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*CORRESPONDENCE
Xianhan Huang
xhhuang@eduhk.hk

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The association between school climate, teacher emotions, and adaptive instruction

Masoumeh Kouhsari[1], Xianhan Huang[2]*, Chan Wang[3] and John Chi-Kin Lee[2]

[1]Department of Education Policy and Leadership, The Education University of Hong Kong, Tai Po, Hong Kong SAR, China, [2]Department of Curriculum and Instruction, The Education University of Hong Kong, Shatin, China, [3]Department of Curriculum and Instruction, The Chinese University of Hong Kong, Shatin, Hong Kong, China

Introduction: Although adaptive instruction has become increasingly important as a component of effective instruction, the mechanism of adaptive instruction remains underexplored. This study examined the potential associations between school climate and teacher emotions on adaptive instruction.

Methods: This study used cross-sectional approach with a sample included 2,880 primary school teachers from Chongqing, China.

Results: The results indicated that of the five dimensions of school climate examined, teacher collaboration, student relations, and instructional innovation had positive and significant associations with adaptive instruction. Regarding teachers' emotions, enjoyment was positively while anxiety was negatively associated with teachers' adaptive instruction.

Discussion: As teachers' positive emotions play important roles in adaptive instruction, policymakers and educators should focus on fostering teachers' experiences of positive emotions. The finding of an adverse role of a teacher's negative emotion in shaping adaptive instruction may be used in intervention programs and pieces of training for both pre-service and in-service teachers.

KEYWORDS

adaptive instruction, school climate, enjoyment, anxiety, anger

1 Introduction

Classrooms are messy, unpredictable, and shifting daily. In a classroom, students have different backgrounds, learning interests and motivations; and varying levels of ability and academic achievement (Parsons et al., 2018). To effectively navigate complicated contexts and provide all students with quality education, teachers must be flexible and creative in their approach as they adapt their instruction to support the various learners under their care (Segura and Ferrando, 2023; Parsons et al., 2018). Adaptive instruction is thus an important aspect of effective teaching (Vaughn, 2019) and is critical to student engagement and achievement (Parsons et al., 2018).

Many studies have explored the antecedents of adaptive instruction (Jeong et al., 2018; Parsons et al., 2018), but notable knowledge gaps remain (Huang et al., 2022). Regarding the association between teacher emotion and their adaptive instruction, previous studies have confirmed that enthusiasm, as a motivational construct, serves as a critical predictor (Huang et al., 2022; Kalinowski et al., 2024) but leaves the link between adaptive instruction and teachers' negative emotions, such as anxiety and anger, underexplored. With the student population, it is shown that anxiety and anger had influential but different effects on students' learning outcomes and adaptive behaviour (Soydan, 2023; Li et al., 2024; Lauermann and

Butler, 2021). We then postulated that negative emotions may also serve as critical impact factors for teachers' adaptive instruction.

Furthermore, some observations have been made about the link between school context, such as cooperation, autonomy, and collegial support to adaptive instruction (Mewald and Mürwald-Scheifinger, 2019; Sibley et al., 2024; Vaughn, 2019; Gallagher et al., 2022). Few studies have comprehensively examined the impact of different aspects of school climate on teachers' adaptive instruction and whether some aspects of school climate are more important.

This study makes two significant contributions to the field. First, within the framework of the school climate (Johnson et al., 2007), we comprehensively explore how various dimensions of the school climate are related to adaptive instruction. Second, this study provides strong evidence of the significant association between teacher emotions and adaptive instruction. Generally, this study intends to contribute to theoretical development, facilitate the empirical investigation, and offer practical suggestions for fostering adaptive instruction of school teachers. Connecting different dimensions of school climate and teacher emotions to adaptive instruction enriches our knowledge regarding the antecedents of adaptive instruction. The findings of this study could be significant in providing practical implications for improving policymaking and school administration practices regarding teachers' professional development. The study sought to explore the relationship between teacher emotions, school climate and adaptive instructions. The research questions were as follows:

1) What is the relationship between teacher emotions and adaptive instruction?
2) What is the impact of school climate on adaptive instruction?

2 Literature review

2.1 Adaptive instruction

Adaptive instruction has increasingly received global attention (Schipper et al., 2020) and is highlighted in all content areas (Gallagher et al., 2022). Understanding adaptive instruction in today's highly changing educational landscape and how adaptive instruction can be affected and lead to better educational outcomes for students is essential (Vaughn, 2019). Teachers' adaptive instruction can be viewed as a self-regulated behaviour that requires them to engage in ongoing observation of different students' needs consciously, to evaluate their knowledge, skills, and teaching effectiveness, and develop alternative teaching materials and approaches to improve student learning (Collie and Martin, 2016; Darling-Hammond and Bransford, 2007).

Some previous studies have revealed that learners' individual differences, teachers' self-efficacy, classroom openness, and instructional innovations are positively related to their adaptive instruction (Ikwumelu et al., 2015; Schipper et al., 2018; Beltramo, 2017). Reuker and Künzell (2021) asserted that diagnostic abilities such as perception, interpretation and decision-making skills are regarded as important prerequisites for adaptive instruction. Moreover, Vogt and Rogalla (2009) emphasised that developing and fostering adaptive instruction competency can occur through coaching (Vogt and Rogalla, 2009). More specifically, Schipper et al. (2017) suggested that the potential of lesson study can promote adaptive instruction competence.

