

Article

Sustainability of Cooperative Professional Development: Focused on Teachers' Efficacy

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Abstract: In this study, we aim to gain critical insights into how cooperative professional development affects teachers' efficacy. To this end, the purpose of this study is to identify cooperative professional development types (CPD-type) and to reveal the relationship between CPD-type and teachers' efficacy in Korean middle schools, controlling for gender, age, years of experience and school climate. The data of this study are derived from the 2013 Teaching and Learning International Survey (TALIS) conducted by the OECD. The K-mean cluster analysis was used to identify distinct clusters of middle school teachers based on CPD. This process identified four specific groups: the disengaged group (36.8%), the collaborative group (11.3%), the activity-focused group (24.8%), and the coordinative group (27.1%). Hierarchical regression analysis revealed that all dummy variables of CPD-type were statistically significant, controlling for gender, age, years of experience, and school climate. Comparing the relative importance of each variable on teachers' efficacy, the CPD1 (1 = the collaborative group) variable was most important. The results of this study provide a rationale for teachers to participate in collaborative professional development actively.

Keywords: sustainability education (SE); sustainability of professional development; teachers' efficacy; the collaborative group; the disengaged group; the activity-focused group

1. Introduction

One of the most serious problems in our time is how to sustain our planet's resources, while developing wealth and well-being for a growing population. This task has been defined in the concept of sustainability. Sustainability education (SE) has been launched as an answer to cope with sustainability. Sustainability education is intended to provide learning that fosters personal improvement and encourages taking action for change in our human and natural world. Teachers are considered to play a central role when addressing this educational goal; hence, teacher quality could be crucial to SE. Teachers need to develop competences and skills in each SE proficiency area, focusing on content, pedagogy and assessment approaches.

Relating to this need, professional development for teachers is recognized as a vital component for the enhancement of the quality of teaching and learning in SE. This is very important in that professional development (PD) is related to changes in the teacher's cognition, professional attitude, and pedagogical knowledge [1,2], and can also contribute to the retention of teachers. Various types of PD are offered to support and qualify teachers. Several studies [3,4] have shown the positive effects of professional development on the quality and retention of teachers. The expected outcomes of PD are not only focused on short-term effects, but also on long-term effects. Effects that are both short term and long term can be considered to be sustainable [5]. Based on this point of view, if only professional

development can have a significant impact on teachers' competencies, then professional development can be considered as sustainable professional development (SPD).

What are ways of promoting the sustainability of professional development? There is increased interest in research that identifies features contributing to the sustainability of PD [6–10]. The components contributing to the sustainability of PD are related to reflection about changes in teaching practice, cooperative participation, and are embedded in teachers' day-to-day work in schools [6–10]. Although prior literature provides various characteristics which foster the sustainability of professional development, cooperation or collaboration has been identified as essential for the sustainability of professional development [11,12]. Lerman and Zehetmeier [13] highlight community building and networking as factors facilitating sustainability. As a result, a system which supports collegiality, such as the observation of peers, feedback from peers, and reflection with peers, could be considered to be a way of promoting the sustainability of professional development [14,15].

Glatthorn [16] used cooperative professional development (CPD) as an inclusive term to embrace forms of peer-oriented systems. CPD is defined as any activity in which two or more teachers work together, using a variety of methods and structures, for their own professional growth [17]. Exchange of materials, joint activities across different classes and age groups, professional dialogue, peer supervision, peer coaching, collaborative professional learning, and action research can belong to CPD.

Does CPD actually lead to the sustainability of professional development? The sustainability of CPD has not been investigated to any great extent. Additionally, teachers have participated in various types of CPD, and there could be differences in their effectiveness depending on the types of CPD. For example, merely exchanging instructional materials could not be sufficient, because it limits the opportunity for teachers to focus on instructional practices and reflect. This can be interpreted as implying that CPD-type is likely to have a discriminatory effect on teachers' skills and attitude.

Therefore, this study focuses on whether the CPD-types employed have different sustainable impacts. In this study, we analyzed teachers' efficacy as a lens to determine the effect of CPD-type on teachers' skills and attitude. A teacher's efficacy refers to the level of a teacher's belief in his or her ability to perform certain actions related to the teaching profession [18]. Teachers' self-efficacy has been shown to be related to their instructional behaviors and has been recognized as an important factor that influences student achievement and behavior [19–27].

