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# Elementary school teachers' attitudes towards project-based learning in China

Zhiling Cai<sup>1</sup>, Jinxing Zhu<sup>1</sup>, Yu Yu<sup>1</sup> & Saiqi Tian<sup>1</sup>  

This study analyzed the Chinese elementary school teachers' attitudes toward project-based learning (PBL) and identified factors that may influence elementary school teachers' attitudes. The analysis was based on a questionnaire survey of 257 elementary school teachers and interviews with 10 elementary school teachers in China. Results showed that Chinese elementary school teachers generally had positive attitudes towards PBL, but their attitudes differed based on their educational level, years of teaching, and subjects taught. Results of the regression analysis found that training, social support, resources, and availability of time all positively influenced teachers' attitudes toward PBL. Finally, the interview data were analyzed to understand teachers' perceptions of how they could be helped to use PBL in teaching.

<sup>1</sup>College of Education, Wenzhou University, Wenzhou, P.R. China. ✉email: [tiansaiqi@wzu.edu.cn](mailto:tiansaiqi@wzu.edu.cn)

## Introduction

Project-based learning (PBL) is an educational approach, that is an inquiry process of solving complex and real problems, as well as a process of elaborately designing project-based works, planning and implementing tasks so that students can master the required knowledge and skills (Chu et al., 2011; Markham et al., 2003). As a student-centered method of instruction, PBL aims to develop students' problem-solving and critical thinking capacities, promote peer collaboration, and stimulate affective and cognitive skills that contribute to intellectual and creative development (Chen and Yang, 2019; S. K. W. Chu et al., 2017; Greenier, 2020; S. F. Lam et al., 2010). As a result, PBL has been regarded as an educational approach to achieving the skills for the 21st century, such as critical thinking, communication, collaboration, and creativity (Lamb et al., 2017). Although PBL is beneficial to students' learning, the key factor in implementing this teaching method is the attitude of the teachers (Lam et al., 2008). Teachers' attitudes toward a new teaching method usually determine its teaching effects (Durlak, 1998; Stains and Vickrey, 2017). For example, teachers' attitudes, whether positive or negative, would affect students' attitudes (Denessen et al., 2015). When teachers show higher intrinsic motivation in PBL, their students feel more instructional support in the learning process (Lam et al., 2008). On the contrary, when teachers have a negative attitude or anxiety towards the subject they teach, they could pass the anxiety on to their students (Geist, 2010). A deep understanding of teachers' attitudes towards PBL will help promote the development of PBL and provide better suggestions for the implementation of PBL.

However, to the best of our knowledge, comparatively little research has paid attention to the factors related to elementary school teachers' attitudes toward PBL. Some studies adopted a quantitative approach to examine teachers' motivation to implement PBL (S.F. Lam et al., 2010; Lam et al., 2009) and perceptions of PBL (Habok and Nagy, 2016). Mixed methods with qualitative and quantitative data were also utilized to investigate teachers' attitudes toward PBL (Petersen and Nassaji, 2016). Nonetheless, studies about how elementary school teachers perceive PBL, as well as what factors might predict their attitudes toward PBL, are scarce. Therefore, the current study focuses on the attitudes of elementary school teachers toward PBL and the factors that impact their attitudes. Although this study was conducted in the context of Chinese education, efforts on PBL education innovation can serve as a source of inspiration for other countries, as there are some important similarities across countries, especially in the implementation issues faced by teachers who are accustomed to traditional methods. Specifically, we sought to answer the following research questions:

- (1) What are the attitudes of elementary school teachers towards PBL in China?
- (2) What factors influence elementary school teachers' attitudes toward PBL?
- (3) What is needed to help teachers teach using PBL?

## Literature review and theoretical background

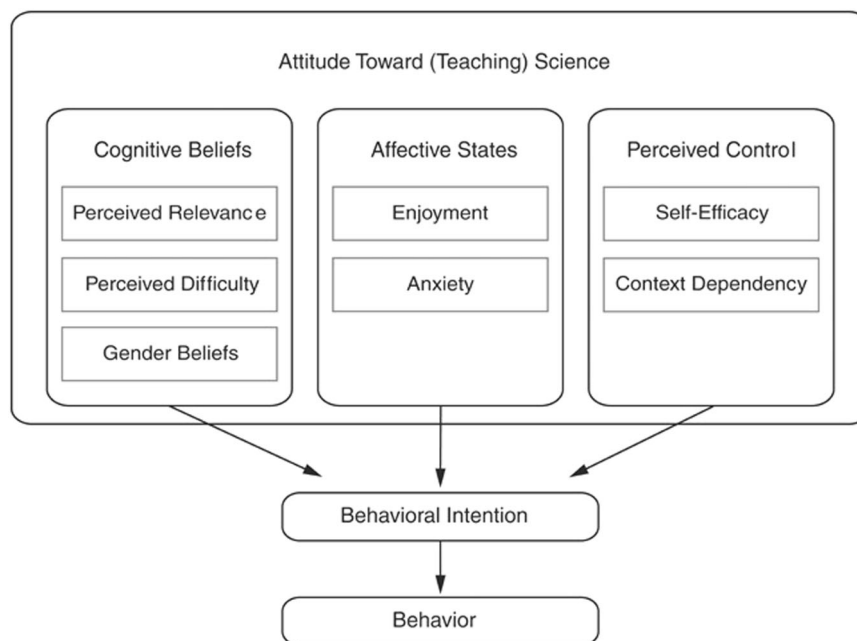
**Project-based learning.** Project-based learning (PBL) refers to a pedagogical method that engages students in knowledge construction by involving them in the task of accomplishing meaningful projects and developing real-world products (Bell, 2010; Chang et al., 2018; Krajcik and Blumenfeld, 2014). PBL is characterized by students' active involvement through collaborative learning, and students control the learning process (Bell, 2010). Teachers act more as facilitators, providing feedback and support to students to help them accomplish the project (Almulla, 2020). The six characteristics of PBL include a driving question, the