2.2 Teacher emotions

Research on teacher emotions in education has recently attracted increased attention (Chen, 2016). Three basic emotions have been acknowledged as the most salient among teachers: enjoyment, anxiety, and anger (Frenzel, 2014; Hagenauer et al., 2015; Huang et al., 2022). Feelings of enjoyment as the most salient positive emotion are characterised by high subjective pleasantness, approach motivational tendencies, open facial and gestural expressions, and caused by appraisals that involve goal congruence and goal conduciveness, coupled with appraisals of controllability and personal agency (Frenzel et al., 2016). The semantic field for this emotion contains: joy/enjoy, fun, happy/happiness, and enthusiasm/enthusiastic (Frenzel et al., 2016). In teacher education studies, there is ample empirical evidence for the significance of teacher's enjoyment of their working performance (Tevfik and Guven, 2017), interpersonal relationships (McLure et al., 2022), and overall well-being (Aldrup et al., 2018).

Anxiety, in turn, is characterised by unpleasant feelings coupled with avoidance motivational tendencies, worry cognitions, defensive facial and gestural expressions, appraisals of threats and low personal coping capabilities (Frenzel et al., 2016). The semantic field for this emotion contains anxiety, nervousness, worry and uneasiness (Frenzel et al., 2016). Anxiety is positively associated with teacher exhaustion (Pressley and Ha, 2022) and negatively related to teachers exhibiting instructional behaviour (Becker et al., 2014) and low levels of teacher performance (Blase, 1986).

Anger is a rather complex emotion characterised by unpleasant feelings, aggressive facial and gestural expressions, and appraisals of goal blockage and other accountability (Frenzel et al., 2016). The semantic field for this emotion should contain anger, annoyance, mad and frustration (Frenzel et al., 2016). Anger, the most prominent negative emotion for teachers (Frenzel, 2014), is negatively linked with teachers' emotional labour, well-being, and self-efficacy (Burić and Frenzel, 2019).

2.3 Linking teacher emotions with adaptive instruction

Prior evidence has emphasised the importance of emotions for teaching behaviour (Frenzel et al., 2016, 2018). However, there is a conspicuous lack of empirical findings regarding the relationship between teachers' emotions and their adaptive instruction. Emotions are intimately involved in virtually every aspect of the teaching process (Schutz and Lanehart, 2002). This study was designed based on the broaden-and-build theory (Fredrickson, 2001). Fredrickson emphasised that positive emotions can produce a broadening effect by stretching awareness boundaries, enabling individuals to become more open to various strategies and options. Based on this theory, positive emotion can broaden the scope of cognition by expanding attention and enhancing flexible information processing (Friedman and Förster, 2010). The effects of positive emotions on adaptive instruction can be illustrated from various angles. First, the vast majority of pertinent studies are concerned with the influences of emotional states on motivational functions (Frenzel, 2014). Teachers' positive emotions (happiness, enjoyment) affect teachers' motivation for teaching (Urdan, 2014), which is an integral part of adaptive instruction (Huda et al., 2017).

Second, positive emotions promote cognition and flexibility (Ashby et al., 1999). Teachers with positive emotions show extraordinary creative, flexible, open-minded, integrated, and effective thinking patterns (Fredrickson, 2001), which is a precursor for adaptive instruction (Janssen et al., 2020; Vaughn et al., 2016). Third, positive emotions are associated with a broadening of the scope of attention (Fredrickson, 2001). More specifically, continual monitoring of the various events that happen in class and deciding where to focus one's attention within this complex array of environmental stimuli are tasks central to teaching because teachers can only react appropriately and provide pupils with the best support possible if they first notice and understand what is going on (Reuker and Künzell, 2021). This skill is an important prerequisite for adapting teaching to diverse requirements and, thus, for meeting diverse learning needs (Choppin, 2011). Fourth, positive emotion influences teachers' decisions, especially about their delivery of instruction, together with its content in facilitating learning (Ramos et al., 2020; McCaughtry, 2004). Decision-making builds an important link between teachers' dispositions and performance, a diagnostic skill for adaptive instruction (Reuker and Künzell, 2021).

On the other hand, teachers whose classroom experiences are dominated by negative emotions, such as anxiety and anger, may find it more difficult to deviate from the predetermined lesson plan, and they most likely use more rigid teaching strategies, such as the rehearsal or rote memorisation (Frenzel, 2014). Moreover, Individuals with negative emotions face errors in the perception and interpretation of actions and events (Eastwood et al., 2001). The skills of perception and interpretation as diagnostic competence take place during ongoing teaching, e.g., to adapt tasks to different requirements (Reuker and Künzell, 2021; Schrader, 2013). Teachers with negative emotions seem to have trouble interpreting and giving events meaning from a teaching perspective, presenting low adaptive instruction (Reuker and Künzell, 2021). Accordingly, we postulated that teacher emotions would influence adaptive instruction and hypothesised as follows:

> *H1:* Teacher enjoyment would be positively associated with adaptive instruction.
>
> *H2:* Teacher anxiety and anger would be negatively associated with adaptive instruction.

2.4 Linking school climate with adaptive instruction

School climate has a variety of meanings, including the set of norms and expectations that others have for students (West, 1985), a set of factors which gives each school a personality, a spirit, and a culture (Tye, 1974), the physical and emotional health of the organisation (Freiberg, 1998), and level of teachers' empowerment and teachers' morale (Short and Rinehart, 1992; Brown and Henry, 1992), or the psychosocial context in which teachers work and teach (Fisher and Fraser, 1990). In contrast, school culture refers to the deeper values, beliefs, and assumptions that underlie these behaviours and interactions. It encompasses the shared norms and traditions that define a school's identity (Schein, 2010; Stolp and Smith, 1995). While climate can be more readily influenced and measured through observable behaviours (such as support), culture evolves more slowly and reflects the collective ethos of the school community (Drago-Severson, 2004; Lunenburg and Ornstein, 2021).