Especially in relation to this research, this is because teachers' self-efficacy may include the potential to influence pedagogical knowledge in SE. The field of SE specifically stresses the need for alternative and student-centered pedagogical methods which are opposed to traditional lecturing [28]. Teachers are more likely to adopt and implement alternative instructional methods when they have confidence in their own ability to control their classrooms and affect student learning.

Smylie [29] suggests that teacher efficacy may act as a professional filter through which new ideas and innovations must pass before teachers internalize them and change their behaviors. Although prior research [30–34] has shown that gender, age, years of experience, school climate, and participation in professional development affect teachers' self-efficacy, little attention has been given to whether teacher efficacy evolves as a result of CPD-type in Korea. Furthermore, there is a lack of research that has divided teacher participation in CPD into categories. It is important to note here that the sustainability of CPD have not been investigated to any great extent. Although research has shown that cooperation in professional development is important for the success and sustainability of professional development, a differential effect by CPD-type is often neglected because many studies have focused mainly on the effects of cooperation. Therefore, it is important to investigate differences in teacher efficacy corresponding to differences in CPD-type. Finally, we aimed to explore whether teacher efficacy is influenced by CPD-type. For this, we first tried to identify CPD-types. Therefore, the purpose of this study was both to identify CPD-types among Korean teachers and to investigate the effects of CPD-type on teachers' self-efficacy in a Korean middle school context. Based on this purpose,

this paper deals with the sustainability of CPD. The specific questions addressed in this paper are as follows:

1. To what extent do Korean middle school teachers engage in CPD?
2. Is it possible to classify Korean middle school teachers into groups according to CPD? If so, what are the different types of CPD?
3. Are there statistically significant differences in teachers' efficacy corresponding to differences in CPD-type, controlling for gender, age, years of teaching experience, and school climate?

2. Theory Background

2.1. Professional Development

The definition of professional development has undergone many changes. It refers to the process of improving teachers' skills and competencies in order to increase students' learning outcomes [35]. Additionally, professional development may also be seen as a program designed to improve teacher quality in a way that could be effective in improving student learning outcomes [36]. Professional development can also occur in informal contexts such as collegial dialogues, peer observations, or personal readings as well as a formal program utilizing workshops and in-services teacher training [37].

The Organization for Economic Cooperation and Development (OECD) Teaching and Learning International Survey (TALIS) adopts a broad definition of professional development among teachers and defines professional development as "activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher" including personal study, reflection, collaborative development, and formal courses [38]. For the purposes of this study, we conceptualized professional development as encompassing formally planned and naturally occurring activities that teachers may engage in collaboratively or independently, to acquire and develop ideas, knowledge, skills, attitudes and practices that bring about change in their work.

Educational researchers have developed various typologies to categorize the broad array of professional learning opportunities. Bransford, Brown and Cocking [39] focus on context and activity in defining five categories of learning opportunities for practicing teachers: learning from their own practice, learning through interactions with other teachers, learning from teacher educators in their schools, in degree programs and in specialized teacher development programs, enrolling in graduate school, and learning about teaching from non-school endeavors such as parenthood, involvement in community activities and coaching.

Åberg [40] identified three main types of professional development: the activity-focused, the professional development and the personnel support. Firstly, the activity-focused type is characterized by a specific need connected to the activity of the school, and the contents are predetermined. Secondly, professional development need not be continuous. The professional development types are mainly focused on the teachers' thoughts on their own practice and their professional role, and they are carried out over a longer period at specific times. This type is based on the teachers' needs, which means that they take control of their professional development. The aim of this type is not only to strengthen the teaching profession in a broad perspective, but also to bridge between theory and practice. Finally, the personnel support type has to do with the opportunity for mental support and relief.

2.2. Factors of Sustainable Professional Development

Factors of promoting the sustainability of professional development are related to the expected outcomes of professional development. As Fullan [41] pointed out, the expected outcomes of professional development are not only focused on short-term effects, but also on long-term effects. Fullan stresses capacity-building through networks, deep learning, and dual commitment to short-term

and long-term results as elements of sustainability. When PD has long-term effects as well as short-term ones, it can be considered to be sustainable.

There is increased interest in research that identifies features contributing to the sustainability of PD. Professional development 'in and from practice' gives teachers time to collaborate with other teachers and allows more sustained learning, since it becomes part of the work rather than 'an additional' aspect of it. Additionally, it allows work to be well integrated in a very meaningful, concrete way that addresses specific problems teachers have in their own classrooms. Teachers' insights of their instructional practices deepen as they engage continuously in collaborative and constructive self-assessment and discussions.

