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ICT-Assisted Support System for Teacher's Problem Solving

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Part I Introduction

"Teachers must be prepared to handle unanticipated situations, to adapt current knowledge to deal with new problems, to learn radically new things in short, to deal constructively with change." (Silverman & Welty, 1990: 95)

1.1 Research background

In practice, teachers may have to confront various problems relating to learners, curriculum, learning environment, parents, public opinions, school management, colleagues, and themselves.

Though difficult, teacher's problem solving is very important because the problems are relating to teacher outcomes and curriculum outcomes (Silins, 1994), teacher education programs (Veenman, 1984: 143; Moussaid & Zerhouni, 2017: 136), teacher support and effective teaching (Gandara, Maxwell-Jolly & Driscoll, 2005: 2), and professional development (Noom-ura, 2013: 139).

Some researchers have investigated the problems encountered by teachers, ranked them by frequency, and examined the problems from the perspective of teacher development, cognitive development, or socialization (e.g. Veenman, 1984; Gandara, Maxwell-Jolly & Driscoll, 2005; Votava, 2006; Noom-ura, 2013; Moussaid & Zerhouni, 2017). The reported problems were found to be similar across countries, over time, between experienced and novice teachers, and by strong or weak research designs (McDonald & Elias, 1983, p. 4; Veenman, 1984, p. 156; Moussaid & Zerhouni, 2017, p. 150).

However, while focusing on the similarities between the reported problems, existing researches may have ignored the differences between them. In fact, the frequency of report is more likely to lead to the problems originating from the nature of the teaching profession, and the demographic, economic or educational (including teacher education) situation of a locality and its schools, but the problems that are

important (rather than frequent) to individual teacher's effectiveness, learning and development have not been pinned down. And it remains unknown how teachers select problems as their targets; which problems are important to them; and why these problems are important.

Based on the research findings of mathematical, cognitive and social problem solving (MPS, CPS, SPS), many researchers stressed the role of cognition in problem solving. They adopted competence-based approaches, which were often rooted in a deficit model of teacher learning (Korthagen, 2017, p. 396), and focused on the assessment (Heppner & Peterson, 1982; Sahin et al., 1993; D'Zurilla et al., 2002; Eskin & Aycan, 2009; Greiff et al., 2017) and training (Sunal, et al., 1989; Yerushalmi & Elyon, 2013; Pannells, 2010) of teacher's problem-solving skills in order to improve their problem-solving competencies or abilities. Teacher's problem-solving skills were often found to be low, but the inventories used in the researches were designed to evaluate teacher's perceptions of their own problem-solving beliefs and their general problem-solving skills (Heppner, Witty & Dixon, 2004, as cited in Yavuz, Arslan & Gulten, 2010; Turgut & Ocak, 2017; Heppner & Peterson, 1982) rather than the actual skills they used while solving different kinds of specific problems. Therefore, the domain-specific knowledges, skills and strategies that teachers actually use for the solving of different types of problems remain unknown.

There are others who believe that the lack of support for teachers is another reason that makes teacher's problem solving difficult. And the lack of prep time, school equipment, guidance, tools and materials, policy support, etc. was reported by participant teachers in earlier researches (Veenman, 1984; Gandara, Maxwell-Jolly & Driscoll, 2005; Votava, 2006; Noom-ura, 2013; Moussaid & Zerhouni, 2017).

Different approaches have been developed to support teacher's problem solving (Gurra, et al., 2009; Blum & Valli, 1988; Gregory, 2010; Dunaley, 2010; Kocyigit & Zembat, 2013; Kinay & Bacecik, 2016; Heitzmann, 2008; Kale & Whitehouse, 2012; Hsu, 2004; Hou, Sung & Chang, 2008; Hew & Knapczyk, 2007; Girod, 2009; Gu, 2010). However, all of these approaches had limitations (Guerra et al., 2009; Blum &

Valli, 1988; Toll, 2017; Hou, Chang & Sung, 2008; Hew & Knapczyk, 2007). And, it remains unknown how teachers seek supports for overcoming the difficulties encountered during the problem-solving process.

To conclude, it seems that existing researches on teacher's problem solving are still inadequate because these questions remain to be answered.

1.2 Objectives and research questions

Thus, the two main objectives of this research are:

- to explore teacher's problem solving
- to explore teacher's support-seeking for their problem solving

The research questions are:

- How do teachers define real-life situations as their problems?
- How do teachers solve problems?
- How do teachers seek support when they encounter difficulties in the process of problem-solving?

