

Lee, Ju-Ho; Kim, Booyuel

Research Report

Educational Reform through Project-based Learning (PBL)

KDI Focus, No. 66

Provided in Cooperation with:

Korea Development Institute (KDI), Sejong

Suggested Citation: Lee, Ju-Ho; Kim, Booyuel (2016) : Educational Reform through Project-based Learning (PBL), KDI Focus, No. 66, Korea Development Institute (KDI), Sejong, <https://doi.org/10.22740/kdi.focus.e.2016.66>

This Version is available at:

<https://hdl.handle.net/10419/200866>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



KDI FOCUS

June 8, 2016 (No. 66, eng.)

For Inquiry: KDI Communications Unit

Address: 263, Namsejong-ro, Sejong-si 30149, Korea

Tel: 82-44-550-4030 **Fax:** 82-44-550-0652

Authors | Ju-Ho Lee, Professor at KDI School(82-44-550-1043)

Booyuel Kim, Professor at KDI School(82-44-550-1023)

Yoonsoo Park, Fellow at KDI(82-44-550-4337)

Syngjoo Choi, Professor at SNU(82-2-880-4109)

KDI FOCUS | Analysis on critical pending issues of the Korean economy to enhance public understanding of the economy and provide useful policy alternatives

Korea's Leading Think Tank

www.kdi.re.kr

Educational Reform through Project-based Learning (PBL)*

Ju-Ho Lee, Professor at KDI School
Booyuel Kim, Professor at KDI School
Yoonsoo Park, Fellow at KDI
Syngjoo Choi, Professor at SNU

“Project-based learning (PBL) is gaining increasing prominence as an educational tool for enhancing students’ key future competences - communication, collaboration, critical thinking and creativity, referred to as the 4Cs. However, the proportion of PBL classes in Korean schools is among the lowest in the world. Nevertheless, results from a pilot PBL module undertaken by two middle schools in Daegu during a free semester show that students’ communication and collaboration skills improved. To boost this momentum, Korea must now establish a mid- to long-term plan aimed at reforming school curriculums and admission systems to fully optimize the use of PBL while seeking short-term measures to encourage teachers to pursue innovative teaching methods.”

I. Importance of PBL

As digital technology converges with different domains at an exponential rate, the world is witnessing seismic technological changes that include cloud computing, big data, Artificial Intelligence (AI), Internet of Things (IoT) and 3D printing. There are those who believe that this is the advent of a 4th industrial revolution (Schwab, 2016), and that such

* Summarized and rewritten article of the forthcoming KDI research paper, *Educational Reform through Project-based Learning* (2016).

<Table 1> PBL Characteristics and Correlation with Future Competencies

Characteristic	Related future competency
Self-directed problem identification and solving skills	Critical thinking, creativity
Working with others	Communication, collaboration

What should we do to help our future generations develop key competencies in preparation for the rapid changes in technology?

Vital future skills are communication, collaboration, critical thinking and creativity - the 4Cs or 21st century skills.

PBL is an educational pedagogy in which students are naturally led to learning through self-directed projects in collaboration with their peers. It has been known to be effective in fostering key future capabilities.

progress will lead to the automation of approximately 47% of US jobs in the coming 10 to 20 years (Frey and Osborne, 2013). In line with the rapid technological change, the role of education will also become increasingly important. So, how should we prepare our future generations? What competences are needed and how can we foster them?

Many speculate that the currently prevalent rote learning method will prove futile during the new revolution. Accordingly, the education field is abuzz with discussions on the necessary key competencies, which encompass communication, collaboration, critical thinking and creativity i.e. the 4Cs or 21st Century Skills. As an effective educational method, many have pointed to project-based learning (PBL),¹⁾ an educational pedagogy in which students are naturally led to learning through self-directed projects in collaboration with their peers. To elaborate, imagine a middle school social studies class where students are taught about democracy and elections.²⁾ In a typical lecture-oriented class, students will merely be delivered textbook knowledge and information. However, in a PBL class, students are provided with the chance to self-learn through various activities to simulate a real election process, for example a school presidential election. While teachers observe and assist, students can develop and promote their own election campaigns and discuss key agendas with opponents, all of which provide them with a better understanding of the election system and enhance their reasoning and presentation and teamwork skills.