focus on learning goals, participation in educational activities, cooperation among students, the use of scaffolding technologies, and the creation of tangible objects (Krajcik and Blumenfeld, 2014). In the learning process through PBL, students work together in groups to solve specific problems, develop products for particular audiences, evaluate products, optimize products, and finally display products (Guo et al., 2020; Helle et al., 2006; Larmer and Mergendoller, 2010).

Compared with the traditional instructional method, PBL provides students with the opportunity to combine knowledge with real-world experience, which can promote deeper learning, deeper understanding, higher learning motivation, stronger implementation ability, and improve learning achievements (Chu et al., 2011; Lavonen et al., 2021; Munoz-Repiso and Gomez-Pablos, 2017; Song, 2018). For example, Lavonen et al. (2021) implemented a multidisciplinary PBL unit that integrated home economics and science education in a Finnish elementary school class, demonstrating that PBL effectively stimulated elementary school-aged pupils' interest in learning science and technology. A study found that elementary school students' literacy competence, social and emotional competencies, and empathy were significantly improved after learning through cooperative PBL (Llorent et al., 2022). Another study found that students who worked according to the model of PBL performed better in mathematics than students who worked in a conventional way, suggesting that PBL had a significantly positive effect on student mathematics achievements (Lazic et al., 2021). PBL supports critical thinking, problem-solving, interpersonal communication, information and media literacy, collaboration, leadership and teamwork, innovation, and creativity as effective ways to develop 21st-century skills (Samuel Kai Wah Chu et al., 2017).

**Teachers' attitudes.** Because "attitude" is a common expression in everyday life, almost everyone knows what it means. Nevertheless, the meaning assigned to the term is not always uniform. One study defined attitudes as feelings about an object or activity, namely an affective component, and distinguished them from beliefs, which are the cognitive component (Koballa Jr., 1988). Other studies did not distinguish between attitudes and beliefs ("The psychology of attitudes. A.H. Eagly & S. Chaiken. Fort Worth, TX: Harcourt, Brace, & Janovich, 1993, 794 pp. Reviewed by Christopher Leone, University of North Florida," 1995; van Aalderen-Smeets et al., 2012). The term "attitude" used in this paper is described as a holistic evaluation of an object or activity, both in the affective and cognitive components. Some researchers divided attitudes into two types (Albarracín et al., 2005). One is general attitudes, which refer to generalized objects or groups (e.g., PBL). The other is attitudes toward behavior, which refers to the performance of a specific behavior toward an object or target (e.g., teaching PBL). General attitudes do not usually accurately predict specific behaviors, while the same behaviors can be predicted well from measures of attitudes toward behaviors (Albarracín et al., 2005). Thus, this paper measures attitudes towards specific behaviors.

Particularly, van Aalderen-Smeets et al. (2012) constructed and validated a dimension of attitude towards science (DAS), which includes three dimensions: cognitive beliefs, affective states, and perceived control (Fig. 1). The cognitive belief consists of perceived relevance, perceived difficulty, and gender beliefs. The affective states, which refer to the positive emotions and negative emotions experienced in teaching, consist of enjoyment and anxiety. The perceived control refers to how much control teachers feel they have over teaching including self-efficacy and



**Fig. 1 Theoretical framework for elementary teachers' attitudes toward (the teaching of) science.** Adopted from van Aalderen-Smeets et al. (2012). This figure is not covered by the Creative Commons Attribution 4.0 International License. Reproduced with permission of John Wiley and Sons © John Wiley and Sons, all rights reserved.

context dependency. DAS was utilized to guide the attitude section of the theoretical framework in this article.

### Factors that affect teachers' attitudes

*Personal characteristics.* It was believed that teachers' attitudes were influenced by personal characteristics (Hayes and Trexler, 2016; Park et al., 2016; Thibaut et al., 2018). Discovering predictors of teachers' attitudes is equivalent to the identification of background characteristics, such as gender, years of teaching, educational level, subject taught, training and professional development, etc. (Collinson, 2012; Crook, 2016).

