Educational leadership and innovative teaching practices: a polynomial regression and response surface analysis

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Abstract

Purpose – This study explores the factors that explain the adoption of innovative teaching practices within schools and how this is determined by the different perceptions of principals and teachers.

Design/methodology/approach – The authors use the self-other agreement to measure the difference between the principal and teachers' rating based on the responses of 255 principals and 10,415 teachers, applying polynomial regression with surface analysis to examine the in-agreement/disagreement of self- and other-ratings.

Findings – Results indicate that schools where principals and teachers agree on the level of collaborative culture, learning climate, professional development and instructional leadership are associated with higher innovative teaching practices, creating opportunities for stimulating learning environments. In addition, the adoption of innovative professional practices is more likely to result when there is disagreement with teacher over-rating the factors.

Practical implications – It has practical implications for developing strategies aimed at encouraging the implementation of innovative teaching practices among teachers and it extends the research on teachers' professional practices by using self-other agreement data collection method and surface analysis.

Originality/value – The vast collection of data provide a unique investigation opportunity of the effects of collaborative culture, learning climate, professional development and instructional leadership on innovative teaching in Italy.

Keywords Educational leadership, Innovative teaching practices, Polynomial regression, Response surface analysis, Collaborative culture, Learning climate, Professional development

Paper type Research paper

Introduction

According to Fenstermacher and Richardson (2005), three main practices constitute a good teaching: the logical, the psychological and the moral acts of teaching. All of these factors stem from teacher effort in their daily work activity. Nevertheless, a good teaching does not necessarily produce a quality teaching. It is a necessary but not sufficient condition. For it to be considered successful, students must acquire at some acceptable level what the teacher is teaching. Therefore, the question of teaching practices that produce successful learning takes a lot of consideration. In an attempt to decode these practices, scholars have identified that the learning goals are not the definitive target, rather what matters the most is the learning process (De Kock *et al.*, 2004). Starting from this principle, the knowledge-construction model of learning assumes that knowledge and skills need not be transmitted but are constructed in a learning environment that stimulates learners to learn. According to this model, teachers are aimed to shape processes and skills, to monitor student learning and to provide metacognitive guidance, and to stimulate students to reflect on their own learning (Simons

et al., 2000). Practices such as cooperative learning, coaching/modelling of thinking skills and domain related practices, and inquiry-based practical work (Abrami, 1995; Akuma and Callaghan, 2019) have been affirmed as innovative professional practices. Innovative professional practices refer to new functional ways of developing students' learning, facilitated by stimulating learning environments, based on the idea that learning is a social-interactive, contextual, constructive, self-regulated and reflective process (Simons *et al.*, 2000; De Kock *et al.*, 2004). Then, scholars have promoted the shifting from knowledge-transmission model of learning to knowledge-construction model, whereas the process of learning is important rather than the learning goals (Bolhuis and Voeten, 2001). The knowledge-construction model of learning assumes that knowledge and skills need not be transmitted but are constructed in a learning environment that stimulates learning to learn.

On the other hand, less is known on how teachers' innovative practices are related with the organizational capacity of school, with few studies confirming its effect on learning climate (Burušić, 2019), and causal link to professional development (Thoonen *et al.*, 2011), collaborative culture (Tschannen-Moran, 2001) and instructional leadership (Blase and Blase, 1999).

It is not within the scope of this paper to offer a thorough examination of the literature on these issues; therefore, the theoretical constructs underlying this study are briefly developed in the following points.

Professional development was seen as the best bet for changing teaching practices, because alternative methods, such as policies and programs that regulated teacher behaviour, have fared no better (Smylie, 1997). Teachers' engagement in professional learning activities, in particular experimenting and reflection has emerged as a powerful antecedent of innovative teaching practices (Thoonen *et al.*, 2011). On another study conducted by Supovitz and Turner (2000), professional development is specifically linked to the improvement of the inquiry-based teaching practices.

Collaboration among teachers has the potential to improve teacher professional practices by fostering their professional learning at school (Munthe, 2003; Stoll *et al.*, 2006). Encouraging active teacher involvement through professional development may allow teachers to bring about systemic reform (Goddard *et al.*, 2007). Collaboration among peers allows teachers to make sense of their work, reducing role ambiguity (Louis and Marks, 1998), and finding solution regarding their classroom problems (Pugach and Johnson, 1995).

