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The Effect of Project-Based Learning on Teacher Self-Efficacy

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Abstract

The expansion of project-based learning has been advocated for as a solution and reform measure to the problem of rote learning-based teaching practices in Korean schools, deemed unfit for the development of diverse skills needed in the 21st century. While the ultimate goal of initiating project-based learning is to affect students in positive ways, it is important to analyze how conducting project-based learning affects teachers, as they are the direct implementers of teaching practices and are bound to have immense influence on the overall learning experience of students. By using the OECD TALIS database, we show that conducting project-based learning is strongly and positively associated with teacher self-efficacy. Such results are in line with an analysis using data obtained from a field experiment on teacher training of project-based learning conducted on Daegu city middle schools.

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I. Introduction

The core skills required in the 21st century, referred to as the "6C's," include communication, collaboration, critical thinking, creativity, character and citizenship (Fullan & Langworthy, 2014). While education is the fundamental route through which skills are developed, Korea's education, which primarily focuses on rote learning, has been criticized for its inability to adapt to the changing times, and deemed insufficient for developing the required skills of the 21st century (Lee, Jeong, & Hong, 2014; Lee, Ryoo, & Lee, 2014). Against this backdrop, the expansion of the implementation of project-based learning has been advocated for as a solution and reform measure to the problem of teaching practices in Korea's education (Lee, 2016).

Project-based learning is defined as learning that is focused on projects through student-centered collaboration and teamwork to solve real problems and tasks (Bender, 2012; Cameron, 2014; Krauss & Boss, 2013; Maltese, 2012; Stanley, 2012). By leading students to collaborate amongst one another, inquire and deal with complexity, deal with actual issues pertaining to society, and develop contextual and systems thinking (Kraus & Boss, 2013), project-based learning is highly relevant to developing the aforementioned skills required in the 21st century.

While the ultimate goal of initiating project-based learning is to affect students in positive ways, it is important to analyze how conducting project-based learning affects teachers, as they are the direct implementers of teaching practices and are bound to have immense influence on the overall learning experience of students. In this regard, this research aims to empirically analyze how conducting project-based learning is associated with teacher self-efficacy.

According to social cognitive theory, an individual's self-efficacy is the degree to which one believes in one's ability to complete a certain task (Bandura, 1986). In the context of education, teacher self-efficacy can be defined as the teachers' beliefs about their capability to teach their subject matter effectively to students and bring about desired outcomes of student engagement and learning (Tschannen-Moran & Woolfolk Hoy, 2001; Holzberger, Phillip, & Kunter, 2013). The self-efficacy of teachers has been shown to be strongly related to various aspects of education, such as teachers' job satisfaction and student achievement outcomes (Caprara et al., 2006). While teacher self-efficacy has generally been assumed to be an important cause of various educational outcomes, the precise direction of causality is not clear (Holzberger et al., 2013). For example, teacher self-efficacy has been shown to be a consequence of educational processes, namely instructional quality (Holzberger et al., 2013). Also, Stein and Wang (1988) show that previous success in the implementation of innovative teaching practices enhanced teacher self-efficacy, but not vice versa.

By utilizing various databases, this research aims to analyze how project-based learning is related to teacher self-efficacy. A better understanding of this relationship will contribute to gaining a more complete understanding of the mechanism of how students are affected by project-based learning. Furthermore, we aim to contribute to the literature on teacher self-efficacy and teaching practices by exploring the empirical relation between them.

To begin with, we use data from the Program for International Student Assessment (PISA), an international student achievement assessment for 15-year old students, and the Teaching and Learning International Study (TALIS), an international survey conducted on middle school teachers, and show that the rate of project-based learning conducted in Korean schools is much lower than that of schools in other countries. We show that there is a strong and positive cross-country correlation between the rate of project-based learning and the level of teacher self-efficacy. Within-country and within-school micro-estimates using the TALIS database show that the correlation between project-based learning and teacher self-efficacy is positive and statistically significant across different countries and among the highest for Korean teachers.

To empirically analyze the relationship between project-based learning in a more causal way, we use data from a field experiment on teacher training for project-based learning conducted on middle schools in Daegu city. We show that teacher training and consultation for conducting project-based learning has a positive effect on teacher self-efficacy. The results of the analyses using the TALIS database and the data from the Daegu middle school experiment provide empirical support for the positive educational effect of project-based learning, and that expanding its implementation can play a vital role in Korea's education reform.

This paper is organized as follows. In Section 2 we use the PISA and TALIS databases to compare the rate of project-based learning conducted in Korean schools to that of schools in other countries. In Section 3 we show that there is a strong and positive cross-country correlation between project-based learning and teacher self-efficacy. In Section 4 we use the TALIS database and find a strong correlation between project-based learning and teacher self-efficacy at the teacher level, both within countries and within schools. In Section 5 we use the data from the Daegu middle school field experiment to empirically analyze the relationship between project-based learning and teacher self-efficacy in a more causal way. Section 6 concludes.

II. Korea's Low Rate of Project-Based Learning

We use databases from the PISA and TALIS to compare the rate of project-based learning conducted in schools in Korea with that of schools in other countries.

PISA, developed by the Organization for Economic Cooperation and Development (OECD), is an international student achievement assessment centered on math, reading, and science for 15-year old students, conducted every three years since 2000. In addition to assessments of academic achievement, PISA provides a wide range of information obtained through student surveys, including various student characteristics and values, characteristics of teachers and schools, and teaching practices. As measures of project-based learning, we use variables that represent the frequency of small group work in math lessons and group

work using computers at school, answered on a four-point and five-point scale, respectively.[1] Taking part in group work may not be the complete equivalent of project-based learning, but since the definitions of the PISA group work measures include coming up with "joint solutions to a problem or task" (for group work in math lessons) and "communication with other students" (for group work using computers at school), they contain the key components of our definition of project-based learning, and thus we use them to measure the rates of project-based learning in our analysis.

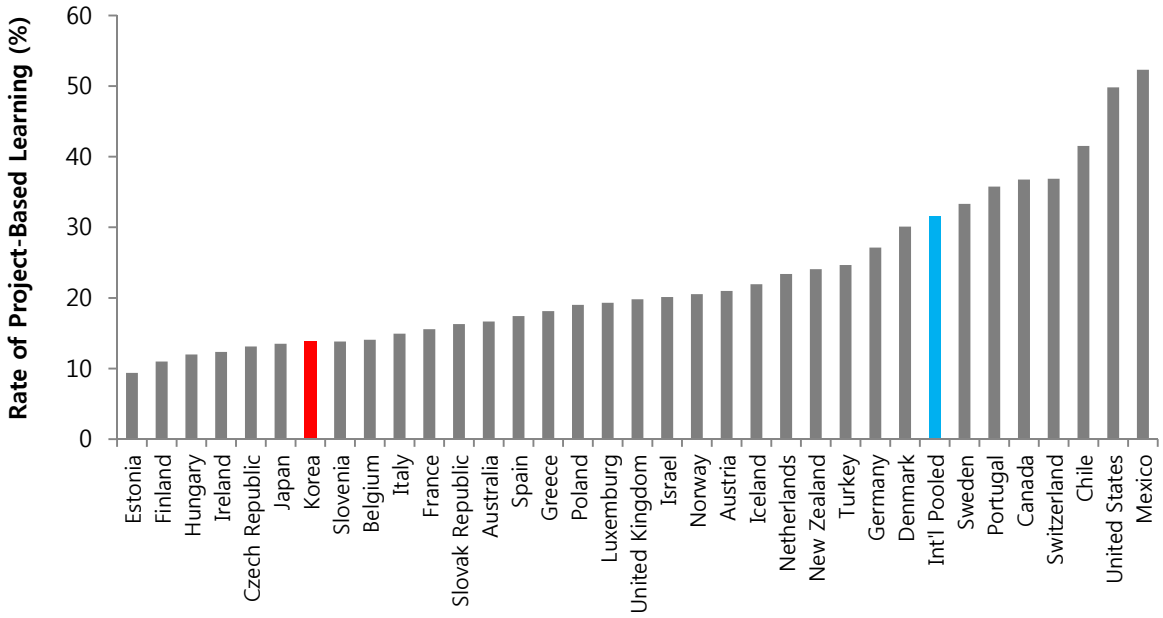
We use the PISA 2012 database, the most recent data available for public use, to compare the rates of project-based learning conducted in math lessons and project-based learning using computers at school among OECD countries.[2] What we specifically observe are the shares of students in each country who take part in group work in math lessons either in "most lessons" or "every lesson," and in group work using computers at school at least "once or twice a week." Results are shown in Figure 1.