1.3 Terminology

Teacher's Problem Solving (TPS) refers to teacher's attempts to improve a situation considered by the teacher as dissatisfied or harmful and as related to his/her teacher identity and needing to be dealt with by him/herself.

ICT-assisted Support System for Teacher's Problem Solving refers to teacher's systematic organization of resources with ICT as an optional tool to acquire, adapt, produce, store, exchange and organize resources for the purpose of overcoming the difficulties encountered during the process of problem-solving.

English Language Teaching (ELT) refers to teaching English to students whose first language is not English in mainland China where English is not the dominant language and natural English language immersion situations tend to be rare.

English as a Foreign Language (EFL) is the term used to describe the study of English by non-native speakers in countries where English is not the dominant language.

Part II Literature review

This part reviewed the literature about the problems perceived by teachers, teacher's problem solving, and support for teacher's problem solving, and introduced the rationale and the social-cultural background of this research.

2.1 Review of literature

Under the influence of MPS, CPS and SPS, there were research interests in problem solving in the teaching profession.

2.1.1 The problems perceived by teachers (omitted)

2.1.2 Teacher's problem solving (omitted)

2.1.3. Support for teacher's problem solving (omitted)

2.1.4 Summary

Existing researches have contributed to the current understanding of teacher's problem solving. However, there are some deficiencies.

Problem is often unclearly defined in earlier studies (Veenman, 1984). Most definitions of problem and problem solving start from mathematics (Verderber, Szivak & Vamos, 2016) and are often used in teacher's problem solving without examining the differences between them. In fact, the problems under discussion are different in these problem-solving models (Table 2.3). They arise in different contexts; solving these problems require different knowledges, skills and strategies; the problem-solving process may be influenced by different factors or the factors may affect the process in different ways; and the problem-solving evaluation may be made by different standards. For Example, though both SPS and TPS deal with interpersonal problems, interpersonal problem solving in SPS aims to identify a resolution that is acceptable or satisfactory

to all parties involved (Chang, D'zurilla & Sanna, 2004), but the teacher-student relationship is characterized by a subordinate structure that develops towards a way benefiting the teachers who are in a dominant status, although the teacher-student relationship should be equivalent and is not always antagonistic (Shao & Hu, 2018). Thus, interpersonal problems between teacher and student can be based on equivalent, antagonistic, or subordinate teacher-student relationship and a teacher may not aim to discover a solution that is satisfactory to both parties. Anyway, it is believed that the problems encountered by teachers are different from those discussed in earlier models and that's why a new working definition that stresses the role of teacher as problem definer is provided in this research.

Table 2.3 Examples of problems in different problem-solving models

Types	Example(s)
Mathematical problems	In a room with ten people, everyone shakes hands with everybody else exactly once. How many handshakes are there? (Avcu & Avcu, 2010)
Cognitive problems	choosing a best route for transportation between two bus stops; to find out how the buttons of a MP3 player works (OECD, 2014)
Everyday problems	missing a train to work, an acute illness, repeated unreasonable demands from a boss, repeated violations of curfew by an adolescent, continuous pain, boredom, feelings of loneliness, and interpersonal problems (D'Zurilla, Nezu, & Maydeu-Olivares, 2004)
Teacher's problems	lack of subject matter knowledge, unmotivated students, lack of teaching materials, lack of school equipment, heavy workload, poor relations with parents (Veenman, 1984)

While earlier studies often used questionnaires for investigation and focused on the similarities between teacher's reports, the reported problems were not described in detail and the differences between them were often ignored, which may lead to an inaccurate understanding of teacher's problems and it is possible that teacher's problems are not so definable and distinguishable as earlier studies suggested.

In addition, the frequency of report is more likely to lead to the problems that are regular rather than important to individual teachers. While teacher's importance ratings may be given to the "not-really-experienced" problems, the experienced problems may

not hamper a teacher's functioning. Anyway, it is necessary to find out which problems are important to teachers; why are the problems important; and how teachers define situations as their problems.

The existing models of MPS, CPS and SPS may not be completely applicable to TPS, especially in explaining the role of non-cognitive factors and domain-specific strategies. Though the general cognitive process may be similar between them, the actual process of teacher's problem solving was rarely reported in earlier studies, and the complexity, dynamicity and interactivity of teacher's problem solving are hardly explored.