Literature on collaborative professional learning shows that it is important that professional development is located within sustainable learning cultures and environments [42]. Professional learning communities also foster change in practice by creating an environment that supports innovation and experimentation [43]. Furthermore, it appears that it is necessary to create effective professional learning communities, so that professional development is sustainable over the long-term [44]. The ongoing collaboration among teachers has the potential to ensure the sustainability of professional development beyond the life of the programs themselves and thereby has an impact in the longer term. Further factors fostering the effectiveness and sustainability of the PD are the prolonged duration of the activity, ongoing and follow-up support opportunities, cooperation and joint practice of teachers [45], and continuous evaluation, assessment, and feedback [46]. In particular, providing rich opportunities for collaborative reflection and discussion presents a core feature of effective change processes [47].

2.3. Teachers' Efficacy

A teachers' efficacy refers to the teacher's judgment about his or her capabilities to bring about the desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated [48]. Teacher efficacy is an important construct because it deals with the teacher's belief regarding instruction and students, and in turn, it influences teachers' behavior. Teacher efficacy is a potent predictor of teachers' willingness to implement new instructional strategies, which implies that teachers who are flexible in their teaching strategies are usually high in their teaching efficacy [49]. Teachers with a high level of efficacy are more open to new ideas and are more willing to apply new teaching methods due to increased levels of effort and persistence [50].

A number of studies have been performed to determine the elements that predict teacher efficacy. Prior studies on predictors of teacher efficacy have reported the relationship of the teacher efficacy construct with gender [51], the effect of teacher experience on teacher efficacy, and a significant relationship between teacher efficacy and age [52]. Teachers exposed to professional development are likely to have higher levels of efficacy [53]. CPD allows teachers to come together and work in teams to stimulate group thinking that can contribute to teacher efficacy [54].

3. Research Design

3.1. Sampling

Participants in this study included Korean middle school teachers. Data used in this study were obtained from the 2013 Teaching and Learning International Survey (TALIS) conducted by the Organization for Economic Cooperation and Development. This data set was downloaded from http://stats.oecd.org/Index.aspx?datasetcode=talis_2013%20. The latest international large-scale database which contains a nationally representative sample of teachers, TALIS 2013, was released for public use on 25 June 2014. It is essential to use the most updated data to identify the educational phenomena associated with teachers' instructional beliefs and practices. TALIS contains nationally representative samples of teachers. TALIS is a data set that provides rich information about teachers. The demographics of teachers are displayed in Table 1.

Table 1. Teacher demographics.

Gender	Female	1813	70.7
	Male	752	29.3
Age	20s	260	10.1
	30s	762	29.7
	40s	872	34.0
	50s	647	25.2
	60s	24	0.9
Year of teaching experience in total	10 years or less	859	33.5
	11–19 years	518	20.2
	20 years or more	1188	46.3
Employment status	Permanent employment	2137	83.3
	Fixed-term contract for a period of more than 1 school year	293	11.4
	Fixed-term contract for a period of 1 school year or less	131	5.1

3.2. Instrument and Methods

Teachers' self-efficacy was examined using 12 items. Each item used a 4-point rating scale measuring the extent to which a teacher performing a given activity believes himself/herself capable to do it effectively. The professional development learning variable was created using 8 items. The school climate variable was developed using 3 single items. Table 2 presents variables, measurement items, the scale, and the Cronbach's α for this study.

Table 2. Variables and measurement items.

Variable	Questionnaire Items	Scale	Cronbach's α
Teacher efficacy	In your teaching, to what extent can you do the following?		
	Control disruptive behavior in the classroom		
	Make expectations about student behavior clear		
	Get students to follow classroom rules		
	Calm a student who is disruptive or noisy		
	Craft good questions for my students		
	Use a variety of assessment strategies		
	Provide an alternative explanation when students are confused		
	Implement alternative instructional strategies		
	Get students to believe they can do in school work		
	Help my students value learning		
	Motivate students who show low interest in school work		
Help students think critically			
		1: Not at all 2: To some extent 3: Quite a bit 4: A lot	0.87
Cooperative professional development	On average, how often do you do the following in this school?		
	Teach jointly as a team in the same class		
	Observe other teachers' classes and provide feedback		
	Engage in joint activities across different classes and age groups (e.g. projects)		
	Exchange teaching materials with colleagues		
	Engage in discussions about the learning development of specific students		
	Work with other teachers in my school to ensure common standards in evaluations for assessing student progress		
	Attend team conferences		
Take part in collaborative professional learning			
		1: never 2: Once a year or less 3: 2–4 times a year 4: 5–10 times a year 5: 1–3 times a month 6: Once a week or more	0.81
School climate	This school provides staff with opportunities to actively participate in school decisions		
	This school has a culture of shared responsibility for school issues		
	There is a collaborative school culture which is characterized by mutual support		
		1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree	0.85