[1] Frequency of group work in math is obtained through the question, "In your mathematics lessons, how often does the teacher have you work in small groups to come up with joint solutions to a problem or task?" answered on the following four-point scale: 1) Every lesson; 2) Most lessons; 3) Some lessons; 4) Never or hardly ever. For frequency of group work using computers at school, students are asked, "How often do you use school computers for group work and communication with other students?" which is answered on the following five-point scale: 1) Never or hardly ever; 2) Once or twice a month; 3) Once or twice a week; 4) Almost every day; 5) Every day.

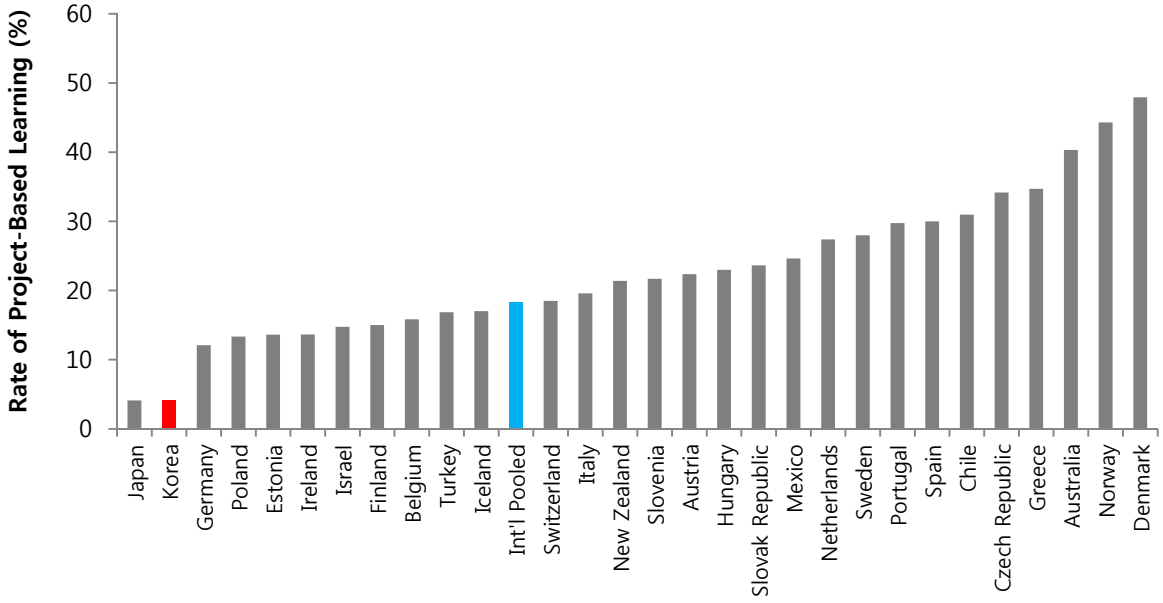
[2] The comparison is restricted to OECD countries that participated in PISA 2012 and whose data is publically available. For group work in math, such countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxemburg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. For group work using computers at school, such countries are Australia, Austria, Belgium, Chile, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and Turkey.

Figure 1. The Rate of Project-Based Learning by Students in OECD Countries (PISA)

(a) Math Lessons



(b) Using Computers at School



Notes: For math lessons, the Rate of Project-Based Learning (%) represents the share of students who take part in project-based learning in either "most lessons" or "every lesson." For using computers at school, the Rate of Project-Based Learning (%) represents the share of students who take part in project-based learning at least "once or twice a week."

Source: PISA 2012.

As evident in Figure 1, Korea's shares of students that experience project-based learning are well below the OECD average levels. For math, Korea's rate of project-based learning is drastically lower than that of other countries, ranking 28th out of 34 OECD countries. For project-based learning using computers, Korea ranks second to last among the 29 OECD countries compared, and Korea's rate is less than one-fourth of that of the international average.

Next, we use the TALIS database to internationally compare the share of teachers that conduct project-based learning in schools. TALIS is an international survey for teachers and principals of middle schools,[3] developed by the OECD in 2008. The survey takes place every five years, and we use the 2013 (second phase) teacher survey data, which focuses on diverse aspects of teachers, such as teaching practices, professional development, work environment, and self-efficacy and job satisfaction. In TALIS 2013 a total of 34 countries,[4] including 24 OECD countries, participated, and the final international sample includes more than 170,000 teachers from more than 10,000 schools. The survey was conducted between 2012 and 2013 through either paper-based or online-based methods, and the final sample for Korea includes 2,933 teachers from 177 schools.

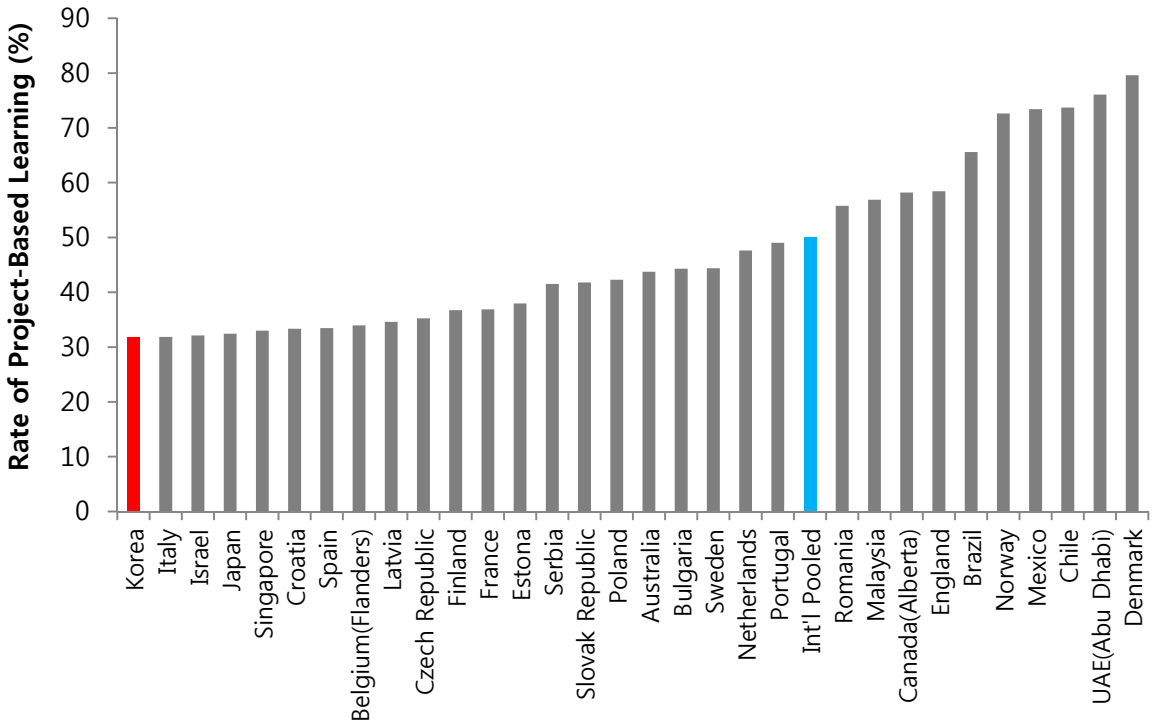
As a measure of the frequency of project-based learning, we use the TALIS variable which asks teachers how often "students work in small groups to come up with a joint solution to a problem or task" (answered on a four-point scale: 1) Never; 2) Occasionally; 3) Frequently; 4) In all or nearly all lessons). As was the case for the PISA variable for group work in math lessons, the TALIS variable includes coming up with "a joint solution to a problem or task," which significantly resembles our definition of project-based learning.