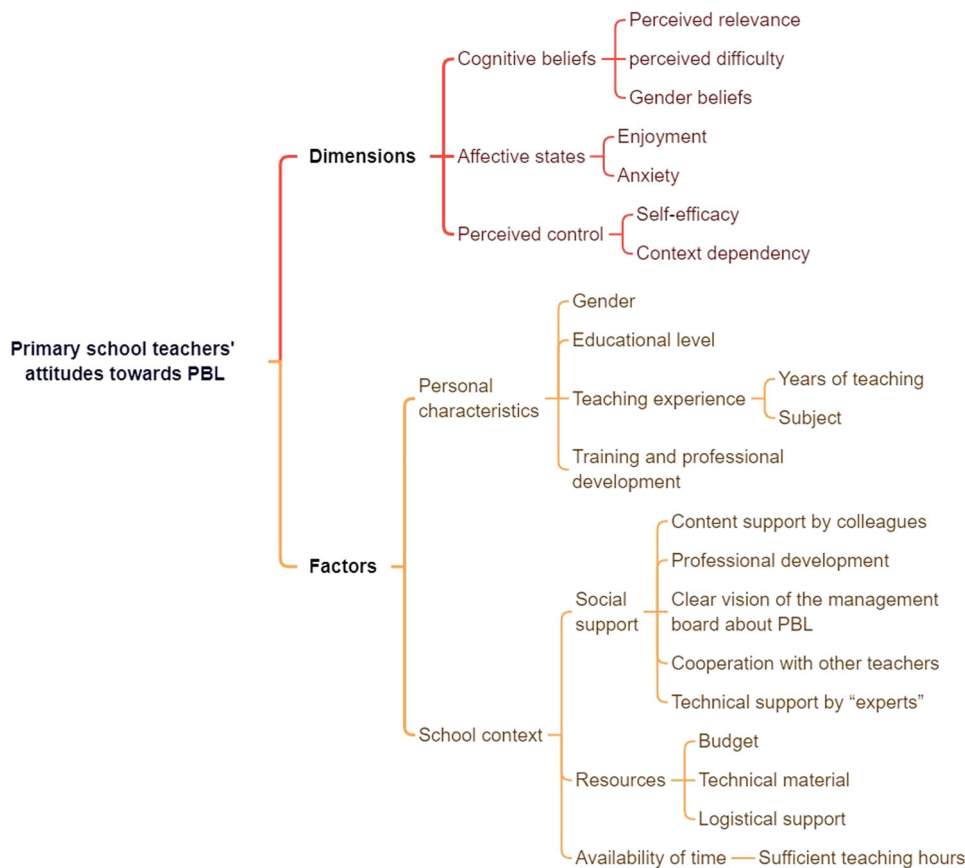
The first personal characteristic in this category refers to the gender of the teachers, but research on the effect of gender on teachers' attitudes has proved contradictory. For example, some studies reported there were no significant gender differences in teachers' attitudes toward promoting student-centered learning, (Lan et al., 2013), the social organization of Schools (Lee et al., 1991), and science teaching (Metin et al., 2012). Self-efficacy is an important part of teachers' attitudes. Some research found that females presented higher levels of teacher self-efficacy than males in elementary schools (Anderson et al., 1988).

The second factor taken into account is educational level. Before 1999, most elementary teachers in China were educated in teacher college and were usually middle school graduates with three or five years of preservice training. After 1999, a 4-year undergraduate (or bachelor) education program was started. Nowadays, most elementary school teachers in China have bachelor's degrees and are usually high school graduates with 4 years of preservice training (Sun, 2020). Moreover, two different graduate teacher education programs exist: a 2-year professional master's or a 3-year academic master of education program. Teachers with different education levels may adopt different teaching methods, so education levels might lead to different attitudes (Jarski et al., 1990). For example, it was found that teachers with master's degrees had higher self-efficacy (Hoover-Dempsey et al., 1987) and more positive attitudes than teachers with bachelor's degrees (Thibaut et al., 2018).

The third personal characteristic in this category refers to a teacher's teaching experience, including years of teaching and subjects taught. In terms of years of teaching, researchers reached conflicting findings. A study proved that age-based differences in attitudes toward geospatial technology use among teachers were less significant (Avdic et al., 2020). The other study found that teachers' self-efficacy increased through their early years and into the middle stages of their careers but decreased at the end of their careers (Klassen and Chiu, 2010). Moreover, teacher attitudes may be domain-specific, as teaching tasks and situations are largely shaped by the nature of the subjects the teacher taught (Chen and Yeung, 2015). Teachers' understanding of subject content and pedagogical content is also an essential factor in PBL practices (Rowan et al., 1997). PBL is usually employed as an interdisciplinary teaching method (Biasutti and El-Deghaidy, 2015; MacLeod and van der Veen, 2020; Vogler et al., 2018). Elementary teachers who taught more than one subject might have a deeper understanding of the interdisciplinary teaching methods and more positive attitudes towards PBL.

The last characteristic is participation in PBL training and professional development. Teachers can take advantage of training and professional development to gain knowledge that can be applied to their teaching (Brion, 2020; Kennedy, 2016; Farrow et al., 2022). The research conducted in 2022 revealed that teachers who had taken part in PBL professional development were more inclined to include PBL in their instruction.

*School context.* According to Bandura's social cognitive theory (Bandura and Cliffs, 1987), teachers' attitudes are influenced by the environment. Lumpe et al. (2000) developed and applied a method to assess teachers' context beliefs from four aspects: standardized teaching methods and curriculum, social support, resources, and time available within the curriculum. Appleton and Kindt (1999) interviewed nine teachers and found that school contexts, such as school support and resources, could influence their teaching. When teachers believed that the school could provide sufficient support, they were more proactive in utilizing PBL in teaching and had a more assertive attitude towards this



**Fig. 2** The figure displays the theoretical framework for elementary school teachers’ attitudes toward PBL in China, including dimensions and factors.

educational innovation (S.-f. Lam et al., 2010). The lack of PBL resources negatively affected the implementation of PBL (Diaz Lantada and De Maria, 2019). Insufficient class time negatively impacted teachers’ attitudes, either (Nadelson and Seifert, 2013). School type is also a factor taken into account. Hackman et al. (2021) found teachers differed in attitudes based on school type in Liberia.