Despite the diverse understanding of school climates held by research, Johnson and colleagues (Johnson and Stevens, 2001; Johnson et al., 2007) identified five main aspects of school climate: teacher collaboration, student relations, school resources, decision-making and instructional innovation. Educators and researchers have widely examined these five aspects across numerous countries and districts (Collie et al., 2012; Malinen and Savolainen, 2016; Huang, 2021).

Collaboration means communication and cooperation with colleagues on curriculum design and implementation. School resources refer to suitable and adequate personnel, facilities, equipment, finance, and resources. Student relations focus on a good rapport between teachers and students. Decision-making refers to teachers' participation in school decision-making. Instructional innovation implies that the school favours planned change and experimentation and fosters classroom openness and individualisation (Johnson et al., 2007; Lopes and Oliveira, 2020). It is expected that contextual conditions within the school will influence adaptive instruction (Sibley et al., 2024). Developing adaptive instruction expertise may depend on contexts in which flexible, innovative, and even adventuresome practice is supported and encouraged or, at the very least, not punished (McDiarmid and Clevenger-Bright, 2008). First, collaboration with colleagues appears to improve adaptive instruction. To act like adaptive expertise, teachers need a repertoire of knowledge, strategies, skills, routines and the judgment to figure out what and when to do (Feiman-Nemser, 2008). Collaboration with colleagues can provide teachers with alternative teaching approaches and in-depth knowledge of subjects and student learning (Huang et al., 2022; Gallagher et al., 2022; Griffith et al., 2013), hence, contributing to adaptive instruction. Based on self-determination theory (SDT), teacher relatedness meets the critical psychological need of teachers to perform self-initiated behaviour in the workplace (Ryan and Deci, 2000). SDT advanced the concept of the need to explain why and how individuals have ongoing psychological growth and perform intrinsically motivated behaviour (Ryan and Deci, 2000). Next, good student relations can also boost adaptive instruction. Adaptive instruction requires a deep understanding of and familiarity with students to diagnose their needs to subsequently adapt their teaching methods, instruction and classroom management (Schipper et al., 2020; Beltramo, 2017; Brühwiler and Blatchford, 2011). With good relations with students, teachers may provide students with clear feedback, appropriate learning strategies, differentiated lesson tasks and assignments (Schipper et al., 2020). Third, available equipment and school resources appear to be key aspects when it comes to nourishing adaptive instruction (Schipper et al., 2020). Concerning adaptive instruction, social constructivism highlights how adaptive teachers notice and use instructional contexts, tools (i.e., language, student discussion, and engagement), resources, materials, and scaffolds to modify their instruction at the moment (Vaughn, 2019). The accessibility of ample educational resources will increase teachers' self-evaluated teaching competence (Huang, 2021), and then, teachers can adaptively adjust their approach. Teachers proactively modify resources to address the diverse needs of individual students and small groups of students to maximise the learning opportunities for each student in the classroom (Tomlinson et al., 2003). Fourth, decision-making builds an important link between teachers' dispositions and performance, which is a diagnostic skill for adaptive instruction (Reuker and Künzell, 2021). Teacher decisions in instructional design, including the assembly of tasks, instructional methods and materials, are conceptualised as intended adaptive

instruction if they refer to instructional choices or teacher actions that are based on diagnosed individual student needs and learning states (Parsons, 2012).

And finally, new tasks, changing work, classroom openness, and instructional innovations were regarded as inspiring and providing new opportunities to learn at work and increasing adaptive instruction (Wenström et al., 2018; Beltramo, 2017). Scholars propose that the understandings and competencies underlying adaptive instruction rely on an individual's development of innovation (Hatano and Oura, 2003). Instructional innovation at the school level represents collective teachers' capacity to creatively apply their professional knowledge in ways that uniquely respond to the particulars of a given context (Beltramo, 2017). It is required for adaptive instruction by offering teachers spaces for gleaning and reflecting on critical information about students' interests and social and learning needs (Beltramo, 2017). Taken together, adaptive instruction can be expected to be strongly influenced by the school environment. Finally, the conceptual framework of all hypotheses is presented in Figure 1.

> *H3:* School climate (collaboration with colleagues, student relations, available resources, decision-making and instructional innovation) would positively predict adaptive instruction.

3 Methods

3.1 Respondents and data collection

Our sample included 2,880 primary school teachers recruited from Chongqing. Since it was difficult to reach a large and diverse population of primary school teachers in Chongqing, we used a convenient sampling method, that is, snowball sampling. However, this approach allowed us to