Figure 2 displays the rate of project-based learning that occurs in middle schools within each country. We refer to the "rate of project-based learning" as the share of teachers who conduct project-based learning either "frequently" or "in all or almost all lessons." As is evident in Figure 2, Korean teachers' rate of project-based learning is the lowest among countries in comparison. It is not only lower than that of developed countries like Canada (Alberta), Finland, France and Singapore, but also much lower than that of developing countries like Chile, Mexico, Brazil and Bulgaria.

[3] Although the main target group for TALIS is teachers and principals of middle schools (International Standard Classification of Education (ISCED) level 2), countries had the option of conducting additional surveys for the ISCED levels 1 (primary school) and 3 (upper-secondary school) (OECD, 2014a).

[4] The countries that participated in the 2013 TALIS survey are Australia, Belgium (Flanders), Brazil, Bulgaria, Canada (Alberta), Chile, Croatia, Cyprus, the Czech Republic, Denmark, England, Estonia, Finland, France, Iceland, Israel, Italy, Japan, Korea, Latvia, Malaysia, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Singapore, the Slovak Republic, Spain, Sweden, the United Arab Emirate (Abu Dhabi), and the United States. The data for Cyprus and Iceland were not publically available, and the data for the US did not meet the sampling standards (OECD, 2014a), and thus these three countries were excluded from this research.

Figure 2. The Rate of Project-Based Learning Conducted by Teachers (TALIS)



Note: The Rate of Project-Based Learning (%) is the share of teachers who conduct project-based learning either "frequently" or "in all or almost all lessons."

Source: TALIS 2013.

III. Cross-Country Correlation between Project-Based Learning and Teacher Self-Efficacy

Next, we analyze the cross-country correlation between project-based learning and teacher self-efficacy to show how the drastically low level of project-based learning in Korea is associated with teacher self-efficacy.

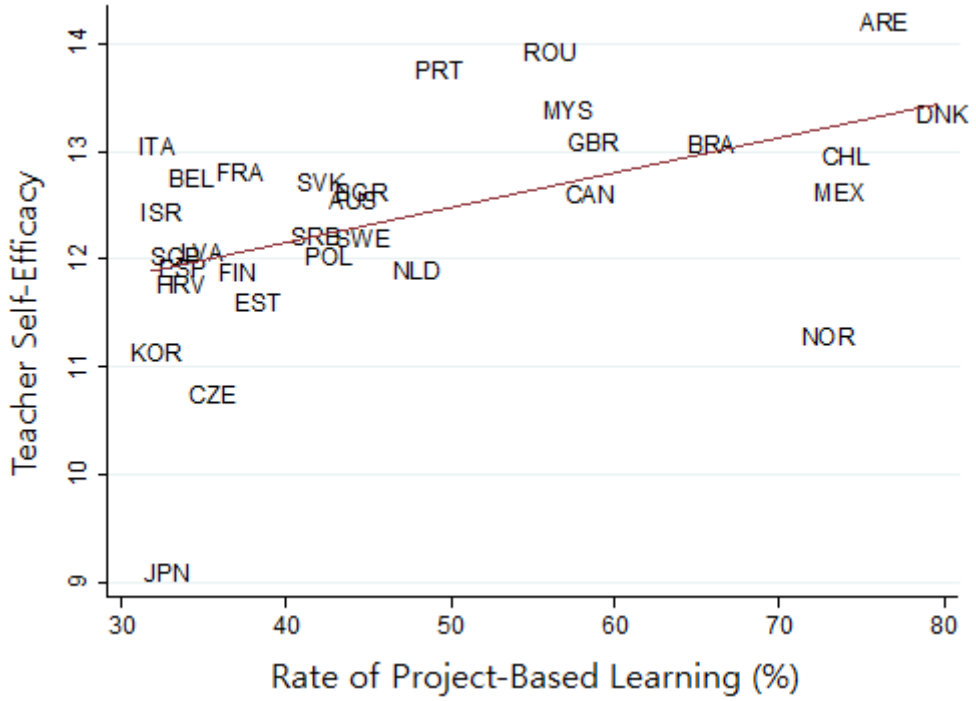
For teacher self-efficacy, TALIS initially measures three different sub-categories: 1) efficacy in instruction; 2) efficacy in student engagement; and 3) efficacy in class management. Four questions are asked for the assessment of each of the sub-categories of teacher self-efficacy, and are answered on a four-point scale. Based on the answers to these four questions the measure of each sub-category is obtained through the CFA (Confirmatory Factor Analysis) method.[5] The integrated measure of teacher self-efficacy is the average of the values of the three sub-categories. Thus, in total, four variables pertaining to self-efficacy are available. The survey questionnaire used in TALIS to measure each sub-category of

[5] For details on the statistical procedure of obtaining the self-efficacy measurements, please refer to OECD (2014b).

teacher self-efficacy are shown in Figures 1A~3A of the Appendix.

Based on the TALIS database, Figure 3 displays the cross-country relationship between project-based learning and teacher self-efficacy. A positive relationship is evident and the coefficient of correlation is 0.497. On the other hand, through Figure 4 it is evident that teacher self-efficacy has no significant relationship with annual teacher income,[6] which goes against the general expectation that one's self-efficacy is greatly influenced by monetary rewards. In particular, the fact that countries with low project-based learning rates also display low levels of teacher self-efficacy is interesting. It provides a clue to why teachers in Korea, despite having relatively higher earnings and higher skills compared to their international counterparts have low levels of self-efficacy.

Figure 3. The Rate of Project-Based Learning and Teacher Self-Efficacy (TALIS)

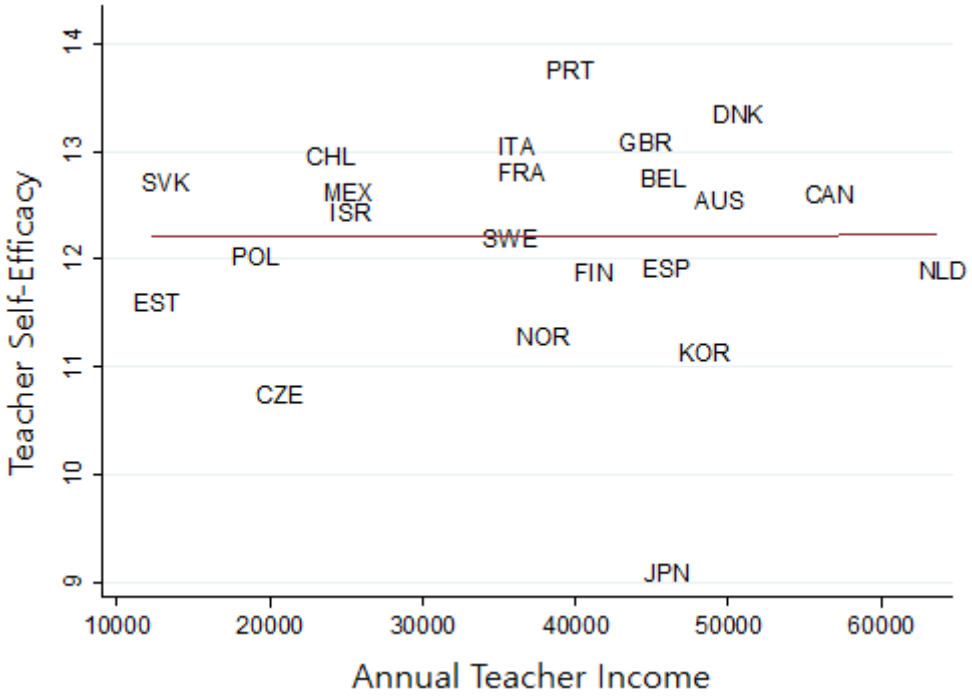


Note: The Rate of Project-Based Learning (%) is the share of teachers who conduct project-based learning either "frequently" or "in all or almost all lessons."

Source: TALIS 2013.

[6] The information for annual teacher income was obtained from OECD (2013). Annual teacher income refers to the average annual income of teachers with 15 years of teaching experience as of 2011, which is the most recent data available.