<Table 1> shows the correlation between PBL characteristics and future competencies. Class activities like finding and solving real-world problems can improve students' critical thinking and creativity, and collaboration with peers can enhance communication and collaborative skills.

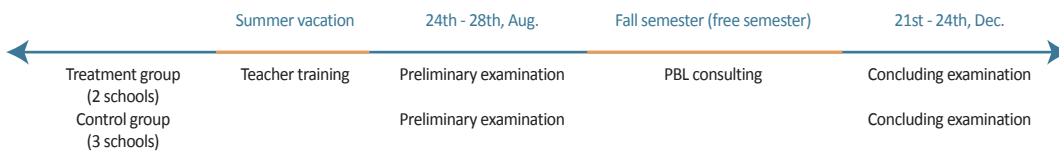
The most exemplary cases of PBL can be found in the US. With California, the birth place of some of the world's leading high-tech companies, at the fore, the number of PBL schools continues to increase. The New Tech Network, comprised of 157 schools including New Technology High School in Napa, is striving to disseminate PBL across the nation while another network consisting of 12 schools, led by High Tech High School in San Diego, has become a showroom for education experts around the globe; China has recently established futuristic schools based on High Tech High School in Beijing and Shenzhen.

However, despite the growing importance of PBL, Korea currently lacks any serious

1) Project-based learning, project learning for short, is a commonly used term in education circles. They are used interchangeably in this paper.

2) One of project learning modules the authors actually arranged for this study.

[Figure 1] Overview of Study Design



interest or motivation. This paper aims to address this issue by analyzing the impact of PBL on two specific 4C skills, communication and collaboration, as they are relatively easier to measure than the others. In order to do this, the authors implemented PBL modules in two middle schools in Daegu during the second semester (free semester) of 2015, prior to which, teacher training and consulting were provided. Accordingly, changes in students' communication and collaboration skills were monitored.

II . Effects on Communication and Collaboration

1. Research Design

To analyze the effects of PBL on communication and collaboration, the authors, together with Daegu Metropolitan Office of Education, assisted two middle schools (treatment group) in implementing PBL programs during the second free semester of 2015. Then, a comparative analysis was conducted on the changes in students' communication and collaboration skills compared to those of their counterparts in three neighboring schools (control group) over the same period.³⁾ The five subject schools are all located within a 2 km radius, meaning that student numbers and general school conditions are similar.

Before the initiation of the program, experts in pedagogy and educational technologies visited the treatment group during the summer vacation (August) of 2015 and offered a 3-day training program on PBL, which covered program concept, teaching procedures and problem construction methods, while none were provided to the control group. Subsequently, the authors visited all five schools at the beginning of the second semester (24th-25th, Aug.) and conducted preliminary evaluations on 678 freshman students to measure their communication and collaboration skills using a customized survey and games—to be described in the following section. The teachers in the treatment group were provided with on- and off-line consulting and coaching during the semester at two-week intervals to ensure that they correctly applied PBL in class. The authors again visited all five schools at the end of the semester (21st-24th, Dec.) and conducted closing evaluations on 666 freshmen. [Figure 1] summarizes how this study is designed.

The authors provided PBL-related assistance to freshmen in two middle schools in Daegu during the free semester in 2015, and observed changes in their communication and collaboration skills.

3) All experiments related to this study were conducted with parental and student consent.

2. Measuring Tools

Due to the difficulties in measuring communication and collaboration skills, the authors used preceding literature on network and behavioral economics (Jackson, 2010; Engel, 2011; Ledyard, 1995; Goeree *et al.*, 2010) as references in formulating a method to gauge each skill.

To measure communication, students were asked to list three closest classmates, and their answers were used to gauge students' level of communication and interaction in class.