The data was analyzed using descriptive techniques and inferential techniques. The purpose of the descriptive statistics was to examine the distribution of values for single variables in order to gain an understanding of the first research question. In addition to the descriptive statistics, factor analysis, cluster analysis, and regression analysis were conducted. Factor analysis explored the factor structure of the instrument. All the scale items were subjected to a principal component analysis (PCA)

followed by Varimax rotation with an eigenvalue >1.00 as a criterion for determining the number of factors. A reliability analysis using Cronbach's alpha was conducted to test the reliability and internal consistency.

This study used the K-means cluster analysis to group teachers. K-means cluster analysis is a tool designed to assign cases to a fixed number of clusters whose characteristics are not yet known but are based on a set of specified variables. The K-means method is a widely used clustering procedure that searches for a nearly optimal partition with a fixed number of clusters. K-means cluster analysis is the task of grouping a set of objects in such a way that objects in the same cluster are more similar in some sense or another to each other than to those in other clusters. K-means clustering aims to partition n observations into k clusters, in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. It is useful for classifying a large number of cases. Hierarchical regression analyses were conducted to analyze the effect of CPD-type on teacher self-efficacy. Descriptive statistics and inferential statistics were derived using the Statistical Package for Social Sciences (SPSS Ver. 25.0).

4. Results

The first research question is as follows: to what extent do Korean middle school teachers engage in CPD?

This study conducted a preliminary analysis using 8 indicators. The degree to which Korean middle school teachers engage in CPD is displayed in Figure 1. In this study, the mid-point is 3.5, which means that a value under 3.5 is inconsistent, and above 3.5 is consistent. Therefore, Korean teachers can be seen as inconsistently involved. Exchanging teaching materials ($M = 3.51$) barely reaches the mid-point, and all variables but exchanging teaching materials are under mid-point. This result can be interpreted as saying that Korean teachers' participation in CPD is very low. Especially, participation in joint activities ($M = 1.79$) and collaborative professional learning ($M = 2.42$) are very low.

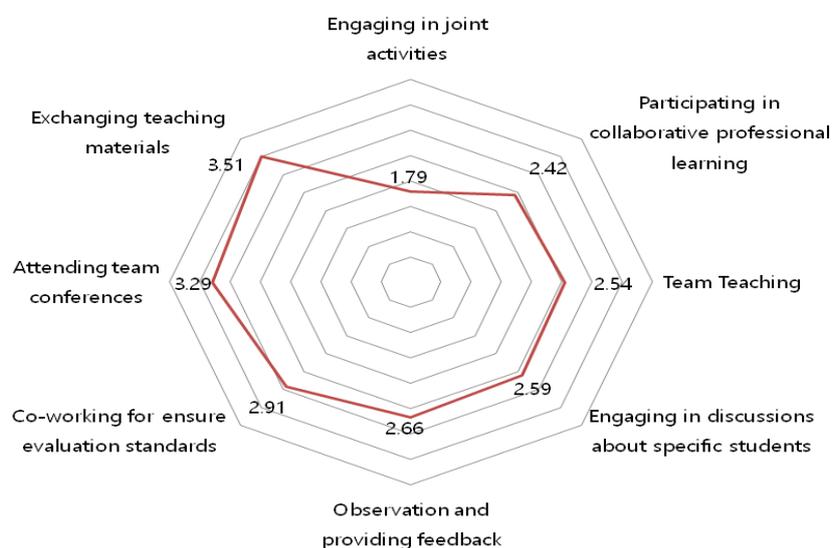


Figure 1. Mean scores of participation in cooperative professional development.

The second research question is as follows: is it possible to classify Korean teachers into groups according to participation in CPD? If so, what are these types?

This study used factor analysis regarding the eight items for CPD to find common factors among these indicators. For measuring sampling adequacy and the factorability of correlation matrix, we conducted the Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. As shown in Table 3, the KMO value (0.86) is above 0.70, which means the data set is likely to factor well. Bartlett's test rejects

the hypothesis that the correlation matrix is an identity matrix, without significant correlations between variables. Both diagnostic tests confirm that the data are suitable for factor analysis. Factor analysis yielded two items (Table 3), which combined accounted for 58.20% of the variance. Factor I includes items such as ‘exchanging teaching materials with colleagues’, ‘working with other teachers to ensure common standards in evaluations’, ‘attending team conferences’, and ‘engaging in discussions about the learning development of specific students’. The items of Factor I are closely related to exchange material and coordination among teachers. Therefore, this factor is referred to as coordination.