Figure 4. Annual Teacher Income and Teacher Self-Efficacy



Notes: Annual teacher income is the average yearly income of teachers with 15 years of teaching experience as of 2011. The scale for teacher annual income is US Dollars (PPP adjusted).

Source: TALIS 2013, OECD (2013)

While we showed that there is a positive cross-country correlation between project-based learning and teacher self-efficacy, there are limitations to such aggregate correlations. First, our analysis does not control for country fixed effects, which means that entire differences among countries are included in analyzing the relationship between teacher self-efficacy and project-based learning. This means that omitted factors which can influence both teacher self-efficacy and project-based learning may have affected the observed cross-country correlation. More importantly, the causal relationship is unclear; higher rates of project-based learning can be either a cause or consequence of higher teacher self-efficacy. To obtain a clearer understanding of the empirical relationship between project-based learning and teacher self-efficacy, we analyze the TALIS data at the teacher level.

IV. Empirical Analysis Based on TALIS

In order to overcome the limitations of cross-country correlation, we use the TALIS database to conduct micro data analysis at the teacher level on the relationship between project-based learning and teacher self-efficacy. We exclude those whose variables for the self-efficacy measure and the rate at which project-based learning is conducted are missing.

As explained in Section 2, the variable for the rate of project-based learning is scaled from one to four, but for our analysis we transform it to a dummy variable whose value is 1 if project-based learning is conducted "frequently" or "in all or nearly all lessons," and 0 if conducted "occasionally" or "never or almost never." The descriptive statistics of all variables used in the analysis are shown separately for the entire international sample and the Korean sample in Table 1. Through Table 1 it is evident that the mean levels of the three sub-categories of self-efficacy, as well as the integrated level of self-efficacy for Korean teachers, are lower than those of the international sample. Also, as observed in the previous section, the average rate of project-based learning conducted in Korean middle schools is lower than the international average rate.[7]

[7] T-tests on comparison of the mean values of the international and Korean sample indicate that the differences are statistically significant at the 1% level.

Table 1. Descriptive Statistics

(a) International Sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Teacher self-efficacy	78155	12.340	1.972	3.777	15.529
Efficacy in instruction	78155	12.423	2.097	2.949	15.775
Efficacy in student engagement	78155	11.921	2.135	3.803	15.375
Efficacy in class management	78155	12.675	2.066	3.967	15.655
Project-based learning	78155	0.490	0.500	0	1
Female	78155	0.356	0.479	0	1
Age	78155	42.087	10.368	18	99
Total teaching experience (years)	78155	15.975	10.140	0	58
Doctorate degree	78155	0.016	0.124	0	1
Permanent employment status	78155	0.833	0.373	0	1
Negative view on prof. development	78155	0.425	0.494	0	1

(b) Korean Sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Teacher self-efficacy	2254	11.133	2.009	3.777	15.406
Efficacy in instruction	2254	10.957	2.141	3.260	15.538
Efficacy in student engagement	2254	11.024	1.937	4.105	15.120
Efficacy in class management	2254	11.418	2.123	3.967	15.561
Project-based learning	2254	0.318	0.466	0	1
Female	2254	0.303	0.460	0	1
Age	2254	42.296	9.182	22	62
Total teaching experience (years)	2254	16.306	9.934	0	40
Doctorate degree	2254	0.015	0.122	0	1
Permanent employment status	2254	0.840	0.366	0	1
Negative view on prof. development	2254	0.427	0.495	0	1

Notes: Sub-categories of teacher self-efficacy were measured through the CFA (Confirmatory Factor Analysis) method using the answers to four questions pertaining to the assessment of each sub-category. *Teacher self-efficacy:* the average of the three variables for the sub-categories of teacher self-efficacy. *Project-based learning:* dummy variable indicating the relative frequency with which project-based learning is conducted in class (=1 if conducted “frequently” or “in all or almost all lessons”; =0 if conducted “occasionally” or “never or almost never”). *Doctorate degree:* dummy variable indicating the completion of a doctorate degree. *Permanent employment status:* dummy variable indicating whether individual is a permanent employ (=1) or on a temporary contract (=0). *Negative view on prof. development:* a dummy variable indicating agreement with the idea that “no relevant professional development offered” is a barrier to participation in professional development (=1 if “Strongly agree” or “agree”; =0 if “Strongly disagree” or “disagree”).

Source: TALIS 2013

As previously mentioned, cross-country analysis on the relationship between project-based learning and teacher self-efficacy may be affected by omitted variables. In order to estimate the across schools, within-country correlation between project-based learning and teacher self-efficacy, the following model is estimated for each country sample:

$$y_{ijc} = \beta_0 + \beta_1 Project_{ijc} + \gamma X_{ijc} + F_c + \varepsilon_{ijc} \quad (1)$$

where y_{ijc} is the self-efficacy level of teacher i in school j in country c, standardized to have a mean of 0 and standard deviation of 1 within each country sample (y is standardized in the same way but across the entire international sample for the regression run on the international pooled sample); $Project_{ijc}$ is the dummy variable for conducting project-based learning of teacher i in school j in country c; X_{ijc} is a vector of characteristics (gender, age, total years of teaching experience, completion of doctorate degree, employment status, and a dummy variable indicating the teacher's opinion on the relevance of professional development activities) of teacher i in school j in country c; F_c is the country fixed effect; and ε_{ijc} is the error term.

It is possible that differences among schools within a country, such as the school culture and principal leadership, may contribute to differences in teaching practice and teacher self-efficacy. In relation to such differences, teachers may self-sort into specific schools. In these cases equation (1) may estimate a school effect, rather than an isolated effect of project-based learning. To estimate the within-school correlation between project-based learning and teacher self-efficacy, we control for differences that may exist between schools within each country and estimate the following model for each country's sample:

$$y_{ijc} = \beta_0 + \beta_1 Project_{ijc} + \gamma X_{ijc} + F_{jc} + \varepsilon_{ijc} \quad (2)$$

where y_{ijc} is the self-efficacy level of teacher i in school j in country c, standardized to have a mean of 0 and standard deviation of 1 within each country sample (y is standardized in the same way but across the entire international sample for the regression run on the international pooled sample); $Project_{ijc}$ is the dummy variable for conducting project-based learning of teacher i in school j in country c; X_{ijc} is a vector of characteristics (gender, age, total years of teaching experience, completion of doctorate degree, employment status, and a dummy variable indicating the teacher's opinion on the relevance of professional development activities) of teacher i in school j in country c; F_j is the school fixed effect; and ε_{ijc} is the error term.

Table 2 reports the OLS estimates of the statistical association between project-based learning and teacher self-efficacy using equation (1). The estimates for Korea, countries in the Asian region (Japan, Singapore), countries in Europe (England, Finland), and the estimates for the pooled international sample with country fixed effects is reported in Table 2.

As reported in Table 2, it is evident that there is a strong positive correlation between project-based learning and teacher self-efficacy in Korea. The point estimate on project-based learning is 0.441 and statistically significant at the 1% level. This means that within Korea,

the self-efficacy level of teachers that conduct project-based learning more frequently is, on average, 0.441 standard deviations higher than teachers that occasionally or never conduct project-based learning. Korea's point estimate on project-based learning is not only greater than the point estimate of the international pooled sample (with country fixed effects), but the fourth highest among the 31 countries included in the analysis (Figure 5).

In addition, it is reported that longer years of teaching experience is associated with greater teacher self-efficacy, but the rate of increase is generally negative across countries. In Korea, the self-efficacy of female teachers is greater than that of male teachers, and the completion of a doctorate degree and permanent employment status do not seem to be associated with teacher self-efficacy. Also, for the Korean sample, teachers who believe that the absence of relevance in professional development activities is a barrier to participation in such activities have a lower level of self-efficacy than those who do not.