Many factors in MPS, CPS and SPS were pinned down, but fewer factors in TPS were reported, suggesting that the key factors in TPS have not been identified. In addition, it is important to understand how the factors operate and interact to influence TPS.

Though the general problem-solving skills (i.e. defining a problem, searching for solutions, choosing a solution, implementing the solution, evaluating the results) for MPS, CPS, SPS and TPS may be similar, domain-specific knowledges, skills and strategies are also required for problem solving. These knowledges, skills and strategies constitute the expertise that are critical to the success of TPS, which distinguishes TPS from MPS, CPS and SPS. But earlier studies often used questionnaires or online tests that focused on cognitive (e.g. brainstorming, analogy, step-by-step analysis, combining, visualization) and meta-cognitive skills for the solving of general or simulated authentic tasks, and teachers were unable to report the domain-specific knowledges, skills and strategies they actually used to solve different types of real-life problems.

Many approaches supporting TPS have been developed and tested, but the existing researches often focused on the development of approaches and ignored teacher's initiatives, needs and choices in seeking supports. It is also necessary to focus on the differences of teacher's support-seeking between problems, individuals and contexts. While it is possible to use ICT to provide effective support for TPS, teacher's everyday

use of ICT for supporting their problem solving often remains unexplored.

Literature review reveals that existing researches on TPS are greatly influenced by the researches on MPS, CPS and SPS, but the differences between them are often ignored. In earlier studies, problem solving was often understood as a skill that can be learned and improved by the understanding, use and practice of sequenced steps: identifying the problem; brainstorming a variety of solutions; choosing one solution and trying it out; evaluating what has happened (Britz, 1993); the focus is often on the assessment and training of teacher's problem-solving skills; and the lack of problem-solving skills was often considered to be a deficit or dysfunction. However, teachers may have different understandings about problem solving (Stecher & Mitchell, 1995) and may not understand it as a skill. For instance, they may consider a challenge to be a problem-solving opportunity rather than a problem (Gleockler & Cassell, 2012) or they may not conceive interpersonal problems as "problems" with an initial and a goal state, and a need for certain steps or strategies to be applied to reaching a solution, but as a specific category of ill-defined problems, which are subjected to a decision-making process rather than to the application of specific technical strategies (Guss & Wiley, 2007, as cited in Metallidou, 2009). Problem solving can be learned and improved by the understanding, use and practice of not only the sequenced steps but also the domain-specific knowledges, skills and strategies, and besides general cognitive skills, finding solutions may also require other skills such as social skills and ICT skills. While focusing on the general problem-solving skills, earlier studies often ignored teacher's goals, needs, efforts and choices.

The research on TPS seems to be inadequate. There is not a term referring to the problems encountered by teachers that can be widely accepted. In this research, "teacher's problems" is used to refer to the group of problems encountered by teachers, believed by them to be related to their teacher identity, and chosen by them as their problem-solving targets because other terms seem to be unsuitable for this research. For instance, the term "perceived problems of teachers" cannot distinguish really experienced problems from teacher's complaints; and "teaching problems" or

"pedagogical problems" exclude many problems that are not directly related to teaching but are important to teachers and their functioning. Besides, there has been a lack of literature on pedagogical (Verderber, Szivak & Vamos, 2016) and mathematical problem solving (Chapman, 1997; Thompson, 1985; Xenofontos, 2007, as cited in Evans, 2012) from teacher's perspective. There are often just some specific problem-areas (such as problematic students, discipline problems, material or socio-economic difficulties) of educational reality discussed without a systematic view (Votava, 2006). But a systematic view is needed because the problems encountered by teachers may be interconnected and may interact with each other.

To conclude, some important questions about TPS are unanswered and this research will focus on the following questions:

1). How do teachers define situations as their problems?

2). What strategies are used by teachers to solve the problems encountered by them?

3). How do teachers seek support for overcoming their problem-solving difficulties?

2.2 Rationale of the research

Based on these literatures, the rationale of this research is established as:

- **Teacher-centeredness**: this research will focus on teachers because they take the central role of problem definer, problem solver and support seeker in the process of problem solving;
- **Problem-orientation**: this research will focus on specific problems because the problems can reveal the real relationship between individual teachers and the specific situations encountered by them;
- **Strategy-implementation**: this research will focus on the real strategies used by teachers for problem solving because these strategies distinguish TPS from MPS, CPS and SPS;
- **Support-seeking**: this research will focus on teacher's support seeking because it is assumed that they will actively deal with the difficulties encountered in the

process of problem solving rather than just wait for help;

- **ICT-assistance**: this research will focus on teacher's use of ICT as an optional tool to facilitate problem solving because ICT can be used to provide problem-specific, individual-specific, and context-specific support for teacher's problem solving.

