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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ceds20

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To cite this article: Zhi Hong Wan, John Chi-Kin Lee, Zi Yan & Po Yuk Ko (2023) Self-regulatory school climate, group regulation and individual regulatory ability: towards a model integrating three domains of self-regulated learning, Educational Studies, 49:5, 783-798, DOI: 10.1080/03055698.2021.1894093

To link to this article: https://doi.org/10.1080/03055698.2021.1894093

EDUCATIONAL STUDIES
2023, VOL. 49, NO. 5, 783–798
https://doi.org/10.1080/03055698.2021.1894093

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Self-regulatory school climate, group regulation and individual regulatory ability: towards a model integrating three domains of self-regulated learning

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ABSTRACT

Developing students' self-regulated learning (SRL) is crucial for nurturing the life-long learners needed in modern and future society. This study adopted structural equation modelling to explore the relationships among self-regulatory climate, group regulation in project-based learning (PBL) and individual regulatory ability. The results indicate that (i) group regulation has a significant positive effect on SRL ability; (ii) self-regulatory climate (i.e. academic emphasis and teacher trust in students) have significant positive effects on both group regulation and SRL ability; and (iii) student trust in teachers has a negative effect on group regulation and a positive effect on SRL ability. A combination of three approaches (i.e., the explicit, implicit and immersion) is recommended to generate convergent forces to efficiently cultivate self-regulatory learners.

ARTICLE HISTORY
Received 16 June 2020
Accepted 19 February 2021

KEYWORDS
Self-regulatory school climate; group regulation; project-based learning; self-regulated learning

Introduction

Self-regulated learning[1] (SRL) is "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate and control their cognition, motivation, and behaviour[2], guided and constrained by their goals and the contextual features in the environment" (Pintrich 2000, 453). It is a significant area in educational research and educational psychology studies (Järvelä et al. 2018; Rotgans and Schmidt 2008) due to its potential to compensate for students' individual differences in learning (Zimmerman 2002), enhance academic achievement (Zimmerman and Pons 1986) and cultivate the adaptive life-long learners needed to work in the rapidly changing information age (Luckin 2018). Although various features can be used to characterise self-regulated learners, such as self-efficacy, task value and intrinsic goal orientation (Pintrich 1999; Zimmerman 1989, 1990) and demonstration, elaboration and organisation learning strategies (Pintrich and DeGroot 1990; Rotgans and Schmidt 2008; Zimmerman 1989), the core of SRL is the use of strategies to plan, monitor and adjust the learning process (Zimmerman 1990).

Early theories of SRL focused on the individual aspect of regulation, highlighting the roles played by students in taking charge of their own learning processes (Winne 1997).

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Some recent studies started to pay attention to the group aspect of SRL (e.g., Didonato 2013; Järvelä, Järvenoja, and Malmberg 2019), in which students' SRL can be further differentiated into two interrelated levels, i.e. the individual and the group. Within the collaborative learning context, two or more peers must work together to co-regulate the collective learning task, which is more difficult than individual SRL because more coordination and communication are required to regulate group activities (Kirschner et al. 2018). At the same time, students are expected to monitor their own tasks distributed by the group, which means that individual SRL is also required in collaborative learning. Moreover, during group regulation, students can further strengthen their individual SRL ability by learning SRL strategies and skills from a more regulated peer or co-constructing SRL strategies and skills from a similarly regulated peer (Vauras et al. 2003). Group regulation and individual regulation are both crucial for solving the complex problems usually encountered in modern societies, as they will be in the future (Hadwin, Bakhtiar, and Miller 2018). This study will follow this new trend to study both individual and group regulation.

Drawing from the interactionist perspective of social cognitive theory (Bandura 1991), the development of group regulation and individual regulation should be embedded within the broader organisational and social contexts (Usher and Schunk 2018). Therefore, a branch of recent research investigated the impacts of school climate on self-regulation. Adams et al. (2015) forged the concept of a self-regulatory climate, which is defined as a set of normative conditions that are formed through the interaction between teachers and students in a school and can satisfy students' psychological needs for autonomy, belonging, security and achievement. The concept of a self-regulatory climate includes three interconnected dimensions: teacher trust in students, student trust in teachers and academic emphasis. Each of these dimensions is thought to enhance students' SRL in both individual and group learning activities. First, the presence of teacher trust in students can cultivate students' feeling of autonomy. Less external control is then needed in both individual and group learning, and students are more willing to make their own choices in the selection of learning tasks and strategies. Second, student trust in teacher makes students feel safe and connected to their teachers, which in turn encourages the behavioural tendency of risk taking that is necessary for becoming autonomous learners in both individual and group learning (Ryan and Deci 2002). The practices that reflect academic emphasis include setting achievable learning goals, requiring students to study hard, maintaining order in the classroom and celebrating academic excellence (Hoy, Tarter, and Hoy 2006). These practices can build up students' sense of achievement during the process of individual and group learning. When students perceive a high level of academic emphasis in their schools, they are more likely to be internally motivated and self-regulated.

Patrick, Ryan, and Kaplan (2007) investigated the influence of six aspects of classroom social environment on students' self-regulation: teacher emotional support, teacher academic support, student emotional support, student academic support, mutual respect and task-related interaction. The findings indicated that only teacher emotional support (related to student trust in teacher), task-related interaction and student academic support were significant predictors of students' self-regulation strategy. Adams (2014) used hierarchical linear modelling to explore the effects of student trust in teachers on school

identification and students' self-regulation strategy. The findings revealed significant effects of student trust in teachers on school identification ($\gamma = .18$, $p < .01$) and SRL ($\gamma = .15$, $p < .01$). Similarly, Adams et al. (2015) adopted hierarchical linear modelling to investigate the effects of a self-regulatory climate as a whole on students' self-regulation strategy. They found that a self-regulatory climate could explain school-level variance in students' self-regulation strategy ($\gamma = .28$, $p < .01$), which in turn influenced students' achievement in mathematics.