Table 3. Final factor loadings from principal component analysis (PCA) with varimax rotation.

Analyzed Items	Coordination	Collaboration
Exchanging teaching materials	0.82	0.04
Co-working for ensure evaluation standards	0.81	0.20
Attending team conferences	0.69	0.28
Engaging in discussions about specific students	0.60	0.41
Engaging in joint activities	0.08	0.83
Team teaching	0.12	0.66
Participating in collaborative professional learning	0.49	0.61
Observation of other teachers’ classes and providing feedback	0.35	0.56
Eigenvalue	3.63	1.03
Percentage of variance explained	45.38	12.82
Cumulative percentage of variance explained	45.38	58.20
Cronbach’ α	0.67	0.77
KMO coefficient 0.86	Bartlett’s test of sphericity 0.000	

Factor II includes items such as ‘engaging in joint activities across different classes and age groups’, ‘teaching jointly as a team in the same class’, ‘taking part in collaborative professional learning’, and ‘observing other teachers’ classes and providing feedback’. The items of Factor II are closely related to activities that involve two or more people working together to achieve a goal. This includes the use of the recursive process in which two or more people or organizations work together to co-create something new. This factor is referred to as collaboration. Both teacher efficacy (eigenvalue: 6.70; percentage of variance explained: 58.29) and school climate (eigenvalue: 2.33; percentage of variance explained: 77.70) yielded one factor each.

Choosing a combination of clustering variables that benefit one another is critical. Clustering variables should also be sufficiently unique to identify distinct clusters. In other words, substantial correlations among clustering variables are expected, but do not exist in a high degree of collinearity. Before we start with the clustering process, we examined the variables for substantial collinearity. To determine this, we run a bivariate correlation analysis. The correlation matrix is displayed in Table 4. As described in Table 4, no concern about the overrepresentation of the cluster solution emerged because the absolute correlations were far below 0.90 [55].

This study used the K-means cluster analysis for grouping. Since two factors were identified above, the high and low values of each factor generated four possibilities. Therefore, groups numbering two, three and four were considered for cluster analysis. Two clusters and three clusters were not very satisfactory, and so we reran the analysis using four clusters. Four clusters gave better results. The K-means algorithm yielded cluster center values, which are the clustering variables’ average scores of all the cases in a cluster; hence, the final cluster centers reflect the characteristics of the typical case for each cluster. The final cluster centers are summarized in Table 5. In addition, we used standardized mean scores to compare distinct cluster differences.

Table 4. Bivariate correlation analysis.

	A	B	C	D	E	F	G	H
Team teaching (A)	1.00	0.30	0.33	0.25	0.27	0.25	0.26	0.31
Observation and providing feedback (B)	0.30	1.00	0.37	0.34	0.34	0.36	0.32	0.41
Engaging in joint activities (C)	0.33	0.37	1.00	0.16	0.39	0.28	0.29	0.48
Exchanging teaching materials (D)	0.25	0.34	0.16	1.00	0.40	0.55	0.44	0.33
Engaging in discussions about specific students (E)	0.27	0.34	0.39	0.40	1.00	0.52	0.43	0.50
Co-working to ensure evaluation standards (F)	0.25	0.36	0.28	0.55	0.52	1.00	0.49	0.48
Attending team conferences (G)	0.26	0.32	0.29	0.44	0.43	0.49	1.00	0.52
Participating in collaborative professional learning (H)	0.31	0.41	0.48	0.33	0.50	0.48	0.52	1.00

Note. *p* value of all correlation coefficients is less than 0.001.

Table 5. Summary of K-means cluster analysis.

	Final Cluster Centers				
	Disengaged	Collaborative	Activity-Focused	Coordinative	F
Exchanging teaching materials	−0.73	1.12	−0.29	0.79	947.81
Co-working for ensure evaluation standards	−0.72	1.42	−0.07	0.45	760.41
Attending team conferences	−0.78	1.22	0.15	0.42	684.02
Engaging in discussions about specific students	−0.68	1.47	0.13	0.19	632.47
Engaging in joint activities	−0.46	1.37	0.59	−0.49	668.75
Team Teaching	−0.47	1.04	0.50	−0.25	338.23
Participating in collaborative professional learning	−0.66	1.69	0.33	−0.11	888.47
Observation and providing feedback	−0.55	1.24	0.24	0.01	359.96
Number of cases in each cluster (%)	945 (36.8)	289 (11.3)	636 (24.8)	695 (27.1)	

Note. *p* value of all variables is less than 0.001, Mean scores of Final Cluster mean Z-Score.