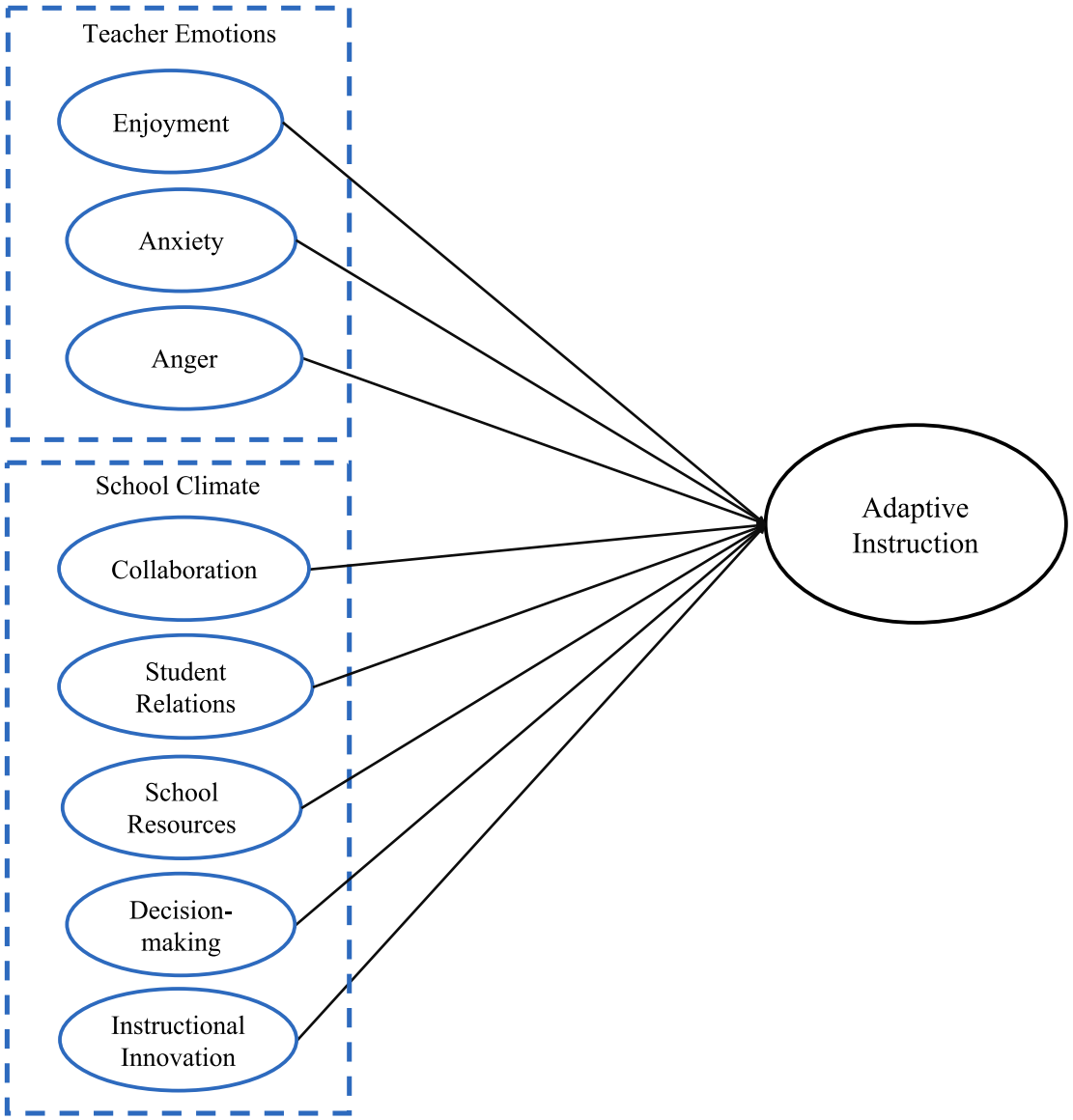

FIGURE 1
The conceptual framework of current study.

leverage existing networks within schools and reach participants who would be difficult to reach otherwise. Random sampling is ideal for generalisability, but we chose our method for sufficient sample size and representation under the constraints of our study. Participants were required to meet specific inclusion criteria: They must currently be primary school teachers in Chongqing who have at least 1 year of teaching experience. Before joining the study, participants also gave an informed consent form. Teachers on extended leave or not actively teaching during the study period who did not complete the questionnaires or consent form were excluded. The questionnaire was distributed by the principals through an online link shared via WeChat, an instant messaging platform widely used in China. The principals did not have access to any of the research data at any point during the process. The participants' average age was 36.34 years, and they had an average of 14.99 years of teaching experience; 85.5% were female. In terms of educational background, 3.13% of the teachers held a Master's degree or above, 74.86% held a Bachelor's degree, and 21.01% held an associate degree.

This study belongs to a large-scale project. With the same dataset, we have separately examined the impact of SLEQ and teacher emotions on their learning behaviour (Huang et al., 2020; Huang, 2021). With a different dataset, we demonstrated that teachers' metacognition and enthusiasm were closely related to their adaptive instruction (Huang et al., 2022). However, it is still unknown to what extent the school environment and teachers' negative emotions (e.g., anxiety and anger) are related to their adaptive instruction. To answer this question, the model of this article was constructed and analysed.

3.2 Measures

All the variables except the respondents' demographic information were rated on Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree) for both teachers' perceptions of the school climate scale and adaptive instruction scale, and from 1 (strongly disagree) to 4 (strongly agree) for the teacher emotions scale. The questionnaire used in this study was in Chinese. The English version of the original scale was translated into Chinese by the corresponding author, an expert in teacher education and school environment research, and then double-checked by the last author, who is also a specialist in this area and ensured the translated version fit the Chinese context. Additionally, two research assistants, both majoring in English language and literature, conducted a back-translation from Chinese to English to further verify accuracy. This procedure aimed to ensure alignment between the Chinese and English versions.

3.2.1 Adaptive instruction

Based on the literature on adaptive instruction (Parsons et al., 2018; Brühwiler and Blatchford, 2011) and curriculum design theory (Tyler, 1949), we developed five items to measure how often teachers adapted their teaching objectives, teaching approach, learning content, and assessment based on their observations of students' learning needs. A sample item is 'To meet my student learning needs, I adapt my teaching objects' ($\alpha = 0.95$). We conducted a pilot study with a smaller group of teachers prior to the main data collection. This pilot allowed us to refine our items based on teacher feedback and expert reviews.