The organizational climate inspires high expectations towards teachers and students' motivation and engagement in learning activities (Cornell and Mayer, 2010). Hence, the notion of climate entails a shared perception of great values and ambitions not only on students' achievements, but also on teachers innovative practices (Vermeulen *et al.*, 2017).

Instructional leadership focuses on roles beyond the classroom, supporting the professional learning of peers, influencing policy/decision making, and ultimately targeting student learning (Wenner and Campbell, 2017). Empirical research has shown the linkage between instructional leadership, changes in teachers' practices and consequently, students' achievement (Hallinger *et al.*, 2020; Paletta *et al.*, 2020).

Referring to the literature the insights on the role of these constructs as variables of effectiveness of teaching and learning, the general goal of the current study is to investigate how the level of agreement between teachers' and principals' perception of their organizational environment could be related to the implementation of innovative professional practices among teachers. In particular, this research focused on self-other agreement − i.e. teachers-principals agreement − in (1) collaborative culture, (2) learning climate, (3) opportunities for professional development and (4) teachers' instructional leadership.

Methods

The current study is based on the data of the "School Evaluation and Development" (VALES)in Italy, promoted by the Italian Ministry of Education, University and Research. This project entailed the introduction of a new school evaluation system that combined different procedures and instruments referred to self- and external evaluation procedures aimed at improving the school effectiveness within the national primary and secondary education system. VALES required the fulfilment of an online questionnaire by school principals and teachers working in the schools involved. The final sample consisted of *N* 5 255 school principals in schools widely distributed across the country. Most of them were women (65.9%) and their mean age was 55.74 years (sd 5 5.99). Principals reported a mean job tenure of 10.22 years (sd 5 7.57), with a mean seniority in the current school equal to 5.67 years (sd 5 5.23), and almost all of them worked with a permanent employment contract (98.4%). Moreover, the questionnaire was sent to 15,600 teachers. Among them, a total of 10,415 participants provided valid responses, with a response rate equal to 66.8%. The sample was composed of 83.4% females and 16.6 males, with an average of 24 years of experience as teachers and 12 years in the actual school.

Measures

All the study variables were measured using a questionnaire previously validated by Paletta *et al.* (2020) and reporting satisfactory psychometric properties. All items were rated on a four-point Likert scale ranging from 1 5 *strongly disagree* to 4 5 *strongly agree*.

(1) *Innovative professional practices*, included as outcome in the performed agreement models, was assessed using 19 items (e.g. "I provide support to the implementation of specific actions for school improvement"). The internal consistency of the scale was α 5 0.93.

(2) *Collaborative culture* was measured through 5 items (e.g. "This school provides staff with opportunities to actively participate in school decisions"). Cronbach's alpha was α 5 0.88.

(3) *Learning climate* was assessed using 4 items (e.g. "Most teachers in this school are interested in what students have to say"). Cronbach's alpha for the scale was α 5 0.84.

(4) *Professional development* among teachers was measured using 6 items (e.g. "My school provides teachers with opportunities to share with colleagues the knowledge acquired during professional development initiatives"). Cronbach's alpha for the scale was α 5 0.93.

(5) Teachers' *instructional leadership* was measured using 10 items (e.g. "How often do you dedicate your time to demonstrate the use of digital technologies to support teaching?). In contrast to previous variables, in that case the response options varied on a four-point frequency scale ranging from 1 5 never to 5 5 every day. The internal consistency of this scale was α 5 0.83.

Strategy of analysis

In order to assess how the congruence/incongruence between principals' and teachers' perception of their school environment is related to the implementation of innovative professional practices among teachers, a polynomial regression with three-dimensional response surface analysis was performed. We did not perform a multilevel polynomial analysis, given the fact that the level of congruence/incongruence is based at school level and no moderating level could be introduced as suggested by Nestler *et al.* (2019). This approach

allows to explore whether and to what extent the combination of two predictors is associated with a criterion variable (Shanock *et al.*, 2014; Canells and Veld, 2019). In order to run this type of analysis, two key conditions must be satisfied (Edwards, 2001): (1) the two predictors, in respect of which the level of agreement is assessed, must pertain to the same conceptual domain, so that any potential divergence could be appropriately explained; (2) the two predictors must be evaluated on the same response scale, in order to measure their level of correspondence. Otherwise, these variables could be standardized in order to place them on a common scale.