Table 2. Project-Based Learning and Teacher Self-Efficacy: OLS Micro Estimates – Within Countries

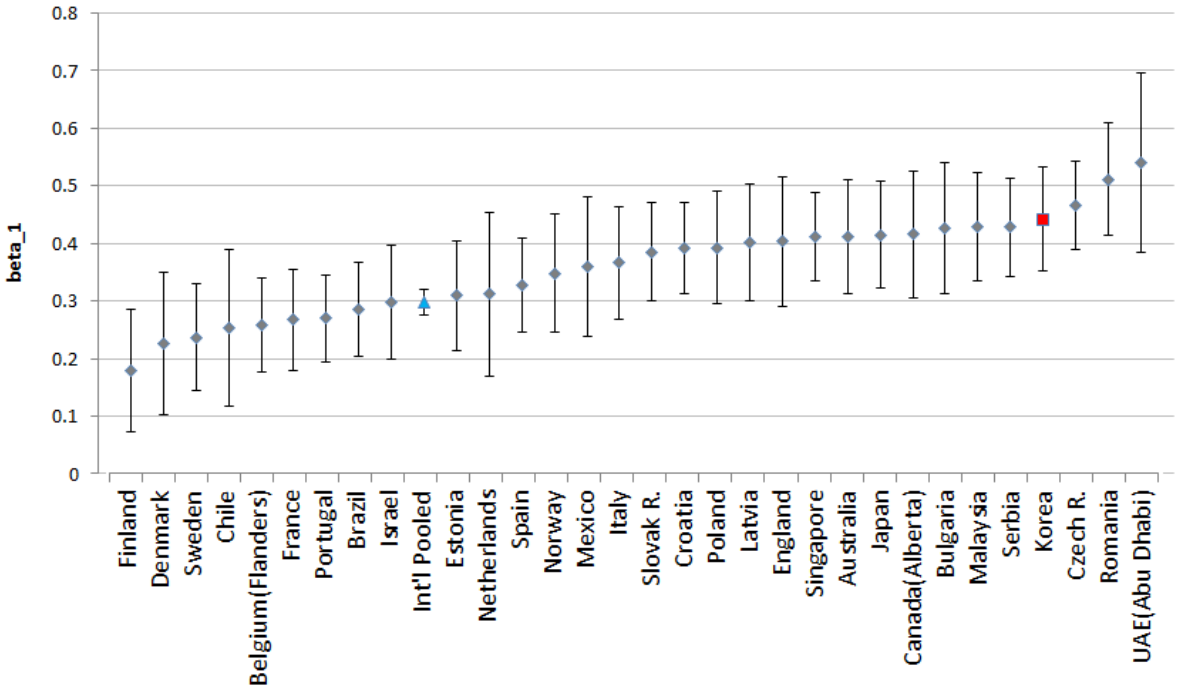
Dependent Variable: Teacher Self-Efficacy	Korea	Japan	Singapore	England	Finland	International Pooled
Project-based learning	0.441***	0.415***	0.411***	0.403***	0.179***	0.298***
	(0.046)	(0.047)	(0.040)	(0.057)	(0.055)	(0.011)
Female	0.151***	0.290***	-0.087**	-0.044	-0.073*	-0.046***
	(0.057)	(0.043)	(0.042)	(0.047)	(0.041)	(0.011)
Age	-0.056	0.022	0.032	-0.007	0.029	0.000
	(0.039)	(0.024)	(0.021)	(0.018)	(0.026)	(0.005)
Age^2	0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.059***	0.010	0.030***	0.028*	0.022*	0.019***
	(0.017)	(0.012)	(0.009)	(0.014)	(0.013)	(0.002)
$Experience^2$	-0.001**	-0.000	-0.000	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Doctorate degree	0.252	0.276	0.788***	-0.247	0.297	0.008
	(0.171)	(0.274)	(0.182)	(0.448)	(0.198)	(0.054)
Permanent	-0.101	-0.003	0.023	0.204**	0.064	0.002
	(0.062)	(0.056)	(0.065)	(0.103)	(0.055)	(0.014)
Negative view on prof. development	-0.218***	0.004	-0.011	-0.097*	-0.094**	-0.082***
	(0.043)	(0.040)	(0.047)	(0.055)	(0.046)	(0.010)
Observations	2,254	2,915	2,828	1,908	2,232	78,155
R-squared	0.077	0.083	0.098	0.058	0.02	0.387

Notes: Teacher self-efficacy variable standardized to have a mean of 0 and standard deviation of 1 within each country. *Experience:* total years of teaching experience. *Doctorate degree:* dummy variable indicating completion of doctorate degree. *Permanent:* dummy variable indicating permanent employment status. *Negative view on prof. development:* dummy variable indicating teacher's negative feelings on the relevance of professional development activities offered. Standard errors obtained through balanced repeated replication weights in parentheses. Results for the international pooled sample includes country fixed effects.

*p<0.1
**p<0.05
***p<0.01

Source: TALIS 2013

Figure 5. Project-Based Learning and Teacher Self-Efficacy: OLS Micro Estimates – Within Countries



Notes: 'beta_1' refers to the beta 1 coefficients of equation (1). Vertical lines indicate the 95% confidence interval.

Source: TALIS 2013

Table 3 reports the results of the OLS regressions run using equation (2). It is evident that including school fixed effects do not drastically change the OLS estimates compared to those obtained through equation (1). For the Korean sample, after controlling for differences that may exist between schools, teachers who conduct project-based learning more frequently are associated with higher self-efficacy levels by 0.448 standard deviations than teachers that occasionally or never conduct project-based learning. As displayed in Figure 6, the point estimate on project-based learning for Korea is the third highest among all countries included in the analysis, lower only than that of the UAE (Abu Dhabi) and Romania.

When considering the fact that difference in school environment may significantly affect teaching practices and teacher self-efficacy, the fact that the OLS estimates of equation (2), which includes school fixed effects, does not significantly differ from those of equation (1) is quite meaningful. In other words, the positive correlation between project-based learning and teacher self-efficacy is shown to be quite stable, maintaining its consistency even after controlling for differences between schools like school culture and principal leadership.

Table 3. Project-Based Learning and Teacher Self-Efficacy: OLS Micro Estimates – Within Schools

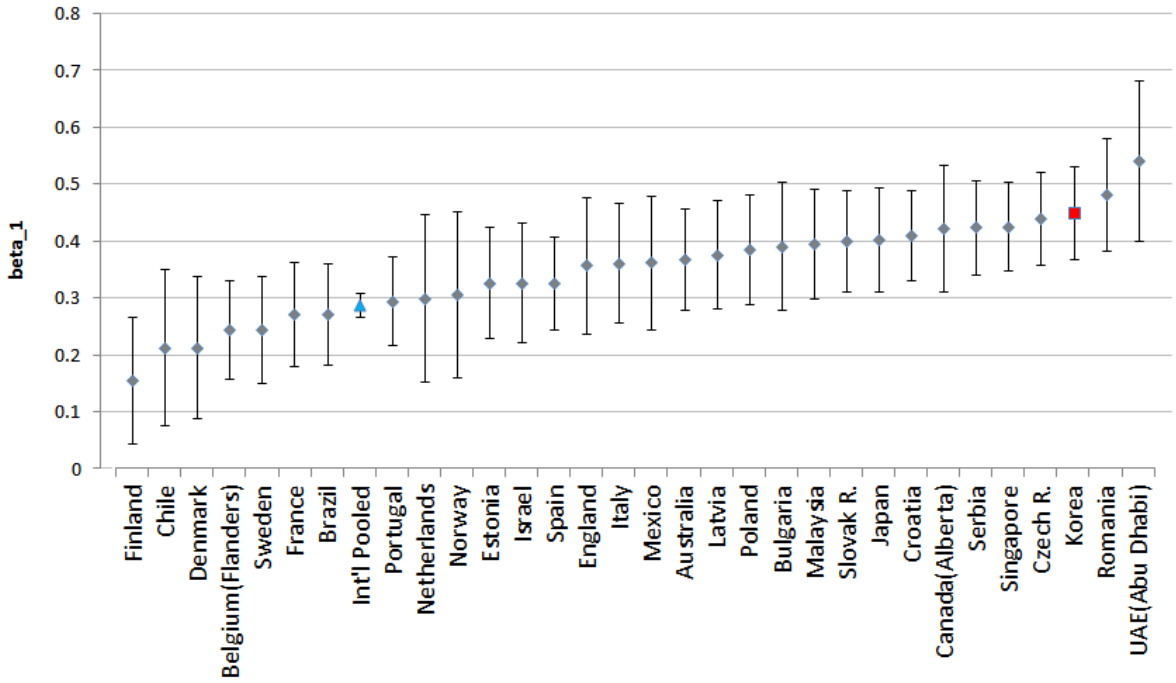
Dependent Variable: Teacher Self-Efficacy	Korea	Japan	Singapore	England	Finland	International Pooled
Project-based learning	0.448***	0.401***	0.425***	0.356***	0.155***	0.287***
	(0.042)	(0.047)	(0.039)	(0.061)	(0.057)	(0.011)
Female	0.177***	0.277***	-0.096**	-0.024	-0.064	-0.045***
	(0.055)	(0.041)	(0.043)	(0.049)	(0.045)	(0.010)
Age	-0.017	0.034	0.043**	-0.004	0.036	0.003
	(0.036)	(0.027)	(0.020)	(0.019)	(0.025)	(0.005)
Age^2	0.000	-0.000	-0.000	0.000	-0.000*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.043***	0.011	0.028***	0.029*	0.023*	0.019***
	(0.015)	(0.014)	(0.009)	(0.016)	(0.012)	(0.002)
$Experience^2$	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Doctorate degree	0.163	0.129	0.663***	-0.172	0.333	0.019
	(0.160)	(0.244)	(0.171)	(0.452)	(0.225)	(0.055)
Permanent	-0.099	-0.026	0.009	0.258**	0.034	0.014
	(0.071)	(0.056)	(0.071)	(0.120)	(0.057)	(0.016)
Negative view on prof. development	-0.206***	-0.006	-0.024	-0.096*	-0.069	-0.077***
	(0.046)	(0.040)	(0.047)	(0.053)	(0.045)	(0.010)
School Fixed Effect	YES	YES	YES	YES	YES	YES
Observations	2,254	2,915	2,828	1,908	2,232	78,155
R-squared	0.186	0.175	0.159	0.164	0.108	0.464