We used *F*-test statistics to investigate the importance of each indicator as a predictor in a cluster and the mean values of each indicator to summarize similarities and dissimilarities between clusters. As described in Table 5, all of the clustering variables' mean values differed significantly across the clusters because the null hypothesis was rejected in every case ($p < 0.001$).

We analyzed the final cluster center position on each of the eight activities. As evident from Figure 1 and Table 4, the four types of teachers included the disengaged group, the collaborative group, the activity-focused group, and the coordinative group.

- (1) the Disengaged group: Teachers in this cluster tend not to engage in professional learning activities. As a result, this type was named the indifferent group. Almost 40% of total respondents belonged to this type;
- (2) the Collaborative group: Teachers in cluster 2 do not exclusively exchange teaching materials, but actively participate in joint activities that exchange knowledge with colleagues. Teachers are especially marked by their participation in collaborative professional learning, observing other teachers' classes and providing feedback. Observing other teachers' classes and providing feedback is based on a high level of trust among members. This type takes place in a collaborative working environment, which can be a very useful means to benefit both the observer and the observed party, because it can provide opportunities for both the observer and the observed to gain awareness of their professional practice. To have the opportunity to observe as well as be observed by other teachers, and discuss with colleagues what meaning professional practice has, will help to apply theory to practice. Taken together, a key feature of this group can be concluded as being a collaborative partnership among teachers. Therefore, this type was named the collaborative group. Only 11% of teachers belong to this group;
- (3) the Activity-focused group: Teachers in cluster 3 engage in joint activities and team up together. Sometimes, Korean teachers team up in the process of carrying out joint tasks. Therefore, this type was labeled the activity-focused group. Approximately 25% of teachers belong to this group;
- (4) the Coordinative group: Teachers in cluster 4 mainly participated in sharing materials as required, but rarely engage in joint activities across different classes and age groups. Teachers are likely

to be interested in providing assistance for mutual benefit. As a result, teachers of group 4 use each other as a resource to facilitate their end goals, and they are willing to assist each other in teaching as well. This type was termed the coordinative group. This group accounts for about 27% of teachers.

In Figure 2, the mid-point is 3.5, which is interpreted that a value under 3.5 is inconsistent and above 3.5 is consistent. The collaborative group has more than four points for most variables, while the disengaged group has only about two points. Therefore, the collaborative group can be interpreted as being involved in CPD continuously. As displayed in Figure 2, type 1 and 2 feature the greatest differences. To understand the relationships between the types in more detail, we analyze the Euclidean distances between the final cluster centers. As seen in Table 6, we confirm that type 1 and 2 are the most different.

