effect of the case concerned is the sum of the estimated β_2 and β_3. In other words, β_3 demonstrates the adjustment effect of the case concerned, by which the total effect differs from the average effect of the other three cases.

Regarding estimated β_3, the highest is for Case 1, at 0.0916, with statistical significance at the 5% level. The lowest is for Case 4, at –0.2078, with statistical significance from zero at the 10% level. Thus perfect answers with LA confirmations have a positive adjustment effect on the final z-score. Imperfect answers without LA confirmations have a negative adjustment effect on the final z-score. For cases 2 and 3, the estimated coefficient's sign is positive for Case 2 and negative for Case 3. However, both estimates are statistically insignificant from zero at the 10% level.

We can say that LA confirmed cases (Cases 1 and 2) increase the final exam z-score, and no LA-confirmed cases (Cases 3 and 4) decrease the z-score. These results are in accord with Column 2 of Table 4. Regarding β_1, the estimated coefficient is statistically insignificant at the 10% level in all columns. The estimated β_2 is statistically significant at the 1% level in all columns. These are the same as Table 4.

In all columns of Table 5, VIFs for β_1, β_2, and β_3 range from 1.0 to 2.0, which are far below 10.0. Thus we can conclude that there is no collinearity problem, and the corresponding standard errors do not needlessly inflate.

Table 5

Extended Estimations

Coef.	Column number	1	2	3	4
	Estimation name	Case 1	Case 2	Case 3	Case 4
	Dependent variable ╱ Explanatory variables	final	final	final	final
β_1	Number of traditional quiz submissions	0.0993 (0.0905) [0.2750] < 1.4192 >	0.1470 (0.0925) [0.1152] < 1.4979 >	0.1409 (0.0926) [0.1313] < 1.4160 >	0.0689 (0.0740) [0.3537] < 1.3993 >
β_2	Number of LA-format quiz submissions	0.2385 (0.0810) [0.0041] < 1.4522 >	0.2801 (0.0783) [0.0005] < 1.3431 >	0.2908 (0.0795) [0.0004] < 1.3861 >	0.3117 (0.0718) [0.0000] < 1.3423 >
β_3	Number of LA confirmations with perfect answers	0.0916 (0.0436) [0.0384] < 1.4034 >			
	Number of LA confirmations with imperfect answers		0.1010 (0.2060) [0.6251] < 1.4249 >		
	Number of no LA confirmations with perfect answers			-0.0207 (0.0490) [0.6733] < 1.4610 >	
	Number of no LA confirmations with imperfect answers				-0.2078 (0.1139) [0.0711] < 1.3737 >
	R-squared	0.3814	0.3634	0.3627	0.4004
	Obs.	111	111	111	111

Note: Robust standard errors are in parentheses. P-values are in brackets. Variance inflation factors (VIFs) are in angle brackets. The regressions control for constant and individual factors: Hometown location, entrance examination type, gender, birth year, and club affiliation.

Discussion. Most notably, perfect answers without an LA confirmation do not have a statistically significant adjustment effect. Besides, the insignificant coefficient is negative. Students who solved the question perfectly without LA support do not match those who produced perfect answers with LA confirmation. In addition, imperfect answers without LA confirmation do have a negative adjustment effect in a statistically significant manner. Of the students who gave imperfect answers, those without LA confirmations trail those with LA confirmations. Even if students gave imperfect answers, the student's effort assisted by an LA increases their understanding of economics content. In a biology course, Knight et al. (2015) report that discussion quality depends on whether students regularly interact with LAs. In an economics course, we introduced LA confirmations into quiz-solving time to begin student interaction with LAs and discovered its enhancement effect on learning outcomes.

Our findings demonstrate that the LAs' in-class support helps undergraduate students learn economics. The favorable evidence for learning support differs from Blatchford et al. (2009), who conclude that support staff make a slight improvement in pupils' learning at elementary and secondary schools. The difference in conclusions may arise from students' ages or the varied support they receive. Because many researchers highly value the LA model and many universities have adopted it, likely the LAs' intervention for support works effectively, at least in undergraduate education (Herrera et al., 2018; Knight et al., 2015; Otero et al., 2010; Thompson et al., 2020).

In our class, LA confirmations did not give any points to the student. Making a request for LA confirmations was entirely the student's voluntary choice. If the confirmation had given the students an extra score, the incentive would have motivated more students to request LA confirmations. As suggested by Chevalier et al. (2018) and Pozo and Stull (2006), the score-inclusion policy might have been beneficial for students who would have asked for LA confirmations under such a scheme. However, in that case, we would need more LAs and a longer time period to complete LA confirmations. Class size, the number of LAs, and time length are significant factors in the practicability of such a study. Regarding in-class management, we need more research to strike a suitable balance among these factors.

5. Recommendations

The LA model provides one of the new approaches for university teaching. In particular, LAs can become a driving force in transforming traditional lectures into more interactive class frameworks. This paper demonstrated how to utilize LAs during the quiz-solving time and revealed that the LA involvement enhances Japanese students' understanding of economics.

Economics teaching usually takes place in lecture rooms rather than in laboratories. Herrera et al. (2018) demonstrate that LAs in the laboratory bring more gains to students than LAs in lecture settings. Nonetheless, we recommend introducing LAs into economics and other disciplines beyond STEM. We can modify our traditional lecture format by using LAs and thereby enhance students' learning outcomes. To this end, we need to explore the appropriate use of LAs in economics and other non-STEM disciplines.

However, to incorporate the LA model, universities must establish a school-wide framework that comprises pedagogical LA training courses, an LA hiring and allocation system, instructors participating in the LA model, and other elements. Therefore the implementation of the LA model relies heavily on high-ranking university officials' perceptions. We expect LA-related research results to provide university managers with a compelling argument for the benefits of LAs. Beyond investigations on individual courses, we also need research outcomes about collective changes, like that of Arteaga (2018), who analyzed a curriculum revision.

6. Conclusion

This paper demonstrated that the LA model fostered students' exam performance when applying the model to an introductory economics course. LAs influence students through both direct and indirect contact. LA confirmations help the assisted students achieve high z-scores in the final exam as a direct contact effect. These students can help neighboring students who do not directly obtain LA support. As an indirect contact effect, having LAs in class leads to students' outperforming those without LAs in class in terms of final exam scores.

In this research, we observed that the LA model worked for Japanese students. Beyond the year 2018, we have used LAs in class teaching with more subjects. Going forward, we share our experience with other universities utilizing the LA model inside

and outside Japan.

For future research, we need more investigation into other cases. LAs are beneficial not only through in-class confirmations but also LAs' enhancement of students' discussion. As stated in the subsection for data, LAs also participate in content preparation meetings with instructors. If researchers succeed in quantitatively measuring those LA activities, the LA model will become more efficient and effective in its systematic function and more persuasive to university administrators.

(Professor, Faculty of Economics, Seikei University)

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