Notes: Teacher self-efficacy variable standardized to have a mean of 0 and standard deviation of 1 within each country. *Experience:* total years of teaching experience. *Doctorate degree:* dummy variable indicating completion of doctorate degree. *Permanent:* dummy variable indicating permanent employment status. *Negative view on prof. development:* dummy variable indicating teacher's negative feelings on the relevance of professional development activities offered. Standard errors obtained through balanced repeated replication weights in parentheses.

*p<0.1
**p<0.05
***p<0.01

Source: TALIS 2013

Figure 6. Project-Based Learning and Teacher Self-Efficacy: OLS Micro Estimates – Within Schools



Notes: 'beta_1' refers to the beta 1 coefficients of equation (1). Vertical lines indicate the 95% confidence interval.

Source: TALIS 2013

As previously mentioned, TALIS measures three sub-categories of teacher self-efficacy (efficacy in instruction, efficacy in student engagement, and efficacy in class management). Table 4-6 report the results of regressions using equation (2), which controls for school fixed effects, with each sub-category of teacher self-efficacy as the dependent variable. As was the case with the integrated teacher self-efficacy measure, project-based learning has a positive and statistically significant association with each sub-category of teacher self-efficacy. In the case of Korea, teachers who conduct project-based learning on a relatively more frequent basis are associated with higher efficacy in instruction by 0.470 standard deviations; higher efficacy in student engagement by 0.466 standard deviations; and higher efficacy in class management by 0.372 standard deviations; and each of the point estimates are greater than those obtained from the international pooled sample.

Since project-based learning is directly associated with instructional methods, the fact that it has a strong association with efficacy in instruction is expected, but the fact that project-based learning is also strongly associated with efficacy in student engagement and class management is quite interesting. Rather than a form of "vertical teaching practice," where learning is centered on teachers lecturing and students copying notes, since project-based learning is a form of "horizontal teaching practice," where students cooperate amongst one another and ask teachers questions (Algan, Cahuc, & Schleifer, 2013), it can be understood that project-based learning also has positive associations with efficacy in student engagement and class management.

Table 4. Project-Based Learning and Efficacy in Instruction: OLS Micro Estimates – Within Schools

Dependent Variable: Efficacy in Instruction	Korea	Japan	Singapore	England	Finland	International Pooled
Project-based learning	0.470***	0.381***	0.462***	0.382***	0.213***	0.300***
	(0.041)	(0.046)	(0.038)	(0.064)	(0.055)	(0.011)
Female	0.154***	0.205***	-0.098**	-0.050	-0.072	-0.063***
	(0.056)	(0.045)	(0.046)	(0.045)	(0.045)	(0.010)
Age	-0.007	0.026	0.033	0.005	0.034	0.005
	(0.034)	(0.027)	(0.021)	(0.020)	(0.026)	(0.005)
Age^2	-0.000	-0.000	-0.000	-0.000	-0.001*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.038**	0.004	0.029***	0.025	0.021*	0.014***
	(0.015)	(0.014)	(0.009)	(0.016)	(0.013)	(0.003)
$Experience^2$	-0.001	0.000	-0.000	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Doctorate degree	0.255	0.136	0.685***	-0.120	0.366	0.072
	(0.171)	(0.230)	(0.181)	(0.436)	(0.225)	(0.052)
Permanent	-0.072	-0.035	0.013	0.157	0.016	-0.008
	(0.072)	(0.059)	(0.070)	(0.122)	(0.055)	(0.015)
Negative view on prof. development	-0.214***	-0.019	-0.007	-0.086	-0.080*	-0.072***
	(0.048)	(0.040)	(0.046)	(0.054)	(0.041)	(0.010)
School Fixed Effect	YES	YES	YES	YES	YES	YES
Observations	2,254	2,915	2,828	1,908	2,232	78,155
R-squared	0.185	0.159	0.160	0.148	0.11	0.458

Notes: Efficacy in instruction variable standardized to have a mean of 0 and standard deviation of 1 within each country. *Experience:* total years of teaching experience. *Doctorate degree:* dummy variable indicating completion of doctorate degree. *Permanent:* dummy variable indicating permanent employment status. *Negative view on prof. development:* dummy variable indicating teacher's negative feelings on the relevance of professional development activities offered. Standard errors obtained through balanced repeated replication weights in parentheses.

*p<0.1
**p<0.05
***p<0.01

Source: TALIS 2013

Table 5. Project-Based Learning and Efficacy in Student Engagement: OLS Micro Estimates – Within Schools

Dependent Variable: Efficacy in Student Engagement	Korea	Japan	Singapore	England	Finland	International Pooled
Project-based learning	0.466***	0.378***	0.384***	0.360***	0.169***	0.270***
	(0.043)	(0.047)	(0.038)	(0.057)	(0.056)	(0.010)
Female	0.151***	0.212***	-0.069	0.015	-0.064	-0.039***
	(0.054)	(0.042)	(0.044)	(0.055)	(0.050)	(0.010)
Age	-0.036	0.036	0.034*	-0.005	0.051**	0.006
	(0.036)	(0.029)	(0.020)	(0.019)	(0.025)	(0.005)
Age^2	0.000	-0.000	-0.000	0.000	-0.001**	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.045***	0.004	0.030***	0.021	0.015	0.014***
	(0.015)	(0.015)	(0.009)	(0.014)	(0.013)	(0.002)
$Experience^2$	-0.001*	0.000	-0.000*	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Doctorate degree	0.192	0.248	0.589***	-0.007	0.405*	0.057
	(0.175)	(0.241)	(0.170)	(0.343)	(0.224)	(0.049)
Permanent	-0.087	-0.082	-0.035	0.138	-0.008	-0.024*
	(0.072)	(0.064)	(0.069)	(0.109)	(0.050)	(0.014)
Negative view on prof. development	-0.204***	-0.022	-0.052	-0.115**	-0.078*	-0.086***
	(0.045)	(0.042)	(0.045)	(0.058)	(0.042)	(0.009)
School Fixed Effect	YES	YES	YES	YES	YES	YES
Observations	2,254	2,915	2,828	1,908	2,232	78,155
R-squared	0.184	0.172	0.157	0.170	0.11	0.527

Notes: Efficacy in student engagement variable standardized to have a mean of 0 and standard deviation of 1 within each country. *Experience:* total years of teaching experience. *Doctorate degree:* dummy variable indicating completion of doctorate degree. *Permanent:* dummy variable indicating permanent employment status. *Negative view on prof. development:* dummy variable indicating teacher's negative feelings on the relevance of professional development activities offered. Standard errors obtained through balanced repeated replication weights in parentheses.