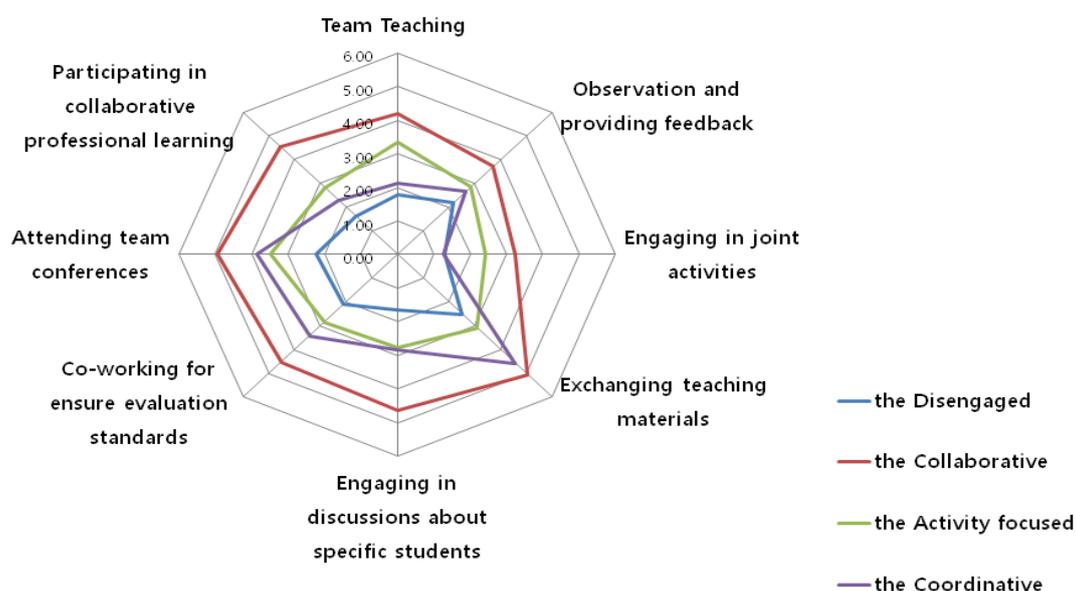


Figure 2. Cluster profiles (mean indicator scores within the four clusters).

Table 6. Distances between final cluster centers.

Cluster	Disengaged (A)	Collaborative (B)	Activity-focused (C)	Coordinative (D)
A		5.56	2.39	2.55
B	5.56		3.30	3.63
C	2.39	3.30		1.87

The third research question is as follows: Are there statistically significant differences in teacher self-efficacy corresponding to differences in CPD-type, controlling for teachers’ gender, age, year of teaching experience, and school climate?

To analyze the effect of CPD-type on teacher self-efficacy, hierarchical regression analyses were conducted. Prior to hierarchical regression analysis, the independent variables were examined for collinearity. As shown in Table 7, results of the variance inflation factor (all less than 7.0) suggest that the estimated β s are well established in the regression models. The results of the hierarchical regression predicting teachers’ efficacy from gender, age, year of teaching experience, school climate, and CPD-type are reported in Table 7 also.

Table 7. Hierarchical regression analysis for variables predicting self-efficacy.

	Predictor	B	SD	Beta	t	VIF		
1	Constant	32.95	1.19		27.68 ***			
	Gender (1 = female)	−0.93	0.27	−0.07	−3.38 **	1.06		
	Age	−0.08	0.03	−0.12	−2.37 **	6.39		
	Years of teaching experience	0.10	0.03	0.16	3.29 **	6.25		
	School climate	0.51	0.07	0.15	7.63 ***	1.00		
2	Constant	32.68	1.17		28.02 ***			
	Gender (1 = female)	−1.07	0.27	−0.08	−3.96 ***	1.08		
	Age	−0.07	0.03	−0.11	−2.21 *	6.41		
	Years of teaching experience	0.10	0.03	0.16	3.43 **	6.25		
	School climate	0.35	0.07	0.10	5.16 ***	1.05		
	CPD1 (1 = the collaborative group)	4.70	0.41	0.24	11.39 ***	1.21		
	CPD2 (1 = the activity-focused group)	1.87	0.31	0.13	6.03 ***	1.29		
CPD3 (1 = the coordinative group)	1.42	0.30	0.10	4.70 ***	1.29			
Model 1	R ²	0.03	Df	4	F	21.71	p-value	0.000
Model 2	R ²	0.08	Df	7	F	32.47	p-value	0.000

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The results of step one indicated that the variance accounted for (R^2) with teachers' gender, age, years of teaching experience, and school climate equal to 0.03, which was significantly significant ($p < 0.001$). Next, CPD-type was entered into the regression equation. The change in variance accounted for was equal to 0.05, which was a statistically significant increase ($p < 0.001$). Table 6 shows that gender, age, years of teaching experience, school climate, and all dummy variables of CPD-type were statistically significant. Comparing the relative importance of each variable on teachers' self-efficacy, the CPD1 (1 = the collaborative group) variable is most important in this model.

5. Discussion and Suggestion

Professional development for teachers is recognized as a critical factor to enhance the quality of teaching and learning in sustainability education (SE). This is because the alternative pedagogical approaches to traditional lectures are recommended as pedagogical methods for SE. These types of alternative pedagogical approaches stress learner-centered methods, and encourage students to participate actively, think critically, and self-reflect. Teachers need engage in ongoing professional development to master new teaching methods. Additionally, PD is emphasized in that teachers' efficacy is a predictor of teachers' willingness to implement alternative instructional strategies. In addition, the effects of PD are meaningful in terms of the sustainability of PD.

In this study, if only PD can have a significant impact on teachers' efficacy, then PD is considered as sustainable professional development (SPD). Although cooperation has been identified as essential for the sustainability of PD, the different effects of CPD-type on teachers' efficacy has been neglected in studies on CPD. In studies on the effectiveness of CPD, this is not the central focus, because research merely focuses on the relationship between features of PD and the effectiveness. Therefore, this study focuses on whether CPD-type does indeed lead to the sustainability of professional development. CPD-type is identified, and significant differences in teachers' efficacy corresponding to differences in CPD-type have been evinced in this study. The significance of the study can be discussed in relation to the results of the study.