For communication skill, students were asked to list their three closest classmates, and their answers were used as data to gauge the level of communication and interaction in class. Specifically, the list of chosen friends gave the information direction. A student's choice of friends is limited to three (out-degree) while a student being chosen as a friend is unlimited (in-degree). As such, the level of communication and interaction in class may vary depending on the answers. To measure the degree, this study used the following four statistics: the proportion of "outcasts" refers to those who were not chosen as a friend; the clustering coefficient denotes the probability that three students chosen by a random student are all friends and the higher the value, the stronger the peer network; the number of subgroups shows the number of unsociable groups who are separated from their peers; the average path length is a calculation of how many friends, on average, have to be connected for one to be a friend of another. Students' connection and interaction can be considered high when the proportion of outcasts, number of subgroups and average path length are low and the clustering coefficient is high.

To measure collaboration, students were placed in a situation in which their own personal interests were in conflict with the interests of the entire class, and their way of caring for and collaborating with others to handle the situation was observed.

As for collaboration skill, students were placed in a situation in which their personal interests were in conflict with the interests of the entire class, and their way of caring for and collaborating with others to handle the situation was observed. To do this, the authors designed two games to gauge consideration and collaboration. In the dictator game, each student was given 2,000 Korean won (about two US dollars) and told to share it freely with anonymous peers. The amount of money they shared was measured to identify how much they consider others at their own expense, since the more they share the less they keep. In the public good game, each student was given 2,000 won to invest in both a personal account and class account, at their discretion. Students would receive 100% of the amount invested in the personal account while receiving 10% of the total amount invested in the class account, regardless of how much they each invested. For example, in a class of 25 students, if all of the students were to invest the whole 2,000 won in their personal accounts, the return for each student would be 2,000 won. Meanwhile, if the students were to invest the whole 2,000 won in the class account, each student would receive 5,000 won ($=2,000 \times 25 \times 10\%$). Then, what if 24 students invested 2,000 won each in the class account while one student invested the 2,000 won in his/her personal account? In this case, the lone student would receive not only the 2,000 won in his/her personal account but also 10% of the total amount in the class account of 4,800 won ($=2,000 \times 24 \times 10\%$). On the other hand, the 24 students who invested their money in the class account

would only get the 10% or 4,800 won. In short, while students can increase the interests of the whole class through the amount they save in the class account, they can also maximize their own interests by saving in their personal account while the rest of the class invest in the class account; this is called free riding. Accordingly, the game provides insight into how much students trust and collaborate with each other to overcome the temptation of free riding to maximize the interests of all.

However, it must be noted that Korea's educational system is overwhelmed by the almost obsessive pursuit of university admission. Accordingly, parents and teachers will certainly reject PBL if there is evidence that it negatively affects school grades, regardless of the confirmed positive influences. In recognition of the reality, this study conducted additional analysis on the effects of PBL on students' academic achievements, measured through a test consisting of 20 questions in Korean, maths, English and science.

3. Analysis Results

<Table 2> presents the changes in students' academic achievements and communication and collaboration skills with PBL. Specifically, it shows the changes in the treatment group compared to those in the control group (schools with similar characteristics e.g. student gender, parental income, maternal education level, number of students per class and whether the school is co-ed or single-sex).

<Table 2> can be summarized as the following. First, with regards to communication skill, an improvement of approximately 0.20 as a result of PBL was confirmed in the clustering coefficient, implying that the three students chosen by a given student are 20%p more likely to be friends. This also points to a tighter peer network. On the other hand, no statistically significant effects were found for the proportion of outcasts, number of subgroups and average path length, suggesting that overall peer relationships did not

<Table 2> Effects of PBL on Students' Academic Achievements and Communication and Collaboration Skills

Dependent variable (unit)	PBL effect (s.e.)
Academic achievement (s.e.)	0.043 (0.115)
Communication	
Proportion of outcasts (0-1)	0.02 (0.034)
Clustering coefficient	0.20** (0.042)
Subgroups (number)	-0.15 (0.633)
Average path length (layer)	-0.27 (0.286)
Collaboration	
Dictator game (0-1)	0.01 (0.0274)
Public good game (0-1)	0.08** (0.0369)

Note: Calculated by authors using observational data on 678 freshmen in five middle schools in Daegu (2 treatment group, 3 control group) during the second semester of 2015.