In addition, this research will adopt a holistic view because it is assumed that there are interconnections and interactions between teacher's problems that may affect the problem-solving process. This research will also focus on the differences between problems, problem types, individuals and contexts.

This research tries to advocate a shift of focus from the frequency of reported problems (quantitative research perspective) to the personal meaning of problems (qualitative research perspective), from general problem-solving skills (rational perspective) to domain-specific knowledges, skills and strategies (pragmatic perspective), from the development of support approaches (instrumental perspective) to the understanding of teacher's problem-solving goals, difficulties, needs, and choices (humanistic perspective).

2.3 Education, teachers and ELT in China

This research will focus on the problem solving of ELT teachers from the upper secondary schools in China. What follows is an introduction of the education system in China, the general situation of education, teachers and ELT, and some issues related to teachers' problem solving and the support for it.

The current situation of education in China is based on her unique history, culture and tradition; geographical, economic and ethnic diversity; impact of social, economic and technological transformations; and conflicts in the philosophies, theories and perspectives on education. The complexity presents difficult cultural, regional, legal, economical, curricular, interpersonal and moral challenges to Chinese teachers. Meanwhile, it provides an overall context for teacher's problem solving and a background for us to understand it.

However, while MoE, schools, researchers, teacher education colleges, private

education institutions or companies, and the public, etc. are making efforts to improve the situation, how do teachers deal with the challenges is a very important but often ignored question.

Part III Research methodology

This research adopts descriptive method and teacher perspective for research.

3.1 Research design

Based on the objectives of research and the result of literature review, pragmatism, mixed methods approach and corresponding data collection and analysis methods were considered to be effective for answering the research questions.

Research paradigm

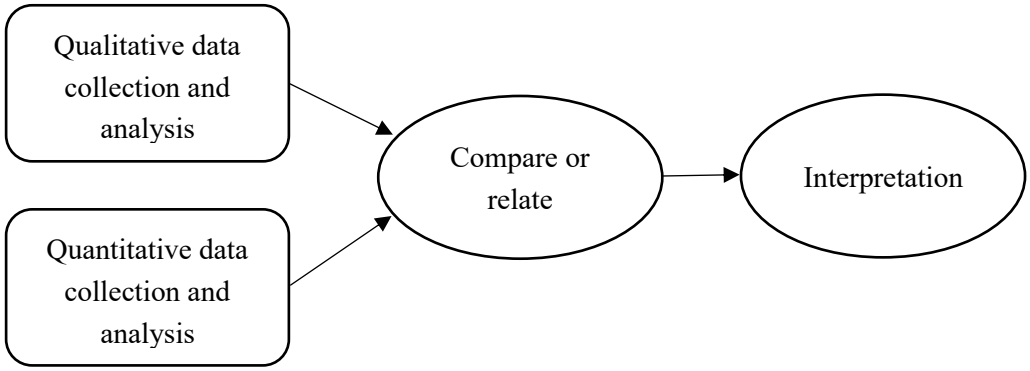
This research adopted pragmatism for several reasons. First, it is believed that there can be different views about the reality of teacher's problem solving. Secondly, this research aims to seek the knowledge of teacher's problem solving according to the contexts in which problem solving occurs. Thirdly, it is believed that mixed research methods can be used to provide multiple perspectives for understanding teacher's problem solving.

Research approaches

In this research, mixed methods was adopted because 1) pragmatism is seen as the paradigm that provides the underlying philosophical framework for mixed methods research (Tashakkori & Teddlie, 2003; Somekh & Lewin, 2005, as cited in Mackenzie & Knipe, 2006); 2) the answer to the research questions should be based on the combination of qualitative and quantitative data, i.e. an integrated explanation of teacher's attitudes, opinions and performances in problem solving.

In this research, convergent parallel mixed methods were adopted so that qualitative and quantitative data can be analyzed separately, and the results can be compared to see if the findings confirm or disconfirm each other (Creswell, 2014). This research highlights the assumption that teachers can have multiple understandings about problem solving, which may vary with many factors such as problem types, and individual and contextual differences, and qualitative and quantitative approach can be combined to present a more complete picture of TPS from teacher's perspective.