**The current study.** The current study aims to examine elementary school teachers’ attitudes toward PBL and find factors that impact their attitudes. Figure 2 displays the theoretical framework for elementary school teachers’ attitudes toward PBL in China, including dimensions and factors. We adopted the framework of DAS (van Aalderen-Smeets et al., 2012) and conducted a questionnaire survey based on the attitude section in DAS and the corresponding theoretical model. The theoretical framework of factors classified is into two categories: personal characteristics and school context. Personal characteristics include gender, educational level, teaching experience, and training and professional development. School context consists of social support (including content support by colleagues, professional development, clear vision of the management board about PBL, cooperation with other teachers, and technical support by “experts”), resources (including budget, technical material, and logistical support), and availability of time.

**Method**

**Research design.** This paper used quantitative and qualitative methods to investigate the attitudes of elementary school teachers toward PBL and the factors that affect their attitudes. We used a side-by-side combination model of across-method triangulation

(Sun, 2006). Both qualitative and quantitative studies were used to study elementary teachers’ attitudes towards PBL and their findings were analyzed separately. At last, the results of the two types of studies were compared, analyzed, and summarized before writing the article. On the whole, the questionnaires were distributed to elementary school teachers, and the collected quantitative data were analyzed to answer research questions (1) and (2). Ten elementary school teachers were interviewed and the qualitative data were analyzed to answer the research question (3).

**Participants.** All of the individuals taking part in this research were Chinese elementary school teachers. A total of 257 teachers took part in the survey. The snowball sampling technique was employed to distribute the questionnaires, which were then filled out by teachers from various elementary schools and subsequently distributed to other teachers. The questionnaire participants’ demographic information, such as gender, educational level, years of teaching, school type, subject taught, and times of PBL training, is outlined in Table 1. The majority of the participants were female, accounting for 69.26%, while the remaining 30.74% were male. The majority of the participants had <5 years of teaching experience, accounting for 65.76%. 87.16% of all teachers had a bachelor’s degree. There were 75.49% of the teachers from private schools and 24.51% of the teachers from public schools. Subject categories were divided into humanities-based (including Chinese, English, music, etc.) and science-based (including science, mathematics, information technology, etc.). 54.86% of the teachers taught humanities-based courses, and 45.14% taught science-based courses. Of these, 70.43% taught only one subject, and 29.57% taught two or more subjects. Only a small percentage of teachers did not participate in PBL training, but most of them never received PBL training.

This study involved interviewing ten elementary school teachers. The chosen teachers all filled out the survey prior to being interviewed. A few of them refrained from attempting PBL in their classroom. A few of them made multiple attempts. The instructor employed the PBL approach on numerous occasions in her lesson. The chosen teachers encompassed individuals of varying levels of achievement in project-based learning. Descriptive information of the participants interviewed is shown in Table 2. Among them, there were two male teachers and eight female teachers. Their teaching experience ranged from 1 to 18 years. Four of them were from public schools and six of them were from private schools. One teacher had a master’s degree and the others had bachelor’s degrees. Four of the ten teachers ever participated in training on PBL teaching. The selected teachers represented varying levels of achievement in PBL teaching.

**Instruments.** The questionnaire consists of three parts. The first section contains demographic information of the participants, including gender, educational level, years of teaching, school type, subjects taught, and times of PBL training they participated in. The second section measures teachers’ attitudes towards PBL. The DAS designed by van Aalderen-Smeets et al. (2012) was adapted and modified for the purpose of this study through the following steps. Firstly, the language was translated into Chinese to enable better understanding by Chinese elementary school teachers. Secondly, the items were modified to be relevant to the research

questions, and irrelevant items were deleted. Finally, 20 items are involved, including three dimensions: cognitive beliefs of PBL, affective states of PBL, and perceived control cognitive of PBL. In the dimension of cognitive beliefs of PBL, teachers reported their perceived relevance to PBL and perceived difficulties in teaching using PBL. Teachers expressed their views on the importance of PBL in terms of cognitive beliefs, as well as any issues they encountered while teaching it. The affective states of teachers’ enjoyment and anxiety were measured in the dimension of PBL. A Likert scale of 5 points, from “strongly agree” to “strongly disagree”, was established to solicit feedback from teachers regarding their views on PBL. For example, “I enjoy teaching using PBL” and “I feel tense while teaching using PBL”. The total scale had a Cronbach’s alpha coefficient of 0.919. The present study yielded satisfactory internal reliabilities: (a) cognitive beliefs of PBL,  $\alpha = 0.734$ , (b) affective states of PBL,  $\alpha = 0.825$ , (c) perceived control cognitive of PBL,  $\alpha = 0.910$ . The reliability of these subscales was satisfactory. The KMO value of 0.866 in the validity test is higher than 0.600, thus satisfying the criteria of construct validity. Bartlett’s Test of Sphericity has a significance of 0.000, which is much  $< 0.005$ . The construct validity was up to standard. Potential elements that could shape teachers’ perspectives on PBL are explored in the third section, which was adapted and modified from a previous study conducted by Thibaut et al. (2018). It includes three dimensions: social support, resources, and availability of time. The reliability of this scale was deemed acceptable, as indicated by Cronbach  $\alpha$  values of 0.954 and 0.718 for each dimension (Cronbach  $\alpha = 0.925, 0.909, \text{ and } 0.718$ , respectively).