Significance level: *(10%), **(5%), ***(1%)

expand much in scope. Given that the duration of the intervention period of this study is relatively short (one semester), it can be concluded that a semester-long PBL-based class can affect the intensity of students' friendship networks but not the scope of the network.

As for collaboration skill, the dictator game presented no statistically significant difference in the amount of donation between the treatment and control groups, although the public good game showed that students in the treatment group invested 8% more in the class account than those in the control group. As explained earlier, the dictator game is designed to measure students' unconditional altruism in seeking the interests of others (other-regarding preference) while the public good game aims to see how much students trust and cooperate with one another for the benefit of the entire class. In this sense, it can be said that the one-semester PBL experience was not effective in enhancing students' unconditional altruism but did improve the level of mutual trust and collaboration for the common good.

Meanwhile, there were no significant effects on academic achievement. Overall, although the PBL program had little impact on students' academic achievement, it helped them build a stronger peer network in class and enhance mutual trust and collaboration in the process. This testifies to the potential of PBL in upgrading students' communication and collaboration skills.

III . PBL in Korea and Policy Implications

This section examines the current status of PBL and its adoption in Korean classrooms. In 2008, the OECD launched the Teaching and Learning International Survey (TALIS), a five-year interval survey aimed at compiling information on teaching methods used by middle school teachers around the world.⁴⁾ [Figure 2] presents the proportion of PBL-based class activities in each country, according to the 2013 TALIS. Korea ranked the lowest among the countries surveyed; the proportion is not only below advanced countries such as Denmark, Norway, Canada, Finland, France and Singapore but also developing countries including Chile, Mexico, Brazil and Bulgaria.

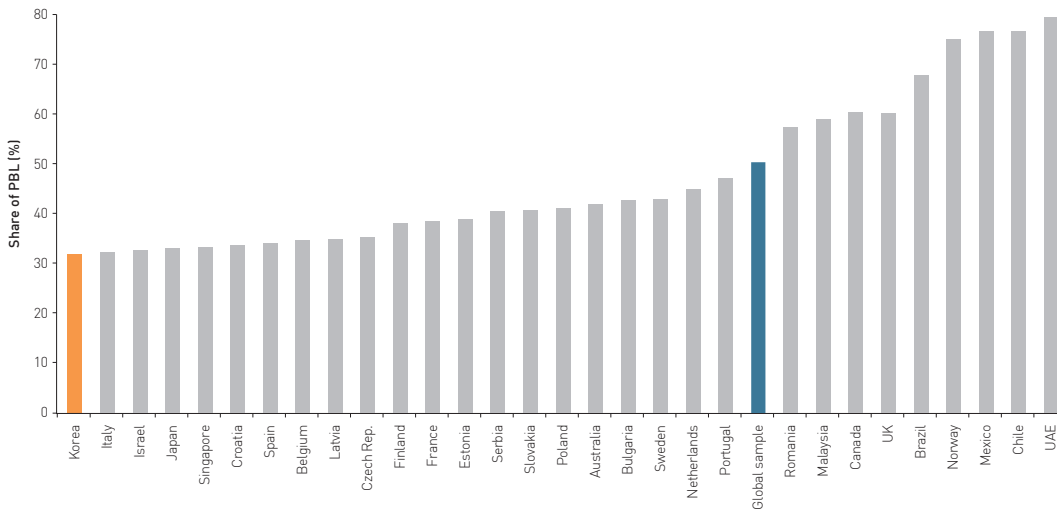
One of the biggest obstacles to the active implementation of PBL in Korea can be found in the school curriculums and admission systems that emphasize rote learning in pursuit