Although these studies generated preliminary evidence of the effects of a self-regulatory climate on individual SRL, there is still a lack of research to investigate the influence of a self-regulatory climate on SRL at both individual and group levels. The literature is also limited in revealing the extent to which group and individual regulation are related. These are the major gaps to be filled by this study. The group regulation studied in this study was in the context of project-based learning (PBL) because (i) a project intends to investigate a complex question or solve a complex problem (Ravitz 2010), in which a high level of uncertainty is embedded and thus regulation is intrinsically required; (ii) all students must work together to accomplish a common goal (Didonato 2013), which realises a natural and close integration between group regulation and individual regulation; and (iii) a project normally lasts a long period (Koutrouba and Karageorgou 2013), so group regulation conducted in PBL may have a significant effect on individual SRL. More specifically, the following two questions are addressed in this study:

- What is the relationship between a self-regulatory climate and students' individual SRL ability?
- Do students' group regulation during PBL mediate the relationship between a self-regulatory climate and the students' individual SRL ability? If yes, how?

Research methods

Participants

PBL is a model that organises learning around projects, which are complex tasks based on challenging questions or problems (Thomas, Mergendoller, and Michaelson 1999). Due to its complexity, a project is usually conducted in a collaborative manner and has a long duration. Over the past two decades, PBL has been designated as a continuous and eminent emphasis in Hong Kong school curriculum reform documents (i.e., Education Commission 2000; Education Bureau (EDB) 2014; Curriculum Development Council 2017). As stated by the Curriculum Development Council, the adoption of PBL aims to "enable students to connect knowledge, skills, values, and attitudes and to construct knowledge through a variety of learning experiences" (2001, 87). Promoted by the government curriculum reforms, it has become a well-recognised and widely implemented teaching strategy in both primary and secondary classrooms in Hong Kong (Lam, Cheng, and Choy 2010; Van Aalst et al. 2007). It is thus appropriate and meaningful to investigate the relationships among school climate, group regulation in PBL and individual regulation in Hong Kong's schools.

Eleven secondary schools in Hong Kong participated in this study. A total of 850 junior secondary students responded to the questionnaire, but 73 questionnaires were excluded due to abnormal responses and incomplete data. Eventually, 777 valid student questionnaires were selected for subsequent analysis. More specifically, 260 (33.5%) were from Secondary One, 264 (34.0%) were from Secondary Two, 253 (32.5%) were from Secondary Three. The gender information of 4 students (.5%) was missing, 408 (52.5%) students were male (with respectively 146, 135 and 127 from Secondary One, Two and Three), 365 (47.0%) were female (with respectively 113, 126 and 126 from Secondary One, Two and Three). The age of students ranged from 12 to 16 years.

Data collection

As discussed in the literature review, this study as part of the larger project (Lee et. al 2019) explored the relationships among three domains related to SRL: self-regulatory climate, group regulation during PBL and individual SRL ability. Three scales were used in this study to assess these constructs with existing tools. All items were written in Chinese and measured on a 6-point Likert scale (1 = "strongly disagree"; 6 = "strongly agree").

Self-regulatory climate

This study used a survey designed by Adams et al. (2015) to assess the self-regulatory climate, in which three dimensions are considered the key indicators. The first dimension is academic emphasis, in which five items adopted from the Academic Emphasis Scale (Goddard, Sweetland, and Hoy 2000) were used to assess the extent to which a student perceives his or her school's expectations for and emphasis on their high academic performance. Sample items include "This school has high expectations for student achievement" and "Teachers in this school encourage students to keep trying even when the work is challenging" (Adams et al. 2015, 27).

The second dimension of a self-regulatory climate is teacher trust in students, which is operationalised as teacher-shared perceptions of the students' openness, honesty, benevolence, reliability and competence. The items for this dimension originated from Hoy and Hoy and Tschannen-Moran (1999) Omnibus Trust Scale. Sample items include "Teachers in this school trust their students", "Students in this school can be counted on to do their work" and "Teachers in this school believe students are competent learners".

The third dimension is student trust in teachers, which indicates the extent to which a student perceives his or her teachers as being ready to help students, competent at teaching, reliable and benevolent. Sample items include: "teachers are always ready to help at this school", "teachers at this school really listen to students", and "teachers at this school are good at teaching".

Group regulation in PBL

To probe students' group regulation during PBL, Didonato (2013) developed the Co-regulated Learning Questionnaire (CRLQ) on the basis of other instruments (Martinez-Pons 1999; Wolters, Pintrich, and Karabenick 2005). Because the group regulation process is the target of the CRLQ, all instances in which "I" was used in the previous self-evaluation items were replaced by "We" to construct a collective evaluation tool. Seven items from

the CRLQ were used in this study to assess students' group regulation in PBL, such as "when we planned, we talked about whether our plans were realistic", "we double-checked each other's work to make sure we were all doing it right" and "we will help each other to effectively manage time, so that we don't have to finish our work at the last minute".

Individual SRL ability

Koutrouba and Karageorgou (2013) developed a 40-item questionnaire to assess students' perception of the cognitive and socio-effective outcomes of PBL. Among the 16 items related to cognitive outcomes, six items concern individual SRL ability, including "personalising learning to suit our personal traits, learning needs and interests", "utilising experiential learning and practice it in daily life to get a more integrated/better knowledge of the real world", "developing meta-cognitive awareness to increase and improve academic attainments", "developing criteria for personal performance evaluation", "reaching best solutions through amalgamation of different points of view and proposals" and "developing skills for successful programming and time management". This study chose to adopt these items to assess students' development of individual SRL ability through PBL because Koutrouba and Karageorgou (2013) designed their tool specifically to probe the effects of PBL on individual learning outcomes, which matched the context of this study.