3.2.2 School climate

Five aspects of school climate were measured by the teachers' perceptions of the school climate questionnaire developed by Johnson et al. (2007): Colleague collaboration (5 items, $\alpha = 0.81$; e.g., 'I have regular opportunities to work with other teachers'), student relations (4 items, $\alpha = 0.84$; e.g., 'Students in this school are well behaved'), school resources (4 items, $\alpha = 0.71$; e.g., 'Video equipment, tapes, and films are readily available'), decision-making (3 items, $\alpha = 0.74$; e.g., 'Teachers are frequently asked to participate in decisions'), and instructional innovation (3 items, $\alpha = 0.89$; e.g., 'New and different ideas are always being tried out').

3.2.3 Teacher emotions

Teachers' self-reported experiences of enjoyment, anger, and anxiety during teaching were measured by the Teacher Emotions Scale (TES) developed by Frenzel et al. (2016). The TES has 12 items covering the three discrete emotions of enjoyment, anxiety and anger. Examples of items on the TES include 'I generally enjoy teaching' for enjoyment (4 items, $\alpha = 0.94$), 'Preparing to teach often causes me to worry' for anxiety (4 items, $\alpha = 0.88$), and 'I often feel annoyed while teaching' for anger (4 items, $\alpha = 0.90$).

3.3 Instrument validation and data analysis

To validate the construct of each scale, we conducted exploratory factor analysis using the teacher responses from a randomly chosen subsample that comprised approximately half of the sample. The remaining responses were used for confirmatory factor analysis. All of the scales yielded an acceptable model fit (see Table 1). All the factor loadings for the five subscales were above 0.50.

The preliminary analysis included the reliability coefficients, descriptive statistics and correlations between the observed variables. To test the proposed hypotheses, we performed multiple regression. Following Hu and Bentler (1999), we used the following guidelines and fit indices for model fit: the standardized root mean square residual (SRMR), which should be a value less than 0.08; the Tuckere Lewis index (TLI), which should be a value of TLI ≥ 0.95; the comparative fit index (CFI), which should be a value CFI ≥ 0.95; and the root mean square error of approximation (RMSEA), which should be a value less than 0.08. We used Amos 24 to analyze the data. Each subscale had a relatively strong degree of internal consistency, with Cronbach's alpha varying from 0.71 to 0.94 (see Table 2).

TABLE 1 Model fit indices of school climate, academic emotions, and adaptive instruction.

	Model fit indices						
	χ^2	df	*p*	RMSEA	CFI	TLI	SRMR
School climate	466.919	113	0.000	0.047	0.969	0.958	0.031
Academic emotions	254.077	43	0.000	0.058	0.984	0.976	0.031
Adaptive instruction	22.927	3	0.000	0.068	0.997	0.990	0.008

TABLE 2 Results of confirmatory factor analysis.

Constructs and items	Standardized factor loading	Composite reliability
Collaboration		0.81
Collaboration 1: Classroom instruction is rarely coordinated across teachers.	0.56***	
Collaboration 2: I have regular opportunities to work with other teachers.	0.73***	
Collaboration 3: There is good communication among teachers.	0.71***	
Collaboration 4: Good teamwork is not emphasised enough at my school.	0.61***	
Collaboration 5: I seldom discuss the needs of individual students with other teachers.	0.70***	
Student relations		0.84
Student relations 1: Most students are well mannered or respectful of the school staff.	0.66***	
Student relations 2: Students in this school are well behaved.	0.82***	
Student relations 3: Most students are helpful and cooperative with teachers.	0.75***	
Student relations 4: Most students are motivated to learn.	0.87***	
School resources		0.71
School resources 1: Instructional equipment is not consistently accessible.	0.55***	
School resources 2: Video equipment, tapes, and films are readily available.	0.62***	
School resources 3: The school library has sufficient resources and materials.	0.72***	
Decision-making		0.74
Decision-making 1: Teachers are frequently asked to participate in decisions.	0.87***	
Decision-making 2: I have very little to say in the running of the school.	0.84***	
Decision-making 3: Decisions about the school are made by the principal.	0.62***	
Instructional innovations		0.89
Instructional innovations 1: We are willing to try new teaching approaches in my school.	0.83***	
Instructional innovations 2: New and different ideas are always being tried out.	0.88***	
Instructional innovations 3: Teachers in this school are innovative.	0.93***	
Enjoyment		0.94
Enjoyment 1: I generally enjoy teaching.	0.91***	
Enjoyment 2: I generally have so much fun teaching that I gladly prepare and teach my lessons.	0.88***	
Enjoyment 3: I often have reasons to be happy while I teach.	0.89***	
Enjoyment 4: I generally teach with enthusiasm.	0.90***	
Anxiety		0.88
Anxiety 1: I generally feel tense and nervous while teaching	0.85***	
Anxiety 2: I am often worried that my teaching is not going so well	0.65***	
Anxiety 3: Preparing to teach often causes me to worry	0.78***	
Anxiety 4: I feel uneasy when I think about teaching	0.91***	
Anger		0.90
Anger 1: I often have reasons to be angry while I teach	0.85***	
Anger 2: I often feel annoyed while teaching	0.93***	
Anger 3: Sometimes I get really mad while I teach	0.73***	
Anger 4: Teaching generally frustrates me	0.89***	
Adaptive instruction		0.95
Adaptive instruction 1: I adjust my teaching goals according to the student's learning needs.	0.90***	
Adaptive instruction 2: I adjust my teaching strategies according to the student's learning needs.	0.94***	
Adaptive instruction 3: I adjust the teaching content or materials according to the student's learning needs.	0.81***	
Adaptive instruction 4: I adjust the teaching evaluation (such as student work) according to the student's learning needs.	0.86***	
Adaptive instruction 5: I fine-tune the teaching according to the students' learning needs (such as changing the way of asking questions, adjusting the teaching order, etc.).	0.85***	

***represent 1% level of significant.

4 Results

Table 3 presents the reliability coefficients, mean scores, standard deviations and correlations of all the variables. The bivariate correlation coefficients showed significant relationships between all of the factor pairings. The coefficients ranged from 0.20 to 0.70 ($p < 0.01$).