First of all, the collaborative group has the strongest effect on teachers' efficacy. This is because participation in the collaborative group allows teachers to come together and work in teams to stimulate group thinking that can contribute to teachers' efficacy. This result implies that collaboration is an essential component for the sustainability of CPD. In order to facilitate the sustainability of professional development, school administrators and policy-makers need to provide opportunities for collaboration among teachers. Above all, school leaders try to establish a collaborative culture in school so that teachers may engage in ongoing learning, giving prominence to a group of teachers who collaborate regularly with a focus on student improvement. School administrators should try

to provide teachers with the opportunity to give and receive feedback about teaching practice and reflect about their own instruction. In order to sustain collaborative groups, policy-makers need to prioritize teacher collaboration. Not only the principal but the teachers themselves need to try to create environments that support collaborative learning. Without the teachers being willing to participating in the collaborative type of professional development, SPD cannot be achieved.

Furthermore, the collaborative group has the characteristics of sharing practice, ideas and problems, and engaging in ongoing class observation and feedback. This result confirmed that teachers' efficacy can be built 'in and from school practice' including collaborative lesson planning, classroom observations, and post-lesson reflections and discussions. This shows that another effective feature of promoting the sustainability of CPD is teachers' daily teaching practice. Therefore, practice in and from contexts can be regarded as another effective way of promoting teachers' sustainable professional development. In this process, professional abilities are reinforced not only by the observed teacher but also by many other observers, so that teachers can increase their efficacy.

Especially, participation in the collaborative type of professional development enables teachers to engage in thoughtful reflection and in-depth discussion with other teachers about changes in instructional practice. It is possible that teachers can develop and share reflections and influences. Self-evaluation, critical feedback and support from others have been shown to be factors in promoting the sustainability of CPD.

Reflective practice is critical because it can enhance teachers' sense of professionalism and lead them to explore a variety of alternative viewpoints about teaching and learning, and their sense of efficacy can be enhanced. The process of reflection provides teachers with the opportunity to cast a light on and make sense of what they have learned while engaging in collaborative dialogue with their peers. In the process of collaborative discussion, teachers are empowered by the support and feedback received from their peers, which leads to an improvement in the teachers' efficacy. As a meaningful result, they are more likely to try alternative pedagogical approaches, emphasized as pedagogy in SE. Additionally, reflection and ongoing in-depth discussion are critical because teaching for sustainability places an emphasis on problem solving and critical thinking. Reflective practice can be essential in the educational context for sustainability.

Thirdly, this result provides valuable information to researchers and policy-makers regarding the relationship between CPD-type and self-efficacy. This knowledge can in turn inform the development of strategies for increasing teachers' self-efficacy and may potentially positively impact the achievement of Korean students. This study findings support the need that teachers participate in collaborative professional development actively.

In spite of the important findings, this study is not without limitations. This study utilized a publicly available TALIS data set, which could be strength but also weakness. Critical aspects of the school climate are consisted of institutional vulnerability, shared leadership, professional teacher behavior, and achievement pressure. Only shared leadership factor can be used in the TALIS data, which is a limitation. We suggest that future studies will be carried out to complement the limitation.

6. Conclusions

Teachers are the single most important factor in sustainability education (SE), because teachers are in a position to shape better-educated future generations. Teacher quality depends on factors including teacher recruitment, teacher certification, and teacher compensation. However, professional development is the most critical factor, because of the constant social changes and the application of alternative pedagogical approaches in SE. Professional development can be a driving force for sustainability education. Based on the results of the study, we can conclude that the collaboration, reflection, feedback, 'in and from school practice', and support from other teachers are critical factors promoting the sustainability of CPD. Sustainable professional development requires a focus on teacher collaboration including collective reflection, shared vision on practice, and peer feedback.

Teacher collaboration, as a key element of CPD, occurs when teachers share instructional methods and strategies, make decisions about instructional issues, and come up with great ideas that improve learning for all members of the school. The school leaders try to provide teachers with collaborative environments, and the teachers try to engage in the collaborative professional development as well. Without factors promoting the sustainability of CPD, CPD is likely to be powerless to implement sustainable change. Finally, we hope that this study will help deepen efforts to explore sustainable professional development, leading to a consistent pedagogy for SE.

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