In order to reduce the risk for multicollinearity between lower-order and higher-order terms, the independent variables were mean-centred (Atwater *et al.*, 1998).

The equation underlaying the polynomial regression analysis is: $Z = b_0 + b_1X + b_2Y + b_3X^2 + b_4XY + b_5Y^2 + e$. In particular, Z represents the criterion variable, X and Y represent the self- and other-rating of the independent variable, respectively. According to this formula, Z is regressed on the following beta values: each independent variable (b_1 and b_2), their interaction term (b_4), and the squared term of each independent variable (b_3 and b_5).

When the R_2 value (i.e. the amount of variance explained by the regression analysis) is significantly different from zero, the results of the polynomial regression could be used to plot the three-dimensional response surface graph and to compute four parameters depicted in this graph (Edwards, 2001): (1) a_1 represents the slope of the line of perfect agreement and is given by the sum of the unstandardized regression coefficients of self- and other-rating ($= b_1 + b_2$); (2) a_2 represents the curvature along the line of perfect agreement and is the result of aggregating the unstandardized beta coefficient of the self-rating squared term, the unstandardized beta coefficient of the interaction term between self- and other-rating and the unstandardized beta coefficient of the other-rating squared term ($= b_3 + b_4 + b_5$); (3) a_3 represents the slope of the line of incongruence between ratings as related to the criterion variable and specifies the direction of the divergence (e.g. self- higher than other-rating) is given by the difference between the unstandardized regression coefficients of self- and other-rating ($= b_1 - b_2$); (4) a_4 indicates the curvature along the incongruence line in relation with the criterion variable and is given by subtracting the coefficient of the interaction term between self- and other-rating from the self-rating squared term and adding the unstandardized beta coefficient of the other-rating squared term ($= b_3 - b_4 + b_5$).

Results

Descriptive results

Table 1 reports the correlations among the study variables. It should be noted that each scale used in the current study showed adequate parameters for internal reliability, with values exceeding the minimum threshold of 0.65 (DeVellis, 2016).

Model testing

The results of polynomial regression analyses are reported in Table 2 and have also been used to model the response surface graphs shown in Figures 1–4. It should be noted that all the regression equations explained a significant amount of variance in the criterion variable (i.e. the adoption of innovative professional practices), therefore the development of response surface plots was justified.

Concerning the role of collaborative culture within schools, the presence of a significant and positive a_1 value suggests that the implementation of innovative professional practices increases when teachers and principals perceive greater levels of collaborative culture ($a_1 = 0.70$, $t = 8.43$, $p = 0.000$). Consistently, the non-significant a_2 value denotes a linear

Table 1. Means, SDs, and correlations among study variables

	r								
	1	2	3	4	5	6	7	8	9
1. Innovative professional practices (teachers self-rating)	(0.90)								
2. Collaborative culture (teachers self-rating)	0.58***	(0.89)							
3. Collaborative culture (principals rating)	—0.21**	—0.21**	(0.82)						
4. Learning climate (teachers self-rating)	0.52***	0.58***	—0.13*	(0.88)					
5. Learning climate (principals rating)	—0.24***	—0.20**	0.57***	—0.25***	(0.82)				
6. Professional development (teachers self-rating)	0.81***	0.72***	—0.22**	0.46***	—0.24***	(0.99)			
7. Professional development (principals rating)	0.15*	0.06	-0.45***	0.08	—0.37***	0.19**	(0.94)		
8. Teachers' instructional leadership (teachers self-rating)	0.52***	0.42***	—0.16*	0.24***	—0.14*	0.59***	0.10	(0.91)	
9. Teachers' instructional leadership (principals rating)	0.22**	0.16*	—0.31***	0.10	—0.17**	0.24***	0.31***	0.20**	(0.87)

Note(s): $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Table 2. Polynomial regressions of innovative professional practices on teachers' and principals' ratings