Figure 3.1 Convergent parallel mixed methods (Creswell, 2014)



Narrative research was used so that teachers can give a detailed report of their problem-solving process, which contains the information for answering the research questions. Survey research was used to investigate teacher's general attitudes and opinions about problem solving and their support-seeking in a chat group. Then, the results of narrative and survey research were compared and combined with each other and related to participant teachers' background information such as their education and work experiences.

Research methods

In this research, qualitative data was collected by narrative interview, and data analysis methods included narrative analysis and thematic analysis, each corresponding to the contextualization and categorization process (Bickman & Rog, 2009; Chen, 2000). Quantitative data collection methods included face-to-face, single-person, semi-structured interview and record of chat log in a teacher's online community. Data analysis methods included descriptive analysis and text analysis. Then, side-by-side comparison, data transformation and joint display of data were used to merge qualitative and quantitative data.

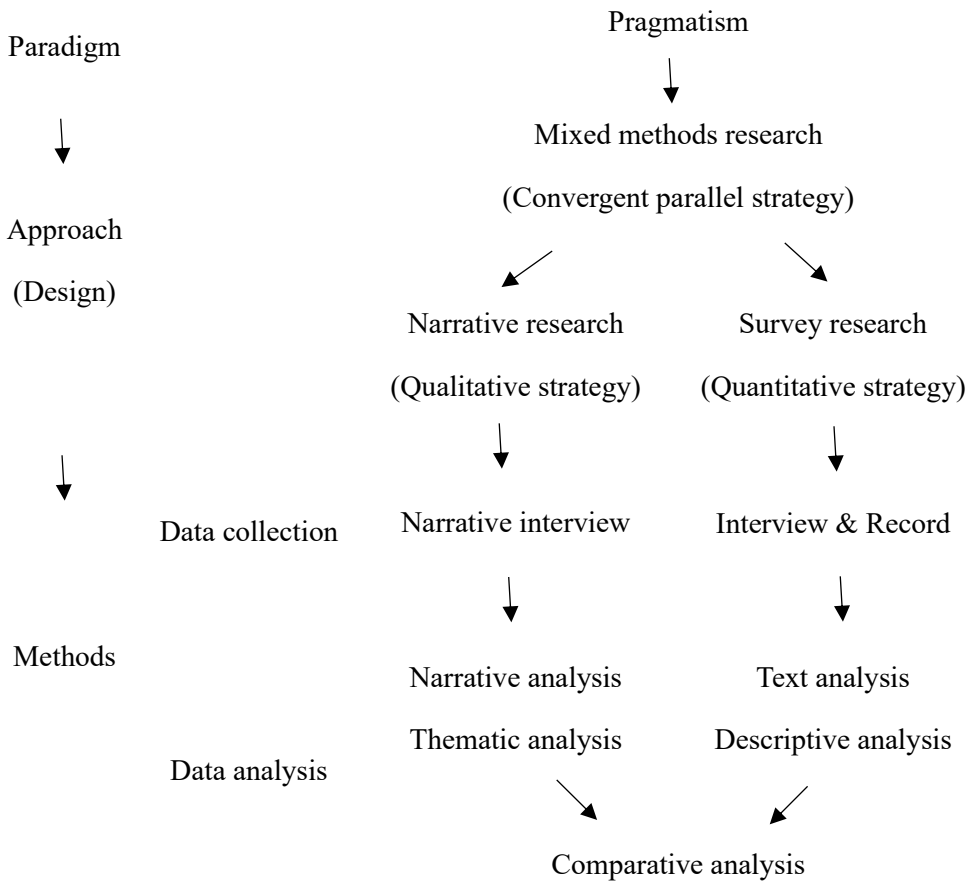
Table 3.3 Research methods used in this research

Research questions	Research design	Data collection methods	Data analysis methods	Merging data
Q1	● Qualitative	● Narrative	● Narrative	● Side-by-side

Q2 Q3	research (Narrative research)	interview	analysis ● Thematic analysis	comparison ● Data transformation ● Joint display of data
	● Quantitative research (Survey research)	● Semi-structured interview ● Record of chat log	● Descriptive analysis ● Text analysis	

To summarize, the research design can be illustrated as follows:

Figure 3.2 The framework of research design



3.2 Research process

The research process (c.f. Mackenzie & Knipe, 2006; Chen, 2012; Creswell, 2014) is as follows:

- determine the area of investigation and the phenomenon of interest
- conduct literature review
- raise research questions
- identify research paradigm and research approach
- determine the scope of investigation
- prepare instruments and tools for data collection and analysis
- identify when, where, who data will come from
- enter the field for ethics approval
- collect qualitative and quantitative data
- process and analyze qualitative and quantitative data
- merge qualitative and quantitative data
- write up findings, discussions and conclusions

Participants

By qualitative research, I investigated ELT teacher's problem solving in the upper secondary schools of Sichuan, China because it would be easier to conduct this research since I have been an ELT teacher working in the province, and the results can be used to help local teachers. I adopted purposeful sampling and selected maximum variation samples to acquire different views on TPS and to compare TPS in different schools.

I selected sample schools by school rankings and local social and economic situations. In this research, the three sample schools belonged to the first, third and fourth rank.

Table 3.4 Background of sample schools

No.	Rank	Number of students	Number of teachers	Number of ELT teachers	Admission Score in 2018
1	First-rank provincial model	3,810	400	50	563
2	Municipal model	2,414	196	24	518
3	Regular	438	59	5	200

I selected participants by gender and experience. And four participants were selected from each sample school, including two males and two females, and two veterans and two novice teachers (Table 3.4).

Table 3.5 Background of participant teachers

No	Name	Gender	Age	Years of teaching	Education	Major	Professional titles	Duties
S11	Frank	M	30	5	bachelor	ELT	Second Rank	1) EFL teacher
S12	Hebe	F	29	5	master	ELT	Second Rank	1) EFL teacher
S13	Gavin	M	56	34	bachelor	ELT	Advanced	1) EFL teacher 2) Class teacher 3) EFL lesson leader 4) Member of municipal ELT team
S14	Sarah	F	46	24	bachelor	ELT	Advanced	1) EFL teacher 2) Excellent class teacher of the city
S21	Donald	M	31	6	master	Linguistics	First Rank	1) EFL teacher 2) Class teacher
S22	Sonia	F	25	1	master	Translation	/	1) EFL teacher 2) Staff of international office
S23	Sean	M	46	22	post-graduate	ELT	Advanced	1) EFL teacher 2) Class teacher
S24	Zandra	F	50	33	bachelor	ELT	Advanced	1) EFL teacher 2) Class teacher 3) Vice dean of students
S31	Simon	M	41	18	bachelor	ELT	First Rank	1) EFL teacher
S32	Zoey	F	27	5	junior college	ELT	/	1) EFL teacher
S33	John	M	54	32	bachelor	ELT	Advanced	1) EFL teacher 2) Head of EFL teaching research group

S34	Yvette	F	36	14	bachelor	ELT	First Rank	1) EFL teacher 2) Class teacher 3) School accountant

*All the names are pseudonyms.

The same participants took part in the narrative interview and semi-structured interview so that the results of the two approaches can be compared.

I selected a QQ chat group for EFL teachers because it was one of the largest of its kind and has been actively used by about 1,200 teachers at the time of data collection from upper secondary schools all over China. I selected the chat log between August 9th and September 9th, 2017 for analysis and comparison to reveal the differences between teacher's use of ICT for support seeking in holidays and workdays.

Instruments

In qualitative research, researcher is the main research instrument. I did four things to prepare myself.

In the process of research, I maintained a dual identity in the field, i.e. the fellow member of ELT profession (insider) and a stranger to participant teachers' life and work (outsider) so that the participants could trust me and tell me what I didn't know.

The second instrument was a self-made outline of interview questions, which combines questions about teacher's specific problem-solving stories and their general attitudes, opinions and performances in problem solving.

The tools used for data processing and analysis included YuJi, QQ Chat Log Analyzer 2.0, and Excel.

Data collection

For qualitative data collection, I found goal keepers through colleagues, friends and acquaintances before entering into the field. The goal keepers helped me to select participants according to the research requirements, get participant's consent and permission, and arrange the time and place for interview.

There were 14-hour-long audio recordings and 137 pages of transcription (Table 3.5).

Table 3.6 The amount of data collected by interview

Participants	Audio recording	Transcription (Chinese)
S11	56m	8p
S12	28m	5p
S13	1h41m	17p
S14	1h3m	11p
S21	57m	12p
S22	1h34m	15p
S23	1h13m	11p
S24	1h59m	24p
S31	37m	5p
S32	55m	9p
S33	51m	6p
S34	1h50m	14p
Total	**14h4m**	**137p**

For quantitative data collection, I acquired membership of the chat group from one of the administrators, who knew about my identity, but the information was not made public. The selected chat log consisted of 2,059 entries. And there were 1,252 entries (61%) in 183 Q&A (Question and Answer) cycles. The Q&A cycles started with a question and ended when no more answers or discussions followed.