Data Analysis

First, Cronbach's alpha coefficients were calculated to determine the reliability of self-regulated climate, SRL and their sub-constructs (Table 1). The overall alpha coefficient for a self-regulated climate was .901, and those for its three constructs – academic emphasis, teacher trust and student trust – were .801, .738 and .863, respectively. The alpha coefficient for group regulation in PBL was .900 and that for individual SRL ability was .819. As suggested by Fink (2015), the criterion for Cronbach's alpha coefficient is .70, so all these scales have considerably good reliability.

Item-to-scale correlation was calculated to estimate the scales' validity (Table 2). Specifically, the average item-to-scale correlation coefficients of the three dimensions of self-regulated climate were .585, .534 and .711, respectively. The average item-to-scale correlation coefficients of group regulation and individual regulation were .727 and .701, respectively. The scales were all valid because a score above.30 indicates internal consistency (Gable 1986).

Table 1. Alpha Coefficients for six constructs in this study.

Constructs	Alpha Coefficients
Self-regulated climate	.901
• Academic emphasis	.801
• Teacher trust	.738
• Student trust	.863
Group regulation in PBL	.900
Individual SRL ability	.819

Table 2. Item-to-scale correlation for six constructs in this study.

Academic emphasis		Teacher trust		Student trust		Group regulation in PBL		Individual SRL ability	
Item	Corr.	Item	Corr.	Item	Corr.	Item	Corr.	Item	Corr.
AE01	.536	TT01	.611	ST01	.703	CL01	.725	IL01	.672
AE02	.639	TT02	.443	ST02	.740	CL02	.684	IL02	.701
AE03	.602	TT03	.648	ST03	.669	CL03	.741	IL03	.751
AE04	.464	TT04	.435	ST04	.731	CL04	.759	IL04	.682
AE05	.682					CL05	.743	IL05	.720
						CL06	.730	IL06	.670
Mean	.585	Mean	.534	Mean	.711	Mean	.727	Mean	.701

Structural equation modelling (SEM) was conducted to further validate the overall construct of the self-regulated climate questionnaire. The three dimensions of self-regulated climate were hypothesised as being correlated. As indicated in Figure 1, adequate fit indices were generated for the structural model of self-regulatory climate (χ^2/df = 2.190; CFI = .983; PNFI = .661; RMSEA = .039).

Given the evidence for the measures' structure validity, correlational analyses and SEM were further conducted to explore the relationships among a self-regulatory climate, group regulation in PBL and individual SRL ability. The SEM analysis was conducted with AMOS 21, whilst Cronbach's alpha and correlation coefficients were calculated with SPSS 21. Numerous fit indices are used in the SEM field, among which the most common is the ratio of the chi-square (χ^2) statistic (Lehman et al. 2013). Three additional commonly used fit indices are often calculated in SEM: the comparative fit index (CFI), the parsimonious normed fit index (PNFI) and the root mean square error of approximation (RMSEA). The χ^2/df value is expected to be below 3 and above 1. For the RMSEA, a value of .05 or lower is assumed to be the best fit, whereas a value of .08 or lower is assumed to be a good fit. For the PNFI, a value of .50 or greater is assumed to be a good fit. For the CFI, a value of .90 or greater is assumed to be a good fit. These four fit indices were used in this study. These criterion values refer to the prescription of Hu and Bentler (1999).

Findings

Correlations among self-regulatory climate, group regulation in PBL and individual SRL ability

Correlational analysis was conducted to investigate the relationships among a self-regulatory climate, group regulation in PBL and individual SRL ability. The results in Table 3 indicated that all five constructs showed positive correlations ($p < .01$) with one another.

Table 3. Correlational analysis of self-regulatory climate, group regulation in PBL and individual SRL ability.

	1	2	3	4	5
1 Academic emphasis	1				
2 Teacher trust in students	.565**	1			
3 Student trust in teachers	.619**	.737**	1		
4 Group regulation in PBL	.393**	.394**	.349**	1	
5 Individual SRL ability	.523**	.541**	.533**	.557**	1

**. Correlation is significant at the .01 level (2-tailed)

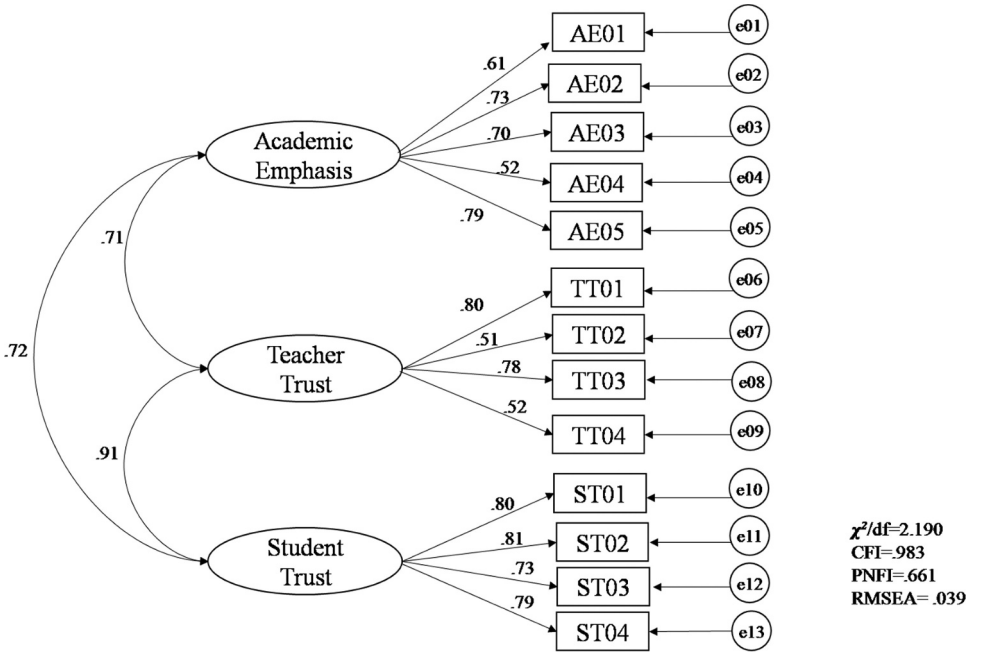

Figure 1. CFA of self-regulated climate.