The online unstructured interviews were conducted based on the theoretical framework and findings from the quantitative data. The participants were made aware of the voluntary nature of the study and had the option to decline or discontinue their involvement at any point. Before asking questions, they were introduced to the concept, method, and some cases of PBL, to ensure that all the interviewees understood and knew what actually PBL is. During the interviews, we used notes and audio recordings to record answers and developed further questions to gain insight into participants’ perceptions of the factors that could help them use PBL in teaching (i.e. How did you learn to use PBL in teaching? Do you think that teaching time has an impact on your teaching using PBL? What other factors do you think to influence your use of PBL in teaching?).

**Data analysis.** The quantitative data was processed and analyzed using an online data analysis platform SPSSPRO (<https://www.spsspro.com>). Independent *T*-tests and ANOVAs were employed to compare the attitudes of the different groups towards PBL. A hierarchical multiple regression model was used to predict the value of factors on teachers’ attitudes towards PBL. Bronfenbrenner’s model served as the foundation for this analysis (Dao-

**Table 1 Demographic information of the participants in the questionnaire.**

Personal characteristics	N	%	
Gender	Female	178	69.26
	Male	79	30.74
Educational level	Master degree and above	46	17.90
	Bachelor degree	178	69.26
	Below bachelor degree	33	12.84
Years of teaching	0-5	169	65.76
	6-10	24	9.34
	11-15	24	9.34
	16-20	20	7.78
	20 and above	20	7.78
School type	Public	194	75.49
	Private	63	24.51
Subject taught	Humanities-based	141	54.86
	Science-based	116	45.14
Number of subjects taught	One	181	70.43
	More than one	76	29.57
Training	0 time	48	19.67
	1-2 times	111	43.19
	3-5 times	67	26.07
	5 times and above	30	11.67

**Table 2 Descriptive information of interview participants.**

Participant	Gender	Years of teaching	Subjects taught	School type	Educational level	PBL Training
A	Male	18	Humanities-based	Private	Bachelor	Training
B	Female	10	Science-based	Private	Bachelor	No
C	Female	8	Science-based	Public	Bachelor	No
D	Female	3	Humanities-based	Private	Master	No
E	Female	9	Humanities-based	Public	Bachelor	Training
F	Female	5	Humanities-based	Public	Bachelor	Training
G	Female	1	Humanities-based	Private	Bachelor	No
H	Female	6	Science-based	Public	Bachelor	Training
I	Male	3	Science-based	Private	Bachelor	No
J	Female	1	Humanities-based	Private	Bachelor	No

de, 2000; Fiebig, 2007). All demographic predictors were included in the first model as control variables. In the second model, all the other factors were included. The first model incorporated all demographic predictors as control variables. The second model encompassed all the remaining factors. We employed a mixture of notes and audio recordings to collect qualitative data and then utilized mind maps to organize the obtained information. In order to gain a better comprehension, the information gathered was repeatedly heard and perused. A single author conducted the initial phase of analysis, which entailed repeatedly listening to the audio recordings and reading written responses in order to fully immerse oneself in the data. This author was asked to create mental maps to organize the information. Subsequently, another writer verified the mental maps by listening to the audio recordings and perusing the written replies. A third author was invited to discuss different points of view. The quantitative data was then grouped into themes through a collaborative process involving three authors. After analyzing the numerical information, a collective decision was reached on the most effective way to depict the data.

**Findings**

**What are the attitudes of elementary school teachers towards PBL in China?** Table 3 summarizes differences between groups in terms of elementary school teachers’ attitudes towards PBL in China. There were significant differences in attitudes towards PBL between elementary school teachers with different educational levels ( $F = 17.524, p = 0.000$ ) and years of teaching ( $F = 11.383, p = 0.000$ ). In addition, the teachers who taught different subjects had different overall attitude scores ( $t = -1.988, p = 0.048$ ). Teachers who taught science-based courses held more positive attitudes than those who taught humanities-based courses. However, there were no significant differences between male and female teachers concerning their overall attitude scores ( $t = -1.287, p = 0.199$ ). The same pattern was seen in the amount of subjects taught ( $t = -2.064, p = 0.405$ ) and school type ( $t = 0.266, p = 0.790$ ).

**What factors influence elementary school teachers’ attitudes toward PBL?** Table 4 shows hierarchical multiple regression

results of factors that influence elementary school teachers’ attitudes toward PBL. The results from the first step of the regression model indicated that the demographic predictors “educational level” and “years of teaching experience” together accounted for 13.0% of the variance in the outcome variable. The regression model’s second step yielded results indicating that the variables’ interactive impact contributed to 62.8% of the variance in the outcome variable. Subject taught ( $\beta = -0.090$ ), training ( $\beta = 0.208$ ), social support ( $\beta = 0.404$ ), resources ( $\beta = 0.157$ ), and availability of time ( $\beta = 0.195$ ) had a significant effect on the model. This generally implied that teachers with more PBL training and more access to social support as well as resources were most likely to have positive attitudes towards PBL. Moreover, teachers who had more teaching hours would have lower anxiety when teaching with PBL.

**What is needed to help teachers teach using PBL?** When participants interviewed were asked what was needed to teach using PBL effectively, there were four recurring themes from their answers: training and professional development, cooperation with other teachers, and a clear vision of the management board about PBL, technical material, and sufficient teaching hours. The mind map of the findings of the interview is presented in Fig. 3.

*Training and professional development.* Ten interviewees all highlighted the importance of training in using PBL in teaching. Four out of the 10 participants (Participants A, E, F, and H) ever participated in PBL training and they agreed that the training was very beneficial. Training could provide teachers with guidance on both theoretical and practical aspects. Conversely, if teachers lacked access to training, they would face many difficulties in conducting PBL. For example, participant D, a 30-year-old female English teacher, said:

As far as I know, teaching using PBL is based on an interdisciplinary concept. I have seen some teachers using PBL in English class, and they all integrated English with art. However, I never participated in training on PBL. I don’t know how to integrate art into my English class, either.