Data analysis

After transcribing the audio recordings and correcting the transcription, I used thematic and narrative analysis methods for qualitative data analysis. Based on Braun and Clarke (2006), the process of thematic analysis in this research is:

- familiarizing with the data
- generating initial codes
- searching for themes (related to the research questions)
- reviewing themes
- defining and naming themes

In this research, the process of narrative analysis is:

- restructuring the narrative in chronological order
- focusing on the themes (research questions)

- making extension by connecting the themes with other information (such as background information of the sample schools and participants or information in another narrative)
- highlighting the dilemma or conflicts related to the themes

On the other hand, I put the log entries into 17 data sets and then used text analysis methods such as word frequency, entity recognition, and association to investigate:

- the number, rate, frequency and duration of Q&A cycles
- the topic, time and rate of response, satisfaction with response, efficiency of response to the questions in Q&A cycles
- the relationship between group members, administrator activities, background information of the chat group, the frequency of logging in, teacher's purpose of using the chat group, etc.

Then I conducted descriptive analysis to measure the frequency of different types of questions more accurately.

And after qualitative and quantitative data analysis, I compared and combined the results to develop an integrative understanding of TPS and support for it.

Ethical considerations

I did the following to address the anticipated ethical issues (cf. Creswell, 2014):

- gain school and participant permission though goalkeepers
- assure that the research will benefit participants by discussion with teachers
- inform the participants of the general purpose of the research
- respect the participant's requirements and opinions
- use pseudo names to protect the privacy of participants and their schools
- bring a gift as reward for participating
- report honestly
- report in a different language
- report multiple perspectives
- store data and materials for 5 years
- give credit for ownership to researcher, participants, and advisors

3.3 Research validity

In this research, validity strategies include (cf. Johnson & Christensen, 2004; Kinnunen, 2017):

- descriptive validity: examining the accuracy of descriptive information
- interpretive validity: respondent validation
- theoretical validity: pattern matching and peer review
- researcher bias: continuous reflection and actively seeking negative cases
- internal validity: data and method triangulation
- external validity: reader's recognition of results or building a theory (Chen, 2000)

And I adopted the following to reduce bias in interview:

- formulate questions carefully so that the meaning is crystal clear
- get familiar with the procedures and get ready for possible problems
- combine probability sampling with non-probability sampling
- include participants of various characteristics

The following was adopted to enhance reliability of interview:

- careful piloting of interview schedules
- learning about how to conduct interview
- use of closed questions

In addition, semi-structured interview was adopted to control validity by making participants feel at ease and to control reliability by having semi-structured interview questions.

Part IV Research results

The results consist of four parts: the problems reported by teachers, the problem-solving strategies used by teachers, support seeking reported by teachers, and understanding and supporting TPS.

4.1 The problems reported by teachers

Now we have a list of problems encountered by teachers. By taking a teacher's perspective, it is possible to categorize these problems by using teacher's primary goal or objective of problem solving as the standard of classification.

Table 4.4 The classification of reported problems

General goal	Specific goal	Problem type
Improving learning	■ Improving student's vocabulary, grammatical knowledge, language skills, knowledge of English culture, performance in exams ■ Improving student's learning habits, learning methods, learning strategies ■ Improving student's interest, motivation, attitude for learning, attitude towards teacher and school ■ Improving student's discipline, manners, family love, gratitude, socialization, patriotism, ambition ■ Reducing student's depression, frustration, anxiety, addiction to cell phones	Learning problems
Improving teaching	■ Improving knowledges about the English language and culture ■ Improving methods and skills of teaching, learning assessment, classroom discipline, communication with students, colleagues and parents, student management as class teacher ■ Finding better teaching materials ■ Dealing with teacher's own attitude, emotional and health problems such as irresponsibility, indulgence to students, guilt, stress, doubt about the profession, lack of plan for professional development, teacher burnout	Teaching problems