Comparatively speaking, the correlation of self-regulatory climate and students' development in individual SRL ability (mean = .532) was greater than that with group regulation in PBL (mean = .378), indicating that even if the connection between self-regulatory climate and students' development in individual SRL ability in PBL was mediated by group regulation in PBL, the mediation effect might be partial, rather than full.

SEM analyses of self-regulatory climate, group regulation in PBL and individual SRL ability

Correlational analysis is limited in investigating mediating effects because it cannot consider the interconnections among all the variables when calculating the coefficients. When multiple causes must be incorporated into the analysis, its limitation is more apparent because the correlations among these causes cannot be integrated into the analysis. SEM analyses were thus further conducted to obtain a more accurate picture of the relationships among self-regulatory climate, group regulation in PBL and individual SRL ability.

Instead of simply testing the partial mediation model, three models were compared: partial, full and no mediation. This comparison can help to prevent a situation in which a model that can to some extent fit the structure of data is accepted even though it is not the most appropriate one available to map the data. As indicated in Figure 2,

- Model 1 is a partial mediation model, in which self-regulation climate has both direct effects on individual SRL ability and indirect effects mediated by group regulation in PBL;

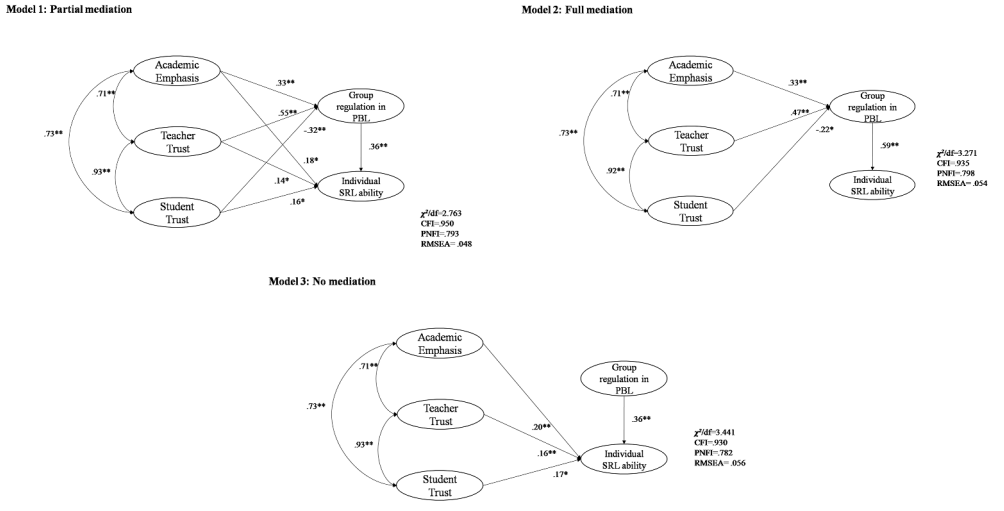

Figure 2. Comparison of three models of self-regulatory climate, group regulation in PBL and individual SRL ability.

- Model 2 is a full mediation model, in which self-regulation climate has only indirect effects on individual SRL ability mediated by group regulation in PBL; and
- Model 3 is a non-mediation model, in which self-regulation climate and group regulation in PBL only have direct effects on individual SRL ability

Through comparing the fit indices of the three models, it can be noted that the three fit indices of Model 1 (χ^2/df = 2.763; CFI = .950; RMSEA = .048) are better generated than those of Models 2 and 3. The PNFI of Model 1 is .793, which also indicates an excellent fit. These findings indicate that the partial mediation model may be best supported by the data.

In addition to the model fit indices, Model 1 indicated that (i) academic emphasis has positive and significant effects on both group regulation in PBL (ß = .33, P < .01) and individual SRL ability (ß = .18, P < .05); (ii) teacher trust in students also has positive and significant effects on both group regulation in PBL (ß = .55, P < .01) and individual SRL ability (ß = .14, P < .05); and (iii) the effects of student trust in teachers vary; negative effects were seen on group regulation in PBL (ß = −.32, P < .01), and positive effects were seen on individual SRL ability (ß = .16, P < .05).

Discussion

Group regulation and individual SRL

Because learning has become increasingly interactive and socially constructive, instead of focusing simply on individual SRL process and strategies, scholars in recent years have become interested in investigating SRL in collaborative learning contexts. Koutrouba and Karageorgou (2013) used a questionnaire to assess students' perception

of the cognitive and socio-effective outcomes of students of PBL. The results indicated that more than 70% of Greek undergraduates (n = 677) believed that much or very much PBL could enhance their individual SRL. Because information was not collected on the group regulation in PBL in this study, no inference was made on the effects of group regulation on individual SRL. Didonato (2013) reported a case study of four U.S. middle-school students who worked as a group to carry out a project for 9 weeks. Observation revealed both group regulation and individual regulation. It was also found that during the process of group regulation, the less-regulated peers might enhance or refine their individual regulative skills via collaboration with the more-regulated peers. Malmberg, Järvelä, and Järvenoja (2017) observed 6 groups of teacher education students who worked collaboratively at various course tasks for 7 weeks. The lag sequential analysis of the video record revealed that group planning and monitoring regulation could significantly stimulate group planning regulation, but no significant interaction was found between group regulation and individual regulation. Although these studies have provided some clues to the potential of group regulation to cultivate individual PBL, they still cannot reveal the extent to which they are related. As indicated in the findings of this study, their correlation coefficient was .596 ($p < .001$) and the predictive effect in SEM was .36 ($p < .001$). Both are very significant. Given this additional evidence, we can have more confidence in considering group regulation as one of the effective approaches to developing self-regulatory learners. More effort should be made to encourage collaborative problem solving in schools. Studies should be conducted to explore how collaboration can be more efficiently organised to encourage both group and individual regulations.