4.1 Multiple regression analysis

We conducted a multiple regression analysis by entering school location, teachers' educational background, gender, and years of teaching experience in the first step. Then, we entered five school climate dimensions (collaboration, student relations, school resources, decision making, and instructional innovation) and all other variables (enjoyment, anxiety, and anger) in the last step.

The reason we chose multiple regression analysis was that in our research we were interested in knowing the associations of several independent variables with the dependent variable, adaptive instruction. By using multiple regression, we can determine the simultaneous effect of multiple predictors (in this case, school climate dimensions and teacher emotions) while controlling for other variables (such as school location, teachers' educational background, gender, and years of teaching experience). This approach makes it possible to understand more complex relationships among variables, as is essential in educational research. The three-step approach in our multiple regression analysis was designed to evaluate the incremental validity of the school climate variables and teacher emotions. In the first step, we included demographic and contextual factors to account for baseline variance in adaptive instruction. Moreover, school climate dimensions were introduced as the second step to examine the collective contribution of all dimensions, and third, teacher emotions were added to assess the additional impact. This sequential modelling provides a clearer understanding of how individual sets of variables explain variance in adaptive instruction.

We conducted a series of statistical tests to validate the assumptions of our regression model. The Durbin-Watson test yielded a statistic of 1.85, which falls within the acceptable range of 1.5 to 2.5, indicating that the independence of residuals is satisfied (Durbin and Watson, 1992; Field, 2009). Additionally, we performed the Breusch-Pagan test, which resulted in a chi-squared statistic of 2.34 and a p-value of 0.13, suggesting that the variance of the residuals remains constant across different levels of the independent variables (Breusch and Pagan, 1979). Furthermore, we assessed the normality of residuals using the Shapiro–Wilk test, which indicated that the residuals were approximately normally distributed ($W = 0.98$, $p = 0.12$).

As we included school climate variables in our first regression model, 22.1% of the variance of adapting instruction has been explained, and this relation was statistically significant: F (5, 2,874) =163.101, $p < 0.001$. The second model accounted for 35.7% of the variance in adaptive instruction and was a significant fit of the data, F (8, 2,871) =199.595, $p < 0.001$. This variance is generally considered as large effect size in educational research (Cohen, 2013). The incremental R^2 of the second model was 0.136 including three teacher emotions in addition to school climate. From the second model, we can conclude the following results.

Among the five dimensions of school climate, collaboration showed the most significant and positive association with adaptive instruction ($\beta = 0.151$, $p < 0.001$), followed by instructional innovation ($\beta = 0.115$, $p < 0.001$), and student relations ($\beta = 0.075$, $p < 0.05$). Teacher-perceived school resources ($\beta = -0.020$, $p > 0.05$) and decision-making ($\beta = -0.020$, $p > 0.05$) did not directly influence adaptive instruction. Enjoyment showed a relatively strong positive association with adaptive instruction ($\beta = 0.399$, $p < 0.001$) (see Table 4).

Additionally, anxiety had a negative and significant association with adaptive instruction ($\beta = -0.052$, $p < 0.05$). However, the results for anger were different, as the association of anger with adaptive instruction was not significant ($\beta = -0.010$, $p > 0.05$).

5 Discussion

This study explored the associations between teacher emotions (enjoyment, anxiety, and anger) and several dimensions of school

TABLE 3 Descriptive statistics and correlations between the variables studied (N = 2,880).

	1	2	3	4	5	6	7	8	9
Descriptive statistics									
M	4.06	4.16	3.76	3.07	3.95	3.24	2.19	2.12	4.21
SD	0.80	0.72	0.93	1.02	0.82	0.58	0.74	0.74	0.72
Correlations									
1. Collaboration	–								
2. Student relations	0.561**	–							
3. School resources	0.474**	0.444**	–						
4. Decision-making	0.462**	0.365**	0.441**	–					
5. Instructional innovation	0.594**	0.577**	0.486**	0.426**	–				
6. Enjoyment	0.364**	0.413**	0.315**	0.328**	0.401**	–			
7. Anxiety	−0.231**	−0.192**	−0.201**	−0.192**	−0.167**	−0.348**	–		
8. Anger	−0.276**	−0.280**	−0.236**	−0.241**	−0.237**	−0.419**	0.704**	–	
9. Adaptive instruction	0.403**	0.388**	0.271**	0.261**	0.401**	0.540**	−0.258**	−0.294**	–

The correlations were significant (**$p < 0.001$, two-tailed).

TABLE 4 Effects of school climate and emotion dimensions on adaptive instruction.