Variable	Collaborative culture		Learning climate		Professional development		Teachers' instructional leadership	
	B	SE	*B*	SE	*B*	SE	*B*	SE
Constant	0.01	0.06	0.07	0.06	−0.08	0.07	−0.13*	0.07
Teacher self-rating (b_1)	0.69***	0.06	0.49***	0.06	0.05	0.07	0.07	0.06
Principal other-rating (b_2)	0.01	0.06	−0.10	0.04	0.34***	0.04	0.70***	0.02
Squared teacher self-rating (b_3)	0.07***	0.02	−0.03	0.03	0.03	0.07	0.00	0.03
Teacher (self) X Principal (b_4)	0.02*	0.05	−0.05	0.06	0.06	0.06	0.14***	0.06
Squared principal other-rating (b_5)	−0.07	0.03	−0.04	0.06	0.04	0.07	−0.08	0.06
R_2	0.61*		0.29***		0.73*		0.61*	
Surface test								
$a_1 = b_1 + b_2$	0.70***	0.08	0.40***	0.09	0.40***	0.09	0.77***	0.09
$a_2 = b_3 + b_4 + b_5$	0.02**	0.06	−0.11**	0.10	0.13*	0.10	0.06**	0.07
$a_3 = b_1 - b_2$	0.67	0.08	0.59	0.07	−0.29	0.09	−0.63**	0.09
$a_4 = b_3 - b_4 + b_5$	−0.02	0.06	−0.02	0.08	0.01	0.10	−0.22	0.07

Note(s): $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

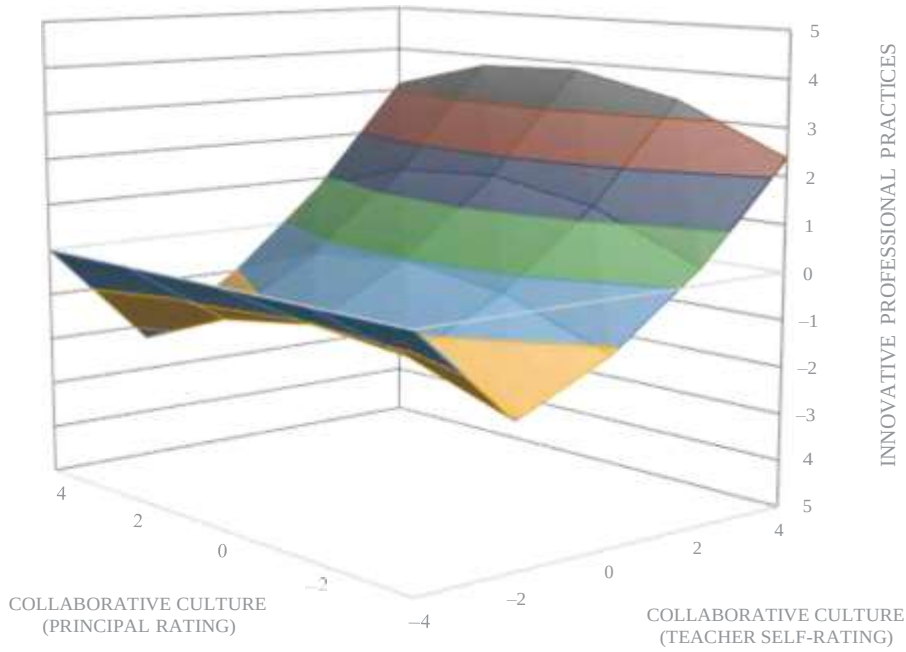

Figure 1. Response surface relating teachers (self) and principals (others) ratings of collaborative culture to teachers' innovative professional practices

relationship between the ratings along the line of perfect agreement ($a_2 = -0.02$, $t = 0.37$, *ns*). Moreover, the significant and positive a_3 value suggests that the adoption of innovative professional practices is more likely when the disagreement between participants is such that teachers' self-ratings are higher than principals' ratings ($a_3 = 0.67$, $t = 8.12$, $p = 0.000$).

As displayed in Figure 1, the presence of a non-significant curvature along the incongruence line ($a_4 = -0.02$, $t = -0.33$, *ns*) suggests that deviating from the middle of the