Self-regulatory school climate and group regulation

SRL should be supported by the school environment or climate (Hadwin et al. 2010). Previous studies (e.g., Adams 2014; Adams et al. 2015; Patrick, Ryan, and Kaplan 2007; Lee et al. 2019) only investigated the effects of school climate on SRL at the individual level. This study is a pioneering work that explores the influence of school climate on group regulation. As indicated by this study, school students' group regulation in PBL was significantly predicted by academic emphasis and teacher trust in students, which echoes previous findings at the individual level. However, a strong negative connection was also found between student trust in teachers and group regulation in PBL, which is different from the common belief of a positive relationship between them. There could be two reasons for this.

One possible reason is Chinese students' high expectations for teachers' help during the learning process. In the concept of self-regulatory school climate, academic emphasis is considered as competence support, teacher trust in students as autonomy support and student trust in teachers as relational support (Adams et al. 2016). As a form of relational support, student trust in teachers should be established by comparison between the expected and actual behaviour of teachers. As found in Lee, Chang, and Tsai (2009), although Chinese secondary science learners preferred less teacher control of the learning content and activities (M = 3.17), they preferred much more teacher's academic help to their learning (M = 3.87). It was also found in Jiang et al. (2021), teacher support had greater impacts on East Asian secondary students' learning motivation and self-efficacy of

learning than their Western counterparts. Given Chinese students' high expectations for teachers' support, to gain student trust, teachers must give students considerable help during their learning, which in turn causes a decline in student' regulation of their own learning. In other words, Chinese students' high expectations for teachers' help may cause a negative connection between their trust in teachers and their self-regulation even in normal learning tasks.

The second possible reason is the complexity of group-regulation in PBL. Unlike normal subject learning, in which the answers to questions or solutions to problems are normally fixed, a project aims to handle a complex question or problem for which no fixed answer or solution is available (Ravitz 2010). PBL also lasts longer (Koutrouba and Karageorgou 2013), and its group regulation requires complicated communication and coordination (Kirschner et al. 2018). Clearly, the challenges for conducting group regulation in PBL should be much greater than for individual SRL in routine learning tasks, which might in turn cause Chinese students to have higher expectations for teachers' help than in normal learning tasks. Therefore, a rather significant negative connection between student trust in teachers and group regulation in PBL was revealed in this study.

Self-regulatory school climate and individual SRL

Previous studies mainly generated significant positive results regarding the effects of the school climate on individual SRL (e.g., Adams et al. 2015, 2016; Patrick, Ryan, and Kaplan 2007), which were echoed in this paper. More importantly, this study not only revealed a direct significant connection between the three dimensions of self-regulatory climate and the development of individual SRL ability, but also the indirect significant connections mediated by group regulation in PBL. These findings provide more detailed information on the mechanism by which individual SRL is influenced by the school climate.

Implications for developing self-regulatory learners

Cultivating self-regulatory learners will prepare our children for the uncertainty and changes that are unavoidable in life and in study both now and in the future (Luckin 2018). This endeavour is not easy (Järvelä et al. 2018) and cannot be achieved via a single approach. A significant implication of this study is to highlight the need to consider the development of SRL in a holistic manner. It is necessary for teachers to use all three kinds of approach (i.e., the explicit, implicit and immersion) to generate convergent forces to efficiently cultivate self-regulatory learners.

Explicit and implicit approaches

A good number of early efforts to enhance students' SRL intended to adopt an explicit approach to train students to use specific strategies, such as self-instruction, verbal elaboration, goal setting, self-recording and process monitoring (Butler et al. 2001; Graham, Harris, and Reid 1992; Simons and Beukhof 1987). Although strategy training can help students acquire the knowledge and skills of SRL, the questions of whether and how well they adopt these strategies in their learning are much more complex than initially envisioned (Zimmerman 1990). Students' learning process might be easily

distracted by watching TV, playing mobile phone, daydreaming and chatting with students. Students might be limited in their ability to estimate the time, resources and outcomes of leaning activity, so they terminate their self-regulatory process when they encounter difficulties or failure. Students have their own learning styles, strengths and weakness, so students need considerable opportunities to practice, refine and develop SRL strategies that can match themselves. Therefore, in addition to explicit strategy training, efforts should also be made to creative a constructive climate in which students can be engaged implicitly into SRL activities and gradually develop their self-regulatory ability.

School climate and family environment

Although the self-regulatory climate studied in this paper was constrained in the school context, the family environment is also crucial because the shaping of children's SRL behaviour begins with their interaction with their parents. Moreover, manipulating the family environment should be less challenging than manipulating the climate of a school. Therefore, to cultivate students' SRL more effectively, we should pay attention to both school climate and family environment. First, school leaders, teachers and parents should have high expectations for and emphasis on students' academic performance. According to the Pygmalion effect (Feldman and Prohaska 1979), others' expectations of a specific person affect this person's performance in work and study. If students can feel the expectations from the important people in both family and school, they will be highly motivated to regulate their own learning. Second, teachers and parents should give students enough room to make decisions on their own learning and daily life (such as choosing learning tasks, planning the schedule, making friends and joining public activities) and should be open to their suggestions. School leaders should also encourage their teachers to do so. In this way, students can feel teachers' and parents' trust and at same time have enough opportunities to develop their self-regulatory ability in the learning and daily life contexts.