Model	Effects	Unstandardized coefficients		Standardized coefficients	*t*	Sig.	95% Confidence interval for B	
		B	Std. error	Beta			Lower bound	Upper bound
Model 1	Constant	2.132***	0.076		28.118	0.000	1.984	2.281
	Collaboration	0.165***	0.020	0.185	8.154	0.000	0.125	0.205
	Student relations	0.166***	0.022	0.165	7.635	0.000	0.123	0.208
	School resources	0.006	0.016	0.008	0.376	0.707	−0.025	0.037
	Decision making	0.025	0.014	0.036	1.843	0.065	−0.002	0.035
	Instructional innovation	0.155***	0.020	0.177	7.781	0.000	0.116	0.194
Model 2	Constant	1.574***	0.105		14.932	0.000	1.368	1.781
	Collaboration	0.135***	0.018	0.151	7.298	0.000	0.099	0.171
	Student relations	0.076***	0.020	0.075	3.759	0.000	0.036	0.115
	School resources	−0.015	0.014	−0.020	−1.077	0.282	−0.043	0.013
	Decision making	−0.014	0.013	−0.020	−1.134	0.257	−0.039	0.010
	Instructional innovation	0.101***	0.018	0.115	5.530	0.000	0.065	0.137
	Enjoyment	0.495***	0.022	0.399	22.038	0.000	0.451	0.539
	Anxiety	−0.050*	0.021	−0.052	−2.446	0.014	−0.091	−0.010
	Anger	−0.010	0.021	−0.010	−0.448	0.654	−0.052	0.032

***represent 1% level of significant.

climate, including teacher collaboration, school resources, student relations, decision-making, and instructional innovation, on adaptive instruction. It yielded two major findings: (1) Two of the three dimensions of teacher emotions (not anger) were significantly related to adaptive instruction; (2) Three of the five dimensions of school climate (not school resources and decision-making) were positively associated with adaptive instruction, with the strongest association being with teacher collaboration.

5.1 Associations of school climate with adaptive instruction

Of the five school climate dimensions we studied, teacher collaboration was the strongest predictor of adaptive instruction ($\beta = 0.151$, $p < 0.001$). This can be considered a moderate effect size according to Cohen's guidelines (Cohen, 2013), where 0.10 is small, 0.30 is medium, and 0.50 is large. Huang et al. (2022) found similar effect sizes for the impact of teacher collaboration on instructional practices. In another study, Sottilare et al. (2018) revealed that collective efficacy (a form of trust in the abilities of the team) exhibited a moderate, and significant association with adaptive instruction. When teachers purposefully interact with their colleagues, they can access their colleagues' teaching experiences, knowledge, and feedback (Kyndt et al., 2016), which significantly enhances their adaptive instruction (Huang et al., 2022). Stupnisky et al. (2019) found that adaptive instruction is strongly tied to social support from colleagues, such as collaborative curriculum development, advising, and sharing of course materials.

The second strongest association was found with instructional innovation ($\beta = 0.115$, $p < 0.001$), which also reflects a moderate effect size. This finding is consistent with previous research that emphasises the importance of innovative teaching practices for fostering adaptive instruction (Beltramo, 2017). Furthermore, student relations exhibited a smaller, yet significant association ($\beta = 0.075$, $p < 0.05$) with adaptive instruction, suggesting a mild effect size. This aligns with self-determination theory (Ryan and Deci, 2000), which posits that positive teacher-student relations can motivate teachers to create active learning environments. Interestingly, our study found that school resources and decision-making were not significantly associated with adaptive instruction. These findings contrast with prior research that identified school resources and decision-making as key factors in promoting adaptive instruction (Schipper et al., 2020; Reuker and Künzell, 2021).

5.2 Associations of teacher emotions with adaptive instruction

Among the three dimensions of teacher emotions, enjoyment was the strongest predictor of adaptive instruction ($\beta = 0.399$, $p < 0.001$), which indicates a large effect size. This finding is consistent with Stupnisky et al. (2019), who reported that positive emotions such as enjoyment significantly foster adaptive instruction. The large effect size highlights the critical role that enjoyment plays in motivating teachers to employ a variety of teaching strategies, as suggested by the broaden-and-build theory (Fredrickson, 2004).

According to previous studies (Frenzel, 2014; Ahmed et al., 2015; Huang and Luthans, 2015), teachers with a high level of enjoyment have a high level of motivational tendencies for teaching, and the flexible use of strategies to achieve in-depth learning, both of which contribute to adaptive behaviour. As noted previously, teachers with positive emotions experience a broadening of the scope of attention and decide where to focus their attention within this complex array of environmental stimuli to provide students with the best support

possible (Reuker and Künzell, 2021), which is a prerequisite for adapting teaching (Choppin, 2011).

Anxiety was found to have a negative and significant association with adaptive instruction ($\beta = -0.052$, $p < 0.05$), reflecting a small effect size. This result may indicate that teachers who experience a low level of anxiety have high personal coping capabilities and may find it easier to deviate from the predetermined lesson plan and rigid teaching strategies (Frenzel et al., 2016; Frenzel, 2014), which is a precursor for adaptive instruction. These kinds of teachers face fewer troubles in interpreting and giving events meaning from a teaching perspective, hence, present adaptive instruction (Reuker and Künzell, 2021). Hence, it revealed that anxiety is negatively related to adaptive instruction and teachers with a low level of anxiety have high adaptive instruction. It seems that teachers with a higher level of anxiety face trouble interpreting and giving events meaning from a teaching perspective, hence, presenting low adaptive instruction (Reuker and Künzell, 2021).