In addition, four out of the 10 participants (participants D, E, H, and I) emphasized that they needed to continuously improve their teaching through different forms of learning, such as seminars, reports by experts, and professional development. They argued that although training could help teachers to use PBL better, it is difficult for them to fully master PBL just through training. Teaching with PBL is a dynamic process and teachers must constantly be learning to implement it effectively. Hence elementary teachers need more opportunities to improve themselves. Participant H, a science teacher from a public elementary school, stated that:

Initially, I didn’t know much about PBL. After participating trainings on PBL several times, I gradually learned about this teaching method. Despite this, there are still many problems that I cannot solve when using PBL in my science class. I think that just participating in training is not enough. I need opportunities to learn more about PBL and become proficient in this teaching method.

*Cooperation with other teachers and a clear vision of the management board about PBL.* Seven participants (Participants A, D, E, F, G, H, I, and J) suggested that the use of PBL required cooperation with other teachers. They felt that communication and collaboration among teachers not only broadened their

**Table 3 Differences between groups in terms of attitudes towards PBL.**

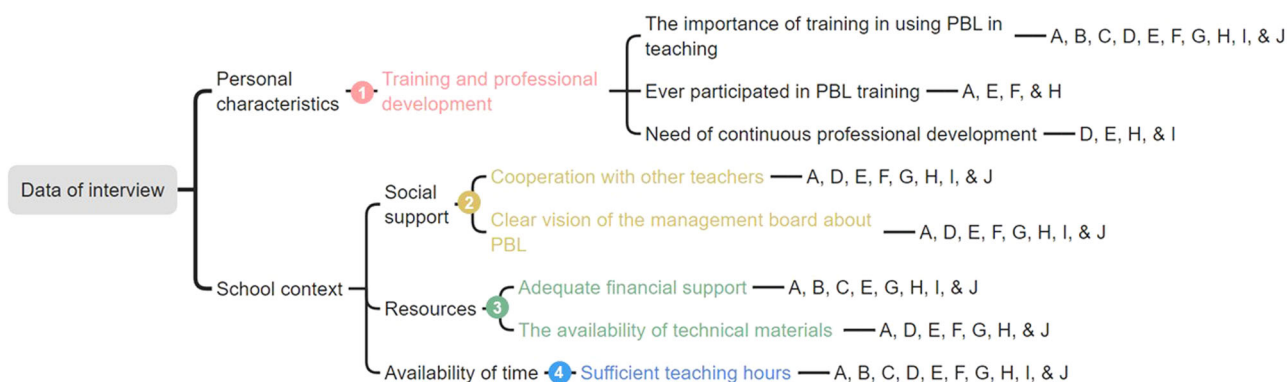
Variable		M	SD	t/F	p
Gender	Female	3.37	0.50	-1.287	0.199
	Male	3.47	0.66		
Educational Level	Master’s degree and above	3.52	0.53	17.524	0.000**
	Bachelor degree	3.47	0.51		
	Below bachelor degree	2.90	0.59		
Years of Teaching	0-5	3.51	0.51	11.383	0.000**
	6-10	3.60	0.54		
	11-15	3.18	0.44		
	16-20	3.02	0.59		
	20 and above	2.90	0.52		
Subject taught	Humanities-based	3.34	0.50	-1.988	0.048*
	Science	3.48	0.60		
Number of subjects taught	One	3.38	0.58	-2.064	0.405
	More than one	3.45	0.48		
School type	Public	3.41	0.56	0.266	0.790
	Private	3.39	0.53		

\* $p < 0.05$ , \*\* $p < 0.01$ .

**Table 4 Hierarchical multiple regression results of factors that influence teachers' attitudes towards PBL.**

Variable	Model 1			Model 2		
	B	$\beta$	p	B	$\beta$	p
(Constant)	2.691**	-	0.000	1.148**	-	0.000
Gender	0.092	0.077	0.209	0.066	0.055	0.182
Educational Level	0.233**	0.233	0.000	0.021	0.021	0.626
Years of Teaching	-0.075**	-0.181	0.004	0.014	0.034	0.436
Subject taught	0.112	0.101	0.099	0.100*	0.090	0.028
Number of subjects taught	0.064	0.053	0.376	-0.052	-0.043	0.288
School type	0.004	0.003	0.964	0.061	0.048	0.233
Training				0.126**	0.208	0.000
Social support				0.276**	0.404	0.000
Resources				0.088**	0.157	0.010
Availability of time				0.106**	0.195	0.000
R <sup>2</sup>	0.130			0.628		
F	6.242**			41.512**		
$\Delta R^2$	0.130			0.498		
$\Delta F$	6.242**			82.244**		

\*p < 0.05, \*\*p < 0.01.



**Fig. 3** The figure presents the mind map of findings of interview.

knowledge but also provided a cheerful environment. On the contrary, it was pretty hard to use PBL without close cooperation among teachers. Participant A, a Chinese teacher with 18 years of teaching experience, expressed his thoughts on this issue by saying:

In my school, teachers do not collaborate closely. This seriously affects my motivation to use PBL in my class. In my opinion, PBL is often associated with the concept of interdisciplinarity. It would be difficult for a teacher to apply PBL without other teachers' help.