It is also necessary to cultivate student trust in teachers and parents (by making students feel safe and connected) to encourage the risk-taking disposition necessary for becoming autonomous learners. Of course, this suggestion should be very carefully taken by Chinese teachers and parents when establishing students' trust. As discussed above, Chinese students have higher expectations for teachers' help during the process of learning (especially in difficult tasks), so they may also have similar expectations for their parents in daily life. When students' expectations for teachers' or parents' support are still high, it may be risky to simply reduce the support because it may reduce students' trust in teachers and parents and cause them to lose their motivation to learn and give up learning tasks. A more sensible strategy may be finding ways to change students' expectations by letting them know the iterative process and difficulty of finishing a complex task and that most difficulties can be conquered by themselves. When they experience the excitement and pleasure of conquering the problems several times, they will be more willing to explore challenging learning tasks by themselves for a longer period before they seek teachers' or parents' help. When students get used to the new learning pattern, because their expectations are changed, student trust in teachers and parents will not decline even if teachers or parents suspend helping students for the time being.

Group regulation and individual regulatory ability

As indicated by this study, in addition to strategy training and establishing self-regulatory school climate and family environment, group cooperation can also accelerate the process of developing individual SRL ability. When designing collaborative tasks for SRL, it is crucial to maintain the optimal levels of challenge (Malmberg, Järvenoja, and Järvelä 2010; Diadonato 2013). If the task is challenging enough, students will feel pressure to work together to finish the task so that individual accountability and positive interdependence among group members can be naturally established and interconnected. The task should not be too short. Otherwise, there will be enough time for the group members to figure out their plan, evaluate the effectiveness of task execution and make necessary modification. In addition, the task should be meaningful and authentic enough to motivate the group members to sustain their efforts for such a long period. Because PBL can match these requirements ideally, it has been recommended as an efficient approach to develop both group regulation and individual SRL. Unlike the explicit approach (i.e., strategy training, in which SRL strategies are directly taught and learning SRL is separate from other learning activities) and the implicit approach (i.e., establishing a self-regulatory school climate and family environment, in which SRL strategies are not presented to students), when students can develop their SRL via PBL, SRL strategies can be learned explicitly, and cultivation of SRL is simultaneously integrated with other learning objectives that can be achieved through PBL (such as critical thinking and creativity). Therefore, it can be considered an immersion approach.

Limitations and further studies

This study only explored the relationship between group regulation in PBL and individual SRL. In fact, teacher regulation should also play an important role in PBL. Future studies should explore the dynamic interaction among self, group and teacher regulation in PBL. Although a negative relationship was revealed in this study between students' trust in teachers and group regulation in PBL, it is necessary to explore whether this finding can be obtained with Chinese students in other regions. A study of non-Chinese students regarding the interaction among school climate, group regulation and individual SRL will also help to test the conclusions drawn in this paper. In addition, this study did not collect the information of the socio-economic background of students and whether there are any students with special educational needs. Future studies should be conducted to compare the relationship between student trust and self-regulation among students from different socio-economic background and between students with and without special educational needs. Motivational self-regulation is a new direction of recent studies of self-regulated learning (Reindl, Tulis, and Dresel 2020; Scholer et al. 2018; Smit, de Brabander, Boekaerts, and Martens 2017), more research should be conducted to explore the interaction among self-regulatory school climate, group motivational regulation and individual motivational regulatory ability in the future.

Notes

1. Abbreviation for "self-regulated learning"
2. Abbreviation for "project-based learning"

Acknowledgment

The authors would like to thank , Professor C. M. Adams, Professor Anita Woolfolk Hoy, Professor Megan Tschannen-Moran, Professor Nicole DiDonato-Barnes, Professor Konstantina Koutrouba, Professor Elissavet Karageorgou, and Professor Wayne K. Hoy for their support in this study. Thanks are also extended to the Centre for Excellence of Learning and Teaching and Department of Curriculum and Instruction, Faculty of Education and Human Development, The Education University of Hong Kong, for their support during the preparation of this manuscript. The authors are responsible for the choice and presentation of information and views contained in this article and for opinions expressed therein, which are not necessarily those of UNESCO and The Education University of Hong Kong, and do not commit the respective Organisations.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Adams, C. M. 2014. "Collective Student Trust: A Social Resource for Urban Elementary Students." *Educational Administration Quarterly* 50 (1): 135–159. doi:10.1177/0013161X13488596.

Adams, C. M., P. B. Forsyth, E. Dollarhide, and R. Miskell. 2015. "Self-regulatory Climate: A Social Resource for Student Regulation and Achievement." *Teachers College Record* 117: 020305.

Adams, C. M., J. K. Ware, R. C. Miskell, and P. B. Forsyth, P.B. 2016. "Self-regulatory Climate: A Positive Attribute of Public Schools." *The Journal of Educational Research* 109 (2): 169–180. doi:10.1080/00220671.2014.934419.

Bandura, A. 1991. "Social Cognitive Theory of Self-regulation." *Organizational Behavior and Human Decision Processes* 50 (2): 248–287. doi:10.1016/0749-5978(91)90022-L.

Butler, D. L., S. Jarvis, B. Beckingham, H. Novak, and C. Elaschuk. 2001. *Teachers as Facilitators of Students' Strategic Performance: Promoting Academic Success by Secondary Students with Learning Difficulties*. Seattle, WA: Presented at the annual meetings of the American Educational Research Association. April.

Curriculum Development Council. 2017. *The Secondary Education Curriculum Guide (Draft- May 2017) Booklet 2: Learning Goals, School Curriculum Framework and Planning*. Hong Kong: Author.

Didonato, D. C. 2013. "Effective Self- and Co-regulation in Collaborative Learning Groups: An Analysis of How Students Regulate Problem Solving of Authentic Interdisciplinary Tasks." *Instructional Sciences* 41 (1): 25–47. doi:10.1007/s11251-012-9206-9.