4) 24 OECD members participated in the 2013 TALIS and it contains final samples of over 170,000 teachers from over 10,000 schools: Australia, Belgium (Flanders), Brazil, Bulgaria, Chile, Canada (Alberta), Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Iceland, Israel, Italy, Japan, Korea, Latvia, Malaysia, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Singapore, Slovakia, Spain, Sweden, UAE (Abu Dhabi), UK (England) and US. Iceland and Cyprus had no available data. The US final samples did not meet TALIS standards on sample extraction (OECD, 2014), hence excluded from this paper. The Survey ran in 2012-2013, both on- and offline, and Korea's final samples include 2,933 teachers from 177 schools. The Survey asks how frequently students engage in subgroup activities such as solving problems or proposing agreed solutions to a given task. Respondents can choose one of the following responses: ① none, ② sometimes, ③ often and ④ almost every class. In this paper, the proportion of teachers who chose ③ and ④ are deemed to practice PBL in their class.

Comparison of the students in the treatment and control groups shows that one semester of PBL contributed to enhancing students' communication and collaboration skills without interfering in their academic achievements.

Despite the growing importance of PBL, Korea ranked the lowest in the world in terms of PBL use in class.

[Figure 2] Proportion of PBL in Middle Schools by Country (TALIS 2013)



Source: TALIS 2013.

of high scores for university admission. Accordingly, Korea must strive to implement a fundamental, full-scale reform of its educational system, including curriculums and admission systems; in Hong Kong, wide-ranging educational reforms have been consistently implemented. However, the urgency to rectify the problems must not serve as an excuse to put aside the necessity to transform contemporary teaching/learning methods. In this context, the authors suggest four strategies to encourage the acceptance of PBL.

First, a phased approach is needed to increase the number of schools that use PBL modules. Changes should start at the school level with the majority of teachers adopting PBL modules under the leadership of the principal. To this end, the government should provide the necessary support through a bottom-up phased approach, meaning that PBL is gradually applied to an increasing number of schools.

Second, teacher training and consulting programs should be customized to each school so that proper support is provided and a team of outside experts should have full charge of program operations to ensure consistency. Once PBL starts to spread in earnest, indirect assistance should also be given to help teachers formulate their own networks voluntarily and to enable them to function properly.

Third, PBL should be integrated into the free semester and performance assessment systems. In particular, PBL is highly compatible with the recently adopted free semester system, as it can lift the burden of having to attain high scores in multiple-choice assessments for both teachers and students. As PBL progresses further, the focus on GPA scores could all together shift to performance-based assessments.

Fourth, incentive systems to attract more teachers to PBL should be strengthened. One suggestion is a 'PBL Contest' managed by the municipal office of education, in which

The government should urgently reform the curriculum and admission systems to enable a stable adoption of PBL in the mid- to long-term, while attracting more teachers to the bottom-up approach in the short-term.

students submit their project outcomes and are awarded for excellence along with their teachers. The incentive system should be able to offer new opportunities to teachers and also give proper acknowledgement to their contributions so that they can become a driving force in the field of teaching, equipped with the pride and self-recognition of being a PBL expert. ■

References

- Engel, C., "Dictator Games: A Meta Study," *Experimental Economics* 14, 2011, pp.583~610.
- Frey, Carl Benedikt and Michle Osborne, "The Future of Employment: How Susceptable Are Jobs to Computerization?" Oxford Martin School, University of Oxford, 2013.
- Goeree, J., M. A. McConnell, T. Mitchell, T. Tromp, and L. Yariv, "The 1/d Law of Giving," *American Economic Journal: Microeconomics* 2(10), 2010, pp.183~203.
- Jackson, M. O., *Social and Economic Networks*, Princeton University Press, 2010.
- Ledyard, J. O., "Public Goods: A Survey of Experimental Research," in J. Kagel and A. Roth (eds.), *Handbook of Experimental Economics*, Princeton: Princeton University Press, 1995, pp.111~194.
- Lee, Ju-Ho, *Educational Reform through Project-based Learning*, Research Monograph, Korea Development Institute, 2016 (in Korean) (forthcoming).
- OECD, *TALIS 2013 Results: An International Perspective on Teaching and Learning*, OECD Publishing, 2014.
- Schwab, Klaus, *The Fourth Industrial Revolution*, World Economic Forum, 2016.