**p<0.05

***p<0.01

Source: TALIS 2013

Table 6. Project-Based Learning and Efficacy in Class Management: OLS Micro Estimates – Within Schools

Dependent Variable: Efficacy in Class Management	Korea	Japan	Singapore	England	Finland	International Pooled
Project-based learning	0.372***	0.365***	0.357***	0.245***	0.052	0.232***
	(0.042)	(0.047)	(0.043)	(0.065)	(0.056)	(0.012)
Female	0.210***	0.335***	-0.104***	-0.033	-0.043	-0.024**
	(0.055)	(0.039)	(0.040)	(0.050)	(0.043)	(0.011)
Age	-0.009	0.034	0.055***	-0.009	0.014	-0.001
	(0.037)	(0.027)	(0.020)	(0.018)	(0.027)	(0.006)
Age^2	-0.000	-0.000	-0.001**	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.043***	0.021	0.018**	0.033**	0.027**	0.026***
	(0.015)	(0.014)	(0.009)	(0.016)	(0.012)	(0.002)
$Experience^2$	-0.001	-0.000	-0.000	-0.001	-0.001*	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Doctorate degree	0.030	0.031	0.601***	-0.342	0.157	-0.077
	(0.136)	(0.234)	(0.177)	(0.502)	(0.206)	(0.059)
Permanent	-0.127*	0.020	0.047	0.407***	0.087	0.072***
	(0.070)	(0.052)	(0.075)	(0.122)	(0.066)	(0.017)
Negative view on prof. development	-0.184***	0.016	-0.011	-0.065	-0.034	-0.058***
	(0.045)	(0.038)	(0.051)	(0.055)	(0.054)	(0.011)
School Fixed Effect	YES	YES	YES	YES	YES	YES
Observations	2,254	2,915	2,828	1,908	2,232	78,155
R-squared	0.175	0.170	0.132	0.154	0.100	0.351

Notes: Efficacy in class management variable standardized to have a mean of 0 and standard deviation of 1 within each country. *Experience:* total years of teaching experience. *Doctorate degree:* dummy variable indicating completion of doctorate degree. *Permanent:* dummy variable indicating permanent employment status. *Negative view on prof. development:* dummy variable indicating teacher's negative feelings on the relevance of professional development activities offered. Standard errors obtained through balanced repeated replication weights in parentheses.

*p<0.1
**p<0.05
***p<0.01

Source: TALIS 2013

Thus far, our results indicate that greater frequency of conducting project-based learning is positively correlated with teacher self-efficacy. Such a relation holds true not only at the cross-country level, but also within countries. In particular, the strong positive correlation between project-based learning and teacher self-efficacy is existent even after controlling for differences between schools within each country, and the same holds for the relationship between project-based learning and each of the three sub-categories of teacher self-efficacy. Comparisons of the point estimates for project-based learning revealed that the correlation between project-based learning and teacher self-efficacy is particularly strong for Korean teachers. In the case of the between-school analysis using equation (1), conducting project-based learning on a more frequent basis is associated with higher teacher self-efficacy level of 0.441 standard deviations for the Korean sample, which is approximately 48% greater than the higher teacher self-efficacy level (0.298 standard deviations) associated with more frequent project-based learning for the international pooled sample. When controlling for school fixed effects, the point estimate of project-based learning for Korea (0.448) is greater than the point estimate of the international pooled sample (0.287) by approximately 56%.

However, the analyses conducted thus far only reveal relationships of correlation and thus it is difficult to make causal interpretations. In other words, while it is possible that conducting project-based learning leads to higher levels of teacher self-efficacy, it could also be the case that teachers who have greater self-efficacy tend to conduct project-based learning on a more frequent basis.

In order to deal with the issue of causality, we analyze data from a field experiment on project-based learning conducted on middle school teachers of Daegu city.

V. Empirical Analysis of a Field Experiment on Project-Based Learning

In order to empirically analyze the effect of project-based learning on teacher self-efficacy in a more causal way, from August to December of 2015 we conducted a teacher training program on project-based learning for teachers from two Daegu city middle schools. After providing training and consultation on project-based learning for a single semester (the fall semester of the 2015 school year), we surveyed teachers of two middle schools that received training (treatment group) and three schools that did not (control group).[8] As shown in Table 7, 51 teachers from the treatment group and 58 teachers from the control group participated in the survey.

[8] The two schools of the treatment group voluntarily applied for the project-based learning teacher training program, and the three schools of the control group were selected from the same school district as that of the treatment group. Therefore, the field experiment is weak in meeting the condition of random selection and issues of endogeneity are likely to exist.

Table 7. Project-Based Learning Field Experiment Survey

Type		No. of Participants	Proportion	
Treatment Group	School A	12	11.01%	46.79%
	School B	39	35.78%	
Control Group	School C	31	28.44%	53.21%
	School D	16	14.68%	
	School E	11	10.09%	
Total		109	100%	

Notes: After conducting the project-based learning teacher training program on middle school teachers from August 2015 until December 2015, the survey was conducted on the teachers of the treatment group (two schools) and control group (three schools).

Source: Daegu field experiment data.

The difference in pre-determined characteristics between teachers of the treatment and control groups, including gender, education, total teaching experience and experience in current school, are shown in Table 8. It is evident that there is no statistical difference in gender proportion between the treatment and control groups. Also, there is no statistical between-group difference in the proportion of teachers whose highest education level is master's degree or higher. In the case of total teaching experience, teachers of the treatment group, on average, had 11 months of more teaching experience than teachers of the control group, but the difference was not statistically significant. However, teachers in the control group had, on average, more than seven years (87 months) of more experience in teaching at the current school than that of teachers from the treatment group, and this difference was significant at the 1% level.

Table 8. Comparison of Teacher Characteristics between the Treatment and Control Groups

Dependent Variable:	Gender	Education	Total Teaching Experience	Teaching Experience at Current School
Panel A: Entire Treatment Group				
Treatment Group	-0.140	0.150	-10.871	-87.080***
(School A, School B)	(0.096)	(0.096)	(19.634)	(17.746)
Observations	109	108	105	104
R-squared	0.020	0.022	0.003	0.186
Panel B: School A Only				
Treatment Group	-0.052	0.061	-56.185*	-57.462**
(School A)	(0.161)	(0.161)	(29.967)	(27.576)
Observations	70	69	66	65
R-squared	0.002	0.002	0.037	0.037
Panel C: School B Only				
Treatment Group	-0.167	0.177*	3.071	-96.193***
(School B)	(0.103)	(0.103)	(19.966)	(16.960)
Observations	97	96	93	92
R-squared	0.027	0.030	0.000	0.211

Notes: Gender: Male=1, Female=0. *Education:* Dummy indicator for completing master's degree or above (includes master's degree, completion or graduation from doctorate level program). The teaching experience variables are expressed in months. Robust standard errors in parentheses.

*p<0.1
**p<0.05
***p<0.01

Source: Daegu field experiment data.

To assess the level of teacher self-efficacy for our experiment, we used the same 12 questions used by the TALIS 2013 survey to measure the sub-categories of teacher self-efficacy (efficacy in instruction, efficacy in student engagement, efficacy in class management), and then used the average of the three sub-categories to measure teacher self-efficacy. For a more precise empirical analysis, the pre-determined characteristics of the treatment and control groups need to be statistically identical. However, as previously mentioned, there was a statistically significant difference in the 'teaching experience in the current school' between the treatment and control groups. Also, when comparing only School

A of the treatment group with the control group, there was a statistically significant difference in ‘total teaching experience’ and ‘teaching experience in the current school’. For this reason, when estimating the effect of project-based learning on teacher self-efficacy, we include controls for pre-determined characteristics, including gender, a dummy indicator for completion of master’s degree or higher, total teaching experience and teaching experience at the current school. The equation used for analysis is as follows:

$$y_i = \beta_0 + \beta_1 Project^T{}_i + \gamma X^T{}_i + \varepsilon_i \quad (3)$$

where y_i is a variable on self-efficacy of teacher i, standardized to have a mean of 0 and standard deviation of 1 of the control group, and $Project^T{}_i$ is the dummy variable indicating whether teacher i was treated with the project-based learning training program. X_i is a vector of teacher i’s pre-determined characteristics, and ε_i is the error term.