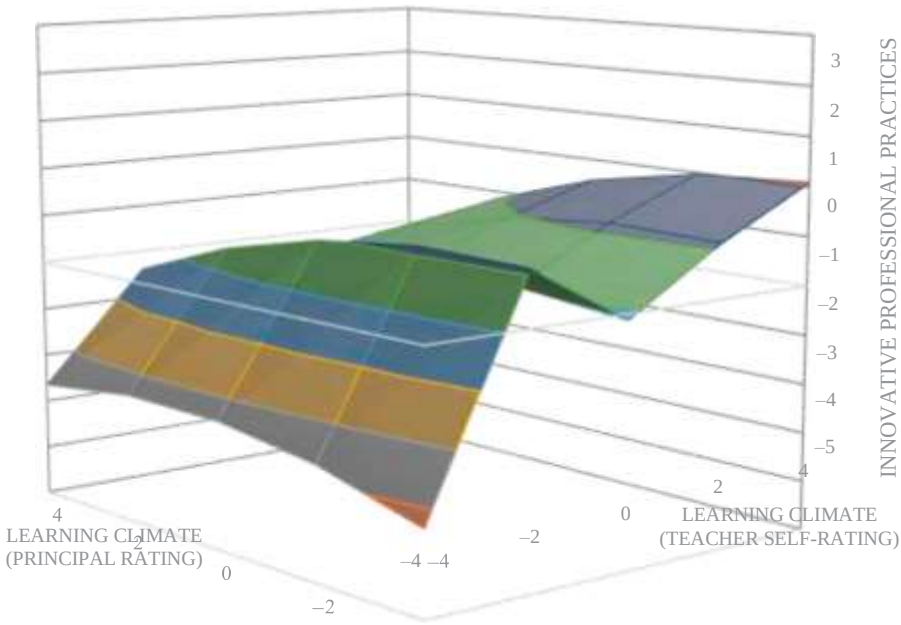

Figure 2.
Response surface relating teachers (self) and principals (others) ratings of learning climate to teachers' innovative professional practices

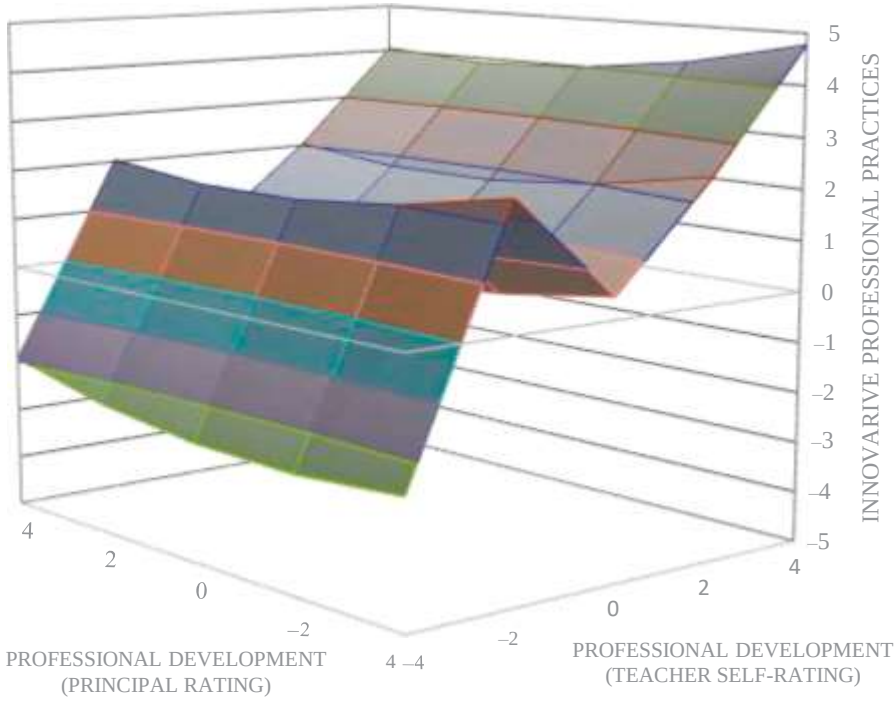

Figure 3.
Response surface relating teachers (self) and principals (others) ratings of opportunities for professional development to teachers' innovative professional practices