Education Bureau (EDB). 2014. *Basic Education Curriculum Guide - to Sustain, Deeepen and Focus on Learning to Learn (Primary 1-6)*. Hong Kong: Author.

Education Commission. 2000. *Learning for Life, Learning through Life: Reform Proposal for the Education System in Hong Kong*. Hong Kong: Author.

Feldman, R. S., and T. Prohaska. 1979. "The Student as Pygmalion: Effect of Student Expectation on the Teacher." *Journal of Educational Psychology* 71 (4): 485. doi:10.1037/0022-0663.71.4.485.

Fink, A. 2015. *How to Conduct Surveys: A Step-by-step Guide*. Los Angeles, CA: Sage Publications.

Gable, R. K. 1986. *Instrument Development in the Affective Domain*. Boston, MA: Kluwer-Nijhoff.

Goddard, R. D., S. R. Sweetland, and W. K. Hoy. 2000. "Academic Emphasis of Urban Elementary Schools and Student Achievement in Reading and Mathematics: A Multilevel Analysis." *Educational Administration Quarterly* 36 (5): 683–702. doi:10.1177/00131610021969164.

Graham, S., K. R. Harris, and R. Reid. 1992. "Developing Self-regulated Learners." *Focus on Exceptional Children* 24 (6): 1–16. doi:10.17161/foec.v24i6.7539.

Hadwin, A. F., A. Bakhtiar, and M. Miller. 2018. "Challenges in Online Collaboration: Effects of Scripting Shared Task Perceptions." *International Journal of Computer-Supported Collaborative Learning* 13 (3): 301–329. doi:10.1007/s11412-018-9279-9.

Hadwin, A. F., M. Oshige, C. L. Z. Gress, and P. H. Winne. 2010. "Innovative Ways for Using gStudy to Orchestrate and Research Social Aspects of Self-regulated Learning." *Computers in Human Behavior* 26 (5): 794–805. doi:10.1016/j.chb.2007.06.007.

Hoy, W. K., C. J. Tarter, and A. W. Hoy. 2006. "Academic Optimism of Schools: A Force for Student Achievement." *American Educational Research Journal* 43 (3): 425–446. doi:10.3102/00028312043003425.

Hoy, W. K., and M. Tschannen-Moran. 1999. "Five Faces of Trust: An Empirical Confirmation in Urban Elementary Schools." *Journal of School Leadership* 9 (3): 184–208. doi:10.1177/105268469900900301.

Hu, L. T., and P. M. Bentler. 1999. "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives." *Structural Equation Modeling: A Multidisciplinary Journal* 6 (1): 1–55. doi:10.1080/10705519909540118.

Järvelä, S., A. Hadwin, J. Malmberg, and M. Miller. 2018. "Contemporary Perspectives of Regulated Learning in Collaboration." In *International Handbook of the Learning Sciences*, edited by F. Fischer, C. E. Hmelo-Silver, S. R. Goldman, and P. Reimann, 127–136. New York, NY: Routledge.

Järvelä, S., H. Järvenoja, and J. Malmberg. 2019. "Capturing the Dynamic and Cyclical Nature of Regulation: Methodological Progress in Understanding Socially Shared Regulation in Learning." *International Journal of Computer-Supported Collaborative Learning* 14 (4): 425–441. doi:10.1007/s11412-019-09313-2.

Jiang, Y., C. K. J. Lee, Z. H. Wan, and J. Chen. 2021. "Stricter Teacher, More Motivated Students? Comparing the Associations between Teacher Behaviors and Motivational Beliefs of Western and East Asian Learners." *Frontiers in Psychology* 11. doi:10.3389/fpsyg.2020.564327.

Kirschner, P. A., J. Sweller, F. Kirschner, and J. Zambrano. 2018. "From Cognitive Load Theory to Collaborative Cognitive Load Theory." *International Journal of Computer-Supported Collaborative Learning* 13 (2): 213–233. doi:10.1007/s11412-018-9277-y.

Koutrouba, K., and E. Karageorgou. 2013. "Cognitive and Socio-affective Outcomes of Project-based Learning: Perceptions of Greek Second Chance School Students." *Improving Schools* 16 (3): 244–260. doi:10.1177/1365480213501062.

Lam, S. F., R. W. Y. Cheng, and H. C. Choy. 2010. "School Support and Teacher Motivation to Implement Project-based Learning." *Learning and Instruction* 20 (6): 487–497. doi:10.1016/j.learninstruc.2009.07.003.

Lee, J. C. K., Z. H. Wan, S. K. F. Hui, and P. Y. Ko. 2019. "More Student Trust, More Self-regulation Strategy? Exploring the Effects of Self-regulatory Climate on Self-regulated Learning." *The Journal of Educational Research* 112 (4): 463–472. doi:10.1080/00220671.2018.1553840.

Lee, M. H., C. Y. Chang, and C. C. Tsai. 2009. "Exploring Taiwanese High School Students' Perceptions of and Preferences for Teacher Authority in the Earth Science Classroom with Relation to Their Attitudes and Achievement." *International Journal of Science Education* 31 (13): 1811–1830. doi:10.1080/09500690802308654.

Lehman, A., N. O'Rourke, L. Hatcher, and E. Stepanski. 2013. *JMP for Basic Univariate and Multivariate Statistics: Methods for Researchers and Social Scientists*. North Carolina: Sas Institute.

Luckin, R. 2018. *Machine Learning and Human Intelligence: The Future of Education for the 21st Century*. London: UCL IOE Press.

Malmberg, J., S. Järvelä, and H. Järvenoja. 2017. "Capturing Temporal and Sequential Patterns of Self-, Co-, and Socially Shared Regulation in the Context of Collaborative Learning." *Contemporary Educational Psychology* 49: 160–174. doi:10.1016/j.cedpsych.2017.01.009.