A clear vision of the management board about PBL is of great importance as well. Eight interviewees (Participants A, D, E, F, G, H, I, and J) highlighted that only when managers present a clear vision and positive attitude towards PBL, will teachers feel confident enough to use PBL well in their teaching. Of course, administrators also need to provide practical support, such as opportunities for teachers to participate in training and collaborate with other teachers. Participant E, a Chinese teacher, expressed her thoughts:

The attitude of the administrators has a significant impact on the attitude of the teachers. It is only with the support of the management board that teachers can actively implement them. Without the support and organization of administrators, teachers are generally busy with their own things but rarely have chances to communicate with each

other. When administrators explicitly assigned teaching tasks about PBL, teachers would try to work collaboratively to accomplish this task.

*Technical material and budget.* Seven interviewees (Participants A, D, E, F, G, H, and J) pointed out that technical material was essential in teaching using PBL. The availability of technical materials will make the use of PBL less difficult and less stressful for teachers. However, all the teachers indicated that current technology materials are not sufficient at all. Participant A, a Chinese teacher, complained:

The use of PBL has been promoted in my school for several years. But we don't have access to various technical materials. Actually, I ever worked with other teachers to develop some materials on PBL. After all, PBL usually integrates many subjects and we often feel confused during the development process of PBL technical materials.

Participants A, B, C, E, G, H, I, and J referred to the budget issue. Students often need to develop a product to solve a real-world problem in the course. Money is required in order to buy the raw materials to make the products. Adequate financial support is necessary to advance the PBL method in teaching. However, the fact is that schools hardly give teachers financial support, leading to various problems and challenges in the

development of PBL. For example, participant E said the following:

Although my school is very supportive of using PBL in teaching, it does not provide financial support. Teaching using PBL usually needs to provide learning materials to students. Sometimes I prepare the learning materials for my students and sometimes I ask parents to buy these learning materials. Nonetheless, it is not a long-term solution.

*Sufficient teaching hours.* Ten participants interviewed all highlighted that insufficient teaching time is the biggest problem in successfully teaching using PBL. Teachers are required to complete their teaching tasks by the end of the term following the National Curriculum standards. The use of PBL often takes up too much class time, compared to the use of conventional teaching methods. This makes it impossible to complete teaching tasks on schedule. Participant F, an English teacher with 5 years of teaching experience, gave the following example:

I ever used PBL in my English classes. A project takes at least a week to complete. If PBL was used in the class, it would take up too much class time. In this way, I cannot complete my teaching tasks.

Participant H, a science teacher, also stressed the importance of sufficient teaching hours. She hoped teachers would be provided with extra teaching time to carry out PBL. She put it this way:

PBL encourages students to solve real-world problems and develop real-world products. Obviously, this cannot be done in one or two lessons. Allowing students sufficient time to think and produce is key to completing the project. If the teaching time is insufficient, students may not be able to solve the real-world problem in the project.

## Discussion

The main goal of this study was to investigate the attitudes of Chinese elementary school teachers toward PBL and find factors that impact their attitudes. For this purpose, we used a mixed method. A questionnaire was employed to collect quantitative data to understand the attitudes of Chinese elementary school teachers toward PBL and the factors that influence their attitudes. Qualitative data were collected from interviews to understand teachers' views on what was needed to help teachers teach using the PBL. The research questions of the current study have led to the discussion of the results of this study in the following sections.

**What are the attitudes of elementary school teachers towards PBL in China?** Research question one investigated teachers' attitudes towards PBL in different contexts. Results showed that Chinese elementary school teachers had a fairly positive attitude towards PBL and their attitudes differed based on educational level, years of teaching, and subject taught. However, there were no significant differences between gender, school type, or number of subjects taught.

The more educated the teacher, the more positive the attitude towards PBL. Teachers with master's degrees are more confident in using PBL and are more comfortable using it to teach. They have received adequate training in research during their graduate studies and their high educational level has enabled them to work in elementary schools with better conditions. These all led to a more positive attitude towards PBL. Teachers below a bachelor's degree presented a negative attitude towards PBL. Only a small percentage of elementary school teachers in China do not have a bachelor's degree and most of them teach in rural elementary

schools (Xiao et al., 2022). These teachers generally do not have strong teaching skills and have few opportunities to participate in training and professional development (Tang, 2020). In addition, they usually work in extremely tough conditions with a heavy workload, lack of resources, and disproportionate compensation (Tang, 2020). From the findings of this study (Table 4), both training and resources influence elementary school teachers' attitudes toward PBL. Therefore, teachers who do not have a bachelor's degree hold a negative attitude toward PBL.

As for years of teaching, teachers who had been teaching for 6–10 years had the most favorable outlook on PBL. When teachers had been teaching for over two decades, they had a pessimistic view of PBL. It is unsurprising that self-efficacy has risen during the initial years of teaching and dropped later in a teacher's career, as evidenced by prior studies on the effect of teaching experience on teachers' self-efficacy (Klassen and Chiu, 2010). Day and Sachs (2004) and Huberman (1989) pointed out that teachers close to the conclusion of their careers have already gone through a lot of educational modifications and may be reluctant to embrace new developments. In order to implement PBL, teachers need to make substantial pedagogical changes. All elementary school teachers, whether novice or skilled, are novice teachers when it comes to using PBL in teaching. This makes it likely that attempts to use PBL in teaching practice might fail, leading to embarrassing results in class (Martin and Hand, 2009). Seasoned teachers have honed their pedagogical practices and are less likely to return to being inexperienced teachers. As a result, teachers with extensive experience are more reluctant to use this teaching method.