Conversely, our study found that anger was not significantly associated with adaptive instruction. In contrast with this finding, Eastwood et al. (2001) asserted that teachers with negative emotions such as anger face errors in the perception and interpretation of actions and events and present low adaptive instruction. Anger and anxiety are both negative in valence and high in arousal, but the appraisal patterns differ (Frenzel et al., 2016). Anger appraisal is typically a 'goal obstacle' coupled with 'other accountability' (e.g., Kuppens et al., 2003), whereas anxiety typically occurs when a situation is appraised as 'potentially threatening' and having a 'low personal capability to control the situation' (e.g., Pekrun, 2006, as cited in Frenzel et al., 2016). Parsons (2012) emphasised that teachers who adopt adaptive instructions have the capability to control the situation and are successful in specific situations.

6 Limitations and future directions

This study has a few limitations that need to be noted. First, given its cross-sectional research design, this study cannot demonstrate causal relationships between teacher emotion and adaptive instruction behaviour. To better validate these results, future work should use a longitudinal research design to capture changes over time and to help clarify causality among the constructs. Second, while the sample size was substantial, it is important to note that all participants were selected through a convenience sampling method from Chongqing city. This localized sample may limit the generalizability of the findings to the broader population of teachers across China, given the country's significant regional differences in educational practices and contexts. Future studies can aim to include a more diverse sample of teachers from various regions to enhance the representativeness of the data. Cross-cultural studies could also yield valuable insights into how different educational contexts shape the relationships between school climate, teacher emotions, and adaptive instructional practices, ultimately contributing to the global discourse on effective teaching strategies. Third, this study only relied on self-reported questionnaires completed by teachers. Future research should use various sources to gain a more comprehensive understanding of adaptive instruction. Qualitative research methods, including interviews and focus groups, offer valuable insights that can enhance the understanding of quantitative findings related to adaptive instruction in educational settings. By delving into teachers' lived experiences and perceptions, qualitative approaches can illuminate the intricate dynamics that shape instructional adaptability. Fourth, because teachers' emotions and decision-making vary across cultures (Sun, 1991; Huang et al., 2022), more studies in other cultural contexts are needed to enrich our understanding of the link between teacher emotions, school climate and adaptive instruction. Additionally, it should be noted that adaptive instruction has two components, adaptive planning and adaptive implementation (Huang et al., 2022). We did not distinguish between these two components when considering the relationships between adaptive instruction and other constructs. Future studies should distinguish between the two components of adaptive instruction and their outcomes to provide additional insight into adaptive instruction behaviour. Moreover, the evaluation of adaptive instruction based on students' learning styles should be included in future research to enhance our understanding of the relationship between adaptive instruction and slearning system. We may also need to include more factors for constructing a comprehensive model of adaptive instruction. Finally, while the study focused on specific dimensions of school climate and teacher emotions, other contextual factors, such as school leadership styles, professional development opportunities, and individual teacher traits, may also play a significant role in adaptive instruction. Future research should explore these additional variables to develop a more holistic view of the factors influencing adaptive instructional practices. Specially, evaluating the effectiveness of professional programs could inform educational policy and practice, promoting environments that foster adaptive instructional strategies. Future research on adaptive instruction can investigate the interplay between teacher emotions and school climate to better understand how these interconnected factors influence teachers' ability to adapt their instructional practices to meet diverse student needs. Despite these limitations, this study provides valuable insights into some antecedents of adaptive instruction.

7 Implications

These findings have some important implications for education communities. First, as teachers' positive emotions play important roles in adaptive instruction, policymakers and educators should focus on fostering teachers' experiences of positive emotions. Given the limited knowledge on how to improve teachers' positive emotions, we strongly recommend that more effort be devoted to the development of intervention programmes and training workshops to improve teachers' positive emotions in China.

Second, the finding of an adverse role of a teacher's negative emotion in shaping adaptive instruction may be used in intervention programs and pieces of training for both pre-service and in-service teachers. More specifically, teachers could be trained to use efficient and adaptive emotion regulation strategies that would hamper or reduce the experience of negative emotions such as anxiety and anger (Burić et al., 2020). For instance, using reappraisal (i.e., modifying the way one thinks either about a situation that evokes an emotion or about one's capacity to manage it) or attempts to actively modify the features of the situation that evoked an emotion may prove fruitful in preventing teachers' negative emotional experiences (Burić et al., 2020; Gross and John, 2003).

Third, the findings indicate that teachers' interactions with students and colleagues and instructional innovation, as dimensions of school climate, influence adaptive instruction. China's teachers use

various instructional resources, and then they will consider how these instructional resources can improve their teaching so as to meet the students' personalized needs (Wu et al., 2021). With good relations with students, teachers may provide students with clear feedback and appropriate learning task and strategies. When teachers begin to pay attention to students with various backgrounds and their needs, a sense of urgency arises to promote teaching and action (Wu et al., 2021). A participation-friendly school environment can encourage sustainable active participation by teachers (Huang et al., 2020), which can in turn increase adaptive instruction. This finding call administrators' attention to be aware of the potential impact of school climate when they formulate school policies concerning teacher learning.

8 Conclusion

This study investigated the associations between teacher emotions and school climate on adaptive instruction. It extends our previous understanding by distinguishing between the associations that different dimensions of teachers' emotions and school climate have on adaptive instruction. The findings demonstrated the crucial roles that teachers' enjoyment and anxiety play in their adaptive instruction and revealed that each dimension of school climate has a different association with adaptive instruction. Specifically, student interactions, teacher collaboration, and instructional innovation were positively and significantly associated with adaptive instruction, with teacher collaboration having the strongest predictive power. This study provides valuable insights for educators and policymakers on how to enhance adaptive instruction.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the ethical committee at the University of Hong Kong. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

MK: Writing – original draft, Writing – review & editing. XH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. CW: Data curation, Formal analysis, Writing – review & editing. JC-KL: Conceptualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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