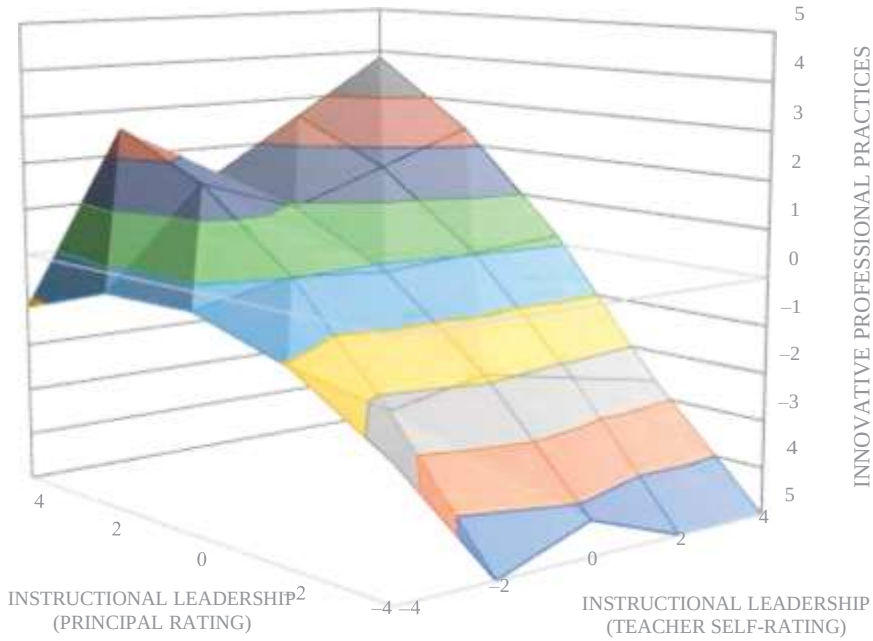

Figure 4.
Response surface relating teachers (self) and principals (others) ratings of instructional leadership to teachers' innovative professional practices

surface graph, the likelihood of innovative professional practices decreases analogously no matter the direction of disagreement intensification (i.e. wherever teachers' or principals' ratings increase).

Results on perceptions of a learning climate present a similar trend. Table 2 indicates a significant and positive a_1 value (a_1 5 0.40, t 5 4.19, p 5 0.000) and a non-significant curvature along the line of perfect agreement (a_2 5 0.11, t 5 1.08, *ns*). Hence, also the occurrence of innovative professional practices rises when teachers' and principals' perception of a learning climate are both enhanced. The direction of the slope along the incongruence line was significant and positive (a_3 5 0.59, t 5 8.39, p 5 0.000), thus suggesting a greater implementation of innovative professional practices in case of over-rating, thus when teachers' (self-) ratings of learning climate are higher than principals' (other-) ratings. Accordingly, Figure 2 reveals that agreement between teachers and principals was associated with lower levels of innovative professional practices in comparison to overestimation. Moreover, the response surface plot points out that the lowest level of innovative practice corresponds to the front corner of the graph, where teachers' and principals' evaluation of learning climate are both low, and progressively enhanced toward the back wall of the chart, where the perception of principals and teachers are consistent and both elevated. The obtained results indicate that the direction of disagreement concerning learning climate perceptions is quite irrelevant, as the curvature along the incongruence line was not significant (a_4 5 0.02, t 5 0.28, *ns*).

Table 2 suggests an additive association along the line of perfect agreement also with reference to the relationship between the perceived opportunities for professional development and teachers' implementation of innovative professional practices. Accordingly, the slope of the response surface along the congruence line was significant (a_1 5 0.82, t 5 15.10, p 5 0.000), whereas the curvature was not statistically significant

(a_2 5 0.05, t 5 1.36, *ns*). In line with previous models, professional development reported a significant positive slope of the line of incongruence as it relates to innovative professional practices among teachers (a_3 5 0.84, t 5 15.35, p 5 0.000). Hence, innovative professional practices are more likely to occur when the discrepancy involves a greater perception of opportunities for professional development among teachers (i.e. self-rating) rather than among principals (i.e. other-rating). The curvature along the disagreement line was not statistically significant, therefore the association between disagreement among teachers' and principals' perception of professional development, on the one hand, and innovative professional practices, on the other hand, was not significant (a_4 5 0.09, t 5 1.25, *ns*). As shown in Figure 3, the highest level of innovative professional practices occurs at the right corner of the graph, where teachers' self-rating of professional development is combined with the lowest perception of development among school principals.