The OLS estimates obtained through equation (3) are reported in Table 9. After conducting a teacher training program on project-based learning for a single semester during the fall semester of the 2015 school year, the teachers of the treatment group show higher levels of efficacy in instruction and efficacy in student engagement than those of the teachers in the control group, and the difference is statistically significant. For efficacy in class management, however, there is no statistical difference between the two groups. In the case of the integrated measure of teacher self-efficacy, the level for teachers of the treatment group are 0.4~0.5 standard deviations higher than that of the control group, which is very similar to the previously reported point estimates of OLS regressions using the TALIS 2013 Korean sample.

In particular, such results seem quite large when considering the relatively short period of time of the experiment. Also, it may be natural that initially there is a positive effect on efficacy in instruction and efficacy in student engagement, and that more time is required for changes in efficacy in class management to occur.

Table 9. The Effects of Project-Based Learning on Teacher Self-Efficacy

Dependent Variable:	Efficacy in Instruction		Efficacy in Student Engagement		Efficacy in Class Management		Teacher Self-Efficacy	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	0.485**	0.509**	0.485**	0.631**	0.184	0.217	0.435**	0.513**
	(0.195)	(0.247)	(0.202)	(0.245)	(0.183)	(0.202)	(0.194)	(0.227)
Control Variables	NO	YES	NO	YES	NO	YES	NO	YES
Observations	109	100	109	100	109	100	109	100
R-squared	0.055	0.123	0.052	0.077	0.009	0.021	0.045	0.079

Notes: Controls: Gender (male=1, female=0), education level (master's degree or above=1, below master's degree=0), total teaching experience, and teaching experience at current school. Dependent variables standardized to have a mean of 0 and standard deviation of 1 of the control group. The survey questions to assess the sub-categories of teacher self-efficacy were obtained from the survey questionnaire of TALIS 2013. Each question is answered on a four-point scale (1: "Never" ~ 4: "In all or nearly all lessons"), and there are four questions asked for each sub-category. The actual survey questionnaire is shown in Figures 1A~3A of the Appendix. Robust standard errors in parentheses.

*p<0.1
**p<0.05
***p<0.01

Source: Daegu field experiment data.

The results of the empirical analysis using data from the Daegu experiment, despite the relatively short period of implementation and the limitation of a small sample, are fairly consistent with the results of the analysis using the TALIS database. The results of the analyses on the two different datasets show that conducting project-based learning is associated with higher teacher self-efficacy levels of approximately 0.4~0.5 standard deviations. The association between project-based learning and efficacy in instruction and efficacy in class management are quite high and statistically significant for analyses using both datasets. In the case of efficacy in class management, training in project-based learning has no significant impact for the Daegu experiment data, but analysis using the TALIS database showed a positive and statistically significant relationship between project-based learning and efficacy in class management. However, for analysis on the TALIS database, it should be noted that the OLS estimate of the project-based learning variable with efficacy in class management as the dependent variable is lower than the OLS estimates of the project-based learning variable for regressions on other sub-categories of teacher self-efficacy, and thus it can be said that the regression results using the two datasets show some degree of consistency.

Despite such consistency between the results of analyses using the TALIS database and the Daegu experiment data, there are limitations that should be noted. In the case of the

TALIS database, although the sample size is quite large and the survey was designed to be compatible for international comparison, endogeneity may exist in the relationship between project-based learning and teacher self-efficacy which cannot be fully controlled. For the Daegu field experiment, the data consists of a relatively small sample size, as a total of 109 teachers from five schools (two in the treatment group, three in the control group) took part in the experiment. Also, schools of the treatment group voluntarily applied for the project-based learning teacher training program, which means participation in the program was not determined exogenously, and schools of the control group were selected among those in the same school district as that of the treatment group. Such a limitation may induce bias pertaining to sample selection and omitted variables.

The second phase of the Daegu experiment, expected to take place in 2016, will provide us with more extensive data, including a larger treatment group (six schools) and information from all remaining schools in Daegu city (126 schools). This will allow us to conduct more rigorous quasi-experimental empirical analysis on the causal relationship between project-based learning and teacher self-efficacy.

VI. Conclusion

In recent years, research in education has recognized the limitations of quantitative measures, such as years of schooling, and has increasingly focused on empirical analysis of qualitative measures like students' academic achievement (Hanushek & Woessmann, 2010). In the case of Korea, focusing on student test scores has the effect of overshadowing serious qualitative problems of Korea's education, namely excessive use of rote learning (Lee, Jeong, & Hong, 2014). Therefore, there needs to be more emphasis on the empirical analysis of variables directly pertaining to teaching practices like project-based learning in order to gain a more clear understanding of the fundamental problems of Korea's education.

This research analyzed the relationship between project-based learning and teacher self-efficacy using various databases, and obtained the following results.

First, through the internationally comparable PISA and TALIS databases it is evident that Korea's rate of conducting project-based learning is much lower than that of other countries. In particular, the TALIS database shows that Korean teachers conduct project-based learning at the lowest rate among the 31 countries compared.

Second, a cross-country analysis shows that low rate of project-based learning is strongly correlated with low teacher self-efficacy. In other words, countries with greater rates of conducting project-based learning tend to have higher levels of teacher self-efficacy, and this implies that Korea's low rate of project-based learning can have important implications for Korea's education.

Third, micro data analysis using the TALIS database reveals that in the case of Korea, conducting project-based learning on a more frequent basis is associated with a higher teacher self-efficacy level of 0.441 standard deviations. After controlling for differences among schools, Korean teachers' relatively more frequent use of project-based learning is associated with a higher teacher self-efficacy level of 0.448 standard deviations, which is the

third highest degree of association among the 31 countries compared. Project-based learning is also strongly and positively associated with efficacy in instruction, efficacy in student engagement, and efficacy in class management.

Fourth, analysis of the Daegu field experiment data reveals that teacher training in project-based learning is associated with higher teacher self-efficacy levels of 0.4 to 0.5 standard deviations, which are similar to the point estimates of the analysis using the TALIS database. The fact that analyses on two different datasets lead to consistent results is quite meaningful, but limitations do exist, as both analyses are not free from endogeneity issues. In particular, for the Daegu field experiment data, the sample size is quite small and the bias pertaining to sample selection and omitted variables could not be fully eliminated.

The second phase of the Daegu field experiment will lead to the gathering of more extensive data which will allow for more precise analysis on the empirical relationship between project-based learning and teacher self-efficacy.

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Appendix

Figure 1A. TALIS Survey Questions on Assessing Efficacy in Instruction

In your teaching, to what extent can you do the following?

Question	Not at all	To some extent	Quite a bit	A lot
Craft good questions for my students	①	②	③	④
Use a variety of assessment strategies	①	②	③	④
Provide an alternative explanation for example when students are confused.	①	②	③	④
Implement alternative instructional strategies in my classroom	①	②	③	④

Figure 2A. TALIS Survey Questions on Assessing Efficacy in Student Engagement

In your teaching, to what extent can you do the following?

Question	Not at all	To some extent	Quite a bit	A lot
Get students to believe they can do well in school work	①	②	③	④
Help my students value learning	①	②	③	④
Motivate students who show low interest in school work.	①	②	③	④
Help students think critically	①	②	③	④

Figure 3A. TALIS Survey Questions on Assessing Efficacy in Class Management

In your teaching, to what extent can you do the following?

Question	Not at all	To some extent	Quite a bit	A lot
Control disruptive behavior in the classroom	①	②	③	④
Make my expectations about student behavior clear	①	②	③	④
Get students to follow classroom rules	①	②	③	④
Calm a student who is disruptive or noisy	①	②	③	④

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