Teachers who teach science-based subjects have more positive attitudes than those who teach humanities-based subjects. Teachers who teach science-based subjects, such as science teachers, often employ cooperative learning and conduct experiments in their classes (Raviv et al., 2019). Meanwhile, science-based courses usually lead students to solve problems in real-life situations. For example, to enhance students' interest in and understanding of mathematics, teachers often encourage students to relate mathematics to their experiences in the real world (Quintero, 2004), raise questions, and solve mathematical problems through group discussion (Bevan and Capraro, 2021). Nevertheless, teachers who teach humanities-based subjects lack experience in collaborative learning and solving real-world problems in their class and therefore show a lower level of attitude towards PBL. Contrary to our predictions, the number of subjects taught had no relationship to teachers' attitudes towards PBL. We initially thought that teachers who taught more than two subjects would have a more positive attitude, as teaching using PBL required a combination of knowledge and methods from different subjects. In fact, we found in the interviews that although some teachers taught two subjects, they tended to focus on one of the subjects and the other one was almost ignored. Thus, their attitudes did not differ from teachers who taught only one course in attitude.

**What factors influence elementary school teachers' attitudes toward PBL?** The second objective of this study was to identify factors that may influence elementary school teachers' attitudes toward PBL. The results of regression analysis found that training, social support, resources, and availability of time all positively influenced teachers' attitudes towards PBL. PBL training opportunities, strong social support, abundant resources, and sufficient classroom time significantly reduce the level of anxiety and difficulty for elementary school teachers teaching using PBL. This discovery is consistent with the outcomes of prior research (Appleton and Kindt, 1999; Diaz Lantada and De Maria, 2019; S.-



f. Lam et al., 2010; Nadelson and Seifert, 2013). For example, a study conducted by S.-f. Lam et al. (2010) revealed that when teachers perceived a greater level of support for their teachers' competence and autonomy, they displayed an increased motivation toward PBL and a heightened willingness to continue implementing this educational innovation. Teaching using PBL requires more time and effort to prepare and teach than traditional teaching methods. Appleton and Kindt (1999) found that if there was not enough time, teachers would lack confidence and were less likely to put in the extra effort.

**What is needed to help teachers teach using PBL?** We found that the need for PBL training and professional development, collaboration, and management board support, technical materials and budget, and sufficient teaching hours featured the most qualitative data. Elementary school teachers in China believed that the main barriers to effectively implementing PBL were lack of training, collaboration, resources, and time. This is in accordance with the previous studies that suggested the importance of these factors in educational innovation (Farrow et al., 2022; van Aalderen-Smeets and Walma van der Molen, 2015). For example, Margot and Kettler (2019) explained the importance of cooperation, which not only created an atmosphere that enhanced lesson preparation but also set an example of teamwork for the students. Another study proposed that professional development could assist teachers in surpassing the mere integration of projects and truly transform their teaching to be disciplinarily rich, authentic, iterative, and collaborative (Farrow et al., 2022).

### Limitations

We acknowledge that there are several limitations to our study. Most elementary school teachers who participated in the questionnaire had 0–5 years of teaching experience, while the number of teachers with other years of teaching experience was smaller. In future studies, the sample size of teachers with long years of teaching experience should be enlarged to make the findings more accurate. Another limitation concerns the factors that explain differences in teachers' attitudes toward teaching. Research has shown that personal characteristics and school context are essential factors that influence teachers' attitudes. However, other factors have also been found to impact their attitudes. For example, students' lack of learning motivation can reduce teachers' teaching enthusiasm (Kelani and Gado, 2018). More factors could be taken into consideration in future studies to provide a more comprehensive explanation of variability in teachers' attitudes. Finally, no inter-rater reliability coefficient was determined when analyzing the qualitative data. Subsequent research will utilize inter-rater reliability coefficient to guarantee the trustworthiness and dependability of the qualitative data analysis.

### Data availability

The data generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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### Author contributions

Saiqi Tian is the PI on the project, leading design, data collection, analysis, and writing; Zhiling Cai was a major contributor to theoretical developments, data collection, and analysis; Jinxing Zhu contributed to interview data collection and analysis. Yu Yu analyzed some data and modified the manuscript. All authors read and approved the final manuscript.

### Competing interests

The authors declare no competing interests.

### Ethical approval

The relevant body of our institution concluded that ethical approval was not necessary since the study did not fall under the category of medical research or human experimentation as outlined in the Declaration of Helsinki. The ethical guidelines set forth by the Human Subjects Ethics Committee of Wenzhou University were adhered to throughout all procedures, including the collection and anonymization of data for this non-interventional study. The survey and interviews encompassed a preamble elucidating the gathering of data for a research endeavor, delineating its composition and objectives (objectives, the advantages that the information will yield, the voluntary nature of involvement, the anonymous handling of the data, and adherence to the Data Protection Act).

### Informed consent

Before taking part in the study, all participants were made aware of the details and agreed to take part. Participants in this study chose to take part of their own volition. Prior to the commencement of the survey, we informed the participants of the study's objective. The participants agreed to take part in this study of their own accord, having been given the assurance of anonymity by the researchers and that their answers were solely for educational

purposes. The interviewee was aware of the confidentiality and privacy regulations prior to consenting to the interview. They agreed to take part in the study of their own accord and that by responding to the interview, they were giving their approval.

### Additional information

**Correspondence** and requests for materials should be addressed to Saiqi Tian.

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