Furthermore, the positive slope along the agreement line regarding instructional leadership (a_1 5 0.77, t 5 8.56, p 5 0.000) indicates that innovative professional practices are more likely to be employed as the convergence between teachers' and principals' perception of instructional leaderships grows. On the other hand, the non-significant value corresponding to the curvature along the agreement line denotes that the line of agreement concerning instructional leadership perceptions was not meaningfully curvilinear for innovative professional practices (a_2 5 0.06, t 5 0.79, *ns*). In contrast to previous models, the slope along the line of disagreement was significant but negative: when teachers' perception of instructional leadership (i.e. self-rating) was weak but the principals' perception (i.e. other-rating) was strong, the employment of innovative professional practices was greater than in case of great teachers' perception combined with low principals' assessment of instructional leadership (a_3 5 ~~0~~.63, t 5 ~~6~~.86, p 5 0.000). As depicted in Figure 4, in the current sample the implementation of innovative professional practices was more likely to occur when the level of instructional leadership reported by principals was stronger rather than when the level of instructional leadership reported by teachers was stronger. Furthermore, this graph presents a concave surface suggesting that innovative professional practices decrease more brusquely as the level of disagreement intensified, as suggested by the significant and negative value of the curvature along the line of disagreement (a_4 5 —0.22, t 5 —3.23, p 5 0.001).

Conclusions

This study extends the research on teachers' professional practices using self-other agreement data collection method and surface analysis. It studies the relation between teachers' innovative professional practices and school organizational capacity factors such as: learning climate, collaborative culture, teacher instructional leadership and professional development. The results provide findings for each of the factors. It has practical implications for developing strategies aimed at encouraging the implementation of innovative teaching practices among teachers and it extends the research on teachers' professional practices by using self-other agreement data collection method and surface analysis.

The relationship between teachers' innovative professional practices and collaborative culture shows that the implementation of innovative professional practices increases when teachers and principals are in-agreement and good-raters, perceiving greater levels of collaborative culture. Moreover, the adoption of innovative professional practices is more likely when the disagreement is such that teachers are over-estimators, confirming that principals which under-estimate the collaborative culture tend to have greater ambitions in creating better working conditions while having reached a good level of collaboration between the teachers. The likelihood of innovative professional practices decreases analogously no matter the direction of disagreement intensification (i.e. wherever teachers or the principals over-estimate). The result suggests that schools reporting the shared

perception of a collaborative culture are more likely to be characterized by innovative strategies in classroom activities. Hence, the development of shared norms concerning core teaching strategies, as well as reflecting on the practices applied and their outcomes allows a collective learning process from practice aimed at attaining common goals in student learning (Doppenberg *et al.*, 2012). School principal plays a key role in developing a collaborative culture by inspiring a sense of collegiality among the staff and stimulating collective discussions and practices and, as a result, a greater involvement of teachers in staff development activities may give rise to a professional learning community within school (Vangrieken *et al.*, 2015).

Consistent with this evidence, our findings suggest that innovative teaching practices are more frequent when teachers and principals perceive a greater learning climate and higher opportunities for professional development. When teachers perceive greater learning climate or opportunities for professional development than their principals, they are more likely to adopt innovative professional practices. The consistent trend of opportunities for professional development and learning climate substantiates the compelling evidence that learning climate involves not only the acquirement of new knowledges and skills among students, but also school staff and teachers (Vermeulen *et al.*, 2017). Thus, our results revealed that perceived school expectations on learning outcomes (i.e. learning climate) and the opportunities for teacher development have a similar impact on innovative learning practices. From a practical point of view, these findings highlight that a strong investment in learning processes dedicated to pupils and teachers could contribute to flourishing school contexts. This association could be explained by the evidence that teachers provided with adequate opportunities to develop new knowledge and skills are intrinsically motivated and feel committed and vigorous towards their job (Simbula *et al.*, 2011). Since teachers identify professional development with the chance to participate in training activities, principals should ease the involvement of teachers in professional development initiatives that, in turn, will encourage the adoption of innovative learning strategies with pupils. This result could be achieved by fostering an instructional leadership style enacted by teachers, as suggested by the current results. According to Goddard *et al.* (2007) instructional leadership implies setting high expectations for students' achievements through the development of a clear curriculum development and a constant monitoring of their progresses. Learning opportunities aimed at enhancing instructional leadership behaviour could translate into innovative strategies in class. For instance, possible actions consist of stimulating teacher reflection and collaboration by attending colleagues' lessons, improving the availability of specific literature, and encouraging the adoption of unfamiliar methods with students (Evers *et al.*, 2016).

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