Malmberg, J., H. Järvenoja, and S. Järvelä. 2010. "Tracing Elementary School Students' Study Tactic Use in gStudy by Examining a Strategic and Self-regulated Learning." *Computers in Human Behavior* 26 (5): 1034–1042. doi:10.1016/j.chb.2010.03.004.

Martinez-Pons, M. 1999. *Statistics in Modern Research: Applications in the Social Sciences and Education*. Lanham, Maryland: University Press of America.

Patrick, H., A. M. Ryan, and A. Kaplan. 2007. "Early Adolescents' Perceptions of the Classroom Social Environment, Motivational Beliefs, and Engagement." *Journal of Educational Psychology* 90 (1): 83–98. doi:10.1037/0022-0663.99.1.83.

Pintrich, P. R. 1999. "The Role of Motivation in Promoting and Sustaining Self-regulated Learning." *International Journal of Educational Research* 31 (6): 459–470. doi:10.1016/S0883-0355(99)00015-4.

Pintrich, P. R. 2000. "The Role of Goal Orientation in Self-regulated Learning." In *Handbook of Self-regulation*, edited by M. Boekaerts, P. R. Pintrich, and M. Zeidner, 451–502. San Diego, CA: Academic.

Pintrich, R. R., and E. V. DeGroot. 1990. "Motivational and Self-regulated Learning Components of Classroom Academic Performance." *Journal of Educational Psychology* 82 (1): 33–40. doi:10.1037/0022-0663.82.1.33.

Ravitz, J. 2010. "Beyond Changing Culture in Small High Schools: Reform Models and Changing Instruction with Project-based Learning." *Peabody Journal of Education* 85 (3): 290–312. doi:10.1080/0161956X.2010.491432.

Reindl, M., M. Tulis, and M. Dresel. 2020. "Profiles of Emotional and Motivational Self-regulation following Errors: Associations with Learning." *Learning and Individual Differences* 77. doi:10.1016/j.lindif.2019.101806.

Rotgans, J. I., and H. G. Schmidt. 2008. "Cross-cultural Validation of Self-regulated Learning in Singapore." In *What the West Can Learn from the East: Asian Perspectives on the Psychology of*

Learning and Motivation, edited by O. S. Tan, D. M. McInerney, A. D. Liem, and A. Tan, 245–266. New York: Information Age Publishing .

Ryan, R. M., and E. L. Deci. 2002. "Overview of Self-determination Theory: An Organismic Dialectical Perspective." In *Handbook of Self-determination Theory Research*, edited by E. Deci and R. Ryan, 3–36. Rochester, NY: University of Rochester Press.

Scholer, A. A., D. B. Miele, K. Murayama, and K. Fujita. 2018. "New Directions in Self-regulation: The Role of Metamotivational Beliefs." *Current Directions in Psychological Science* 27 (6): 437–442. doi:10.1177/0963721418790549.

Simons, P. J., and G. Beukhof. 1987. *Regulation of Learning*. Den Haag, The Netherlands: SVO.

Smit, K., C. J. De Brabander, M. Boekaerts, and R. L. Martens. 2017. "The Self-regulation of Motivation: Motivational Strategies as Mediator between Motivational Beliefs and Engagement for Learning." *International Journal of Educational Research* 82: 124–134. doi:10.1016/j.ijer.2017.01.006.

Thomas, J. W., J. R. Mergendoller, and A. Michaelson. 1999. *Project-based Learning: A Handbook for Middle and High School Teachers*. Novato, CA: Buck Institute for Education.

Usher, E. L., and D. H. Schunk. 2018. "Social Cognitive Theoretical Perspective of Self-regulation." In *Educational Psychology Handbook Series. Handbook of Self-regulation of Learning and Performance*, edited by D. H. Schunk and J. A. Greene, 19-35. New York, NY: Routledge.

Van Aalst, J., F. W. Hing, L. S. May, and W. P. Yan. 2007. "Exploring Information Literacy in Secondary Schools in Hong Kong: A Case Study." *Library & Information Science Research* 29 (4): 533–552. doi:10.1016/j.lisr.2007.06.004.

Vauras, M., T. Iiskala, A. Kajamies, R. Kinnunen, and E. Lehtinen. 2003. "Shared-regulation and Motivation of Collaborating Peers: A Case Analysis." *An International Journal of Psychology in the Orient* 46 (1): 19–37. doi:10.2117/psysoc.2003.19.

Winne, P. 1997. "Experimenting to Bootstrap Self-regulated Learning." *Journal of Educational Psychology* 89 (3): 397–410. doi:10.1037/0022-0663.89.3.397.

Wolters, C. A., P. R. Pintrich, and S. A. Karabenick. 2005. "Assessing Academic Self-regulated Learning." In *What Do Children Need to Flourish?*, edited by K. A. Moore and L. H. Lippman, 251–270. Boston, MA: Springer.

Zimmerman, B. J. 1989. "A Social Cognitive View of Self-regulated Academic Learning." *Journal of Educational Psychology* 81 (3): 329–339. doi:10.1037/0022-0663.81.3.329.

Zimmerman, B. J. 1990. "Self-regulated Learning and Academic Achievement: An Overview." *Educational Psychologist* 25 (1): 3–17. doi:10.1037/0022-0663.81.3.329.

Zimmerman, B. J. 2002. "Becoming a Self-regulated Learner: An Overview." *Theory into Practice* 41 (2): 64–70. doi:10.1207/s15430421tip4102_2.

Zimmerman, B. J., and M. M. Pons. 1986. "Development of a Structured Interview for Assessing Student Use of Self-regulated Learning Strategies." *American Educational Research Journal* 23 (4): 614–628. doi:10.3102/00028312023004614.