Improving environment for teaching and learning	■ Dealing with restrictions from school administration such as lack of EFL class hours, lack of colleagues and collaboration, declining quality of student candidate, inappropriate textbooks and teaching materials, exam-oriented education, excessive concern about student safety, unreasonable reform programs including the downplay of grammar in teaching, unfocused online teaching, long holidays, classroom surveillance system; and heavy workload, low salary, disproportionate salary, rigid professional ranking system, lack of teacher housing, lack of opportunities for learning and professional development ■ Dealing with restrictions from parents and public opinion such as misconceptions about schools and teachers, lack of support for teacher's right to discipline students, lack of social recognition for the profession, criticism against teacher's personal life and image ■ Improving teacher safety	Environment problems

But before we draw the conclusion that these are the problems encountered by teachers, it is necessary to examine their understanding of the term "problems encountered by teachers" when they attend the interview. In fact, the participants defined this term in different ways.

Table 4.5 Teacher's definition of the term "problems encountered by teachers"

Definition	Participant	Example	Meaning
Provide denotation to the term	Frank Hebe Sarah Sonia Sean Zandra Zoey John Yevette	Hebe thinks that she is facing teaching problems. She is not a class teacher, and teacher-student relationship is not her problem. Sean thinks that there are teaching problems and student management problems.	Task or goal
Add emotional	Gavin	Gavin thinks that problem is a very hateful word. He is contented and happy with everything. He	Discomfort

colouring to the term		thinks that there is no problem confronting him. He considers the conflict between his students, a colleague and himself to be a lubricant of interpersonal relationship.	
Explain the meaning of the term	Donald	Donald thinks a problem is a situation that makes him feel perplexed or difficult, or when others (such as colleagues, parents, students) take an unfavourable attitude towards him. Sean thinks there is a problem when something is not within his grasp and his effort fails to yield desired results.	Unknown
Explain a belief about the term	Simon	Simon thinks that teacher has dedication. From this perspective, all problems can be solved and there will be no problem confronting teachers.	Complaint

The difference between teacher's definition of the term is also apparent in their differentiation between the terms "problem", "difficulty" and "challenge".

Table 4.6 Teacher's differentiation between "problem", "difficulty" and "challenge"

Difference	**Participant**	**Example**
Degree of difficulty	Hebe Sonia Sean Zandra Zoey	For Hebe, challenge is harder than difficulty, and difficulty is harder than problem.
Minor or no difference	Frank Gavin John Simon	For Frank, problem, difficulty and challenge have the same essence. They are different stages of a situation or a same situation viewed from different angels.
Emotional colouring	Donald Sarah	For Donald, difficulty lies in everything that a person does, challenge is positive, and problem is the most negative term. For Sarah, problem is a neutral word, challenge is positive, and difficulty makes her feel hopeless.
Meaning	Yevette	For Yevette, problem is the question in the process of learning, difficulty is the gap between the objective and result of teaching, NCEE is the greatest challenge.

This means that teachers have their own diversified, multiple and possibly changeable definition of the term in a personal vocabulary, which may be related to the various problems they encountered in practice. Moreover, their definition of the term is

not completely consistent with the problems they reported earlier. For example, Gavin reported two problems about teacher-student conflict, but he preferred to consider these incidents as normality rather than a “problem”.

However, the participants chose to report those situations as problems. One explanation for this is that besides the personal definitions of the term, there is a common meaning of it shared among the participants and me, and they have recognized the common characteristic in those situations that makes them a problem. So, it would be better to identify teacher’s definition of a problem or the common meaning of the term from the specific situations they reported rather than from their changeable understanding of the terms.

In fact, when the participants report a particular problem, they are either retelling their earlier definitions of the situation or redefining it. By examining their reports, it can be found that in the process, they 1) describe a situation, 2) explain the reasons for their dissatisfaction, 3) make a causal analysis, 4) attribute responsibility, 5) predict the result of their problem-solving attempt, 6) make a decision to engage with or ignore it, and 7) form personal opinions on it. These actions imply a three-stage process of teacher’s problem definition.

Table 4.7 The process of teacher’s problem definition

Stage	**Action**
Representing situation	describe a situation
Gaining understanding	explain reasons for dissatisfaction make causal analysis attribute responsibility predict the result of problem solving form personal opinions
Making decision	make a decision to handle or ignore it

In the process, the participants displayed differences in their actions, which indicated the various styles of teacher’s problem definition.

Table 4.8 Indicators of the style of teacher’s problem definition

Style of problem definition	Personal interpretation	Differing Conforming
	Attribution of responsibility	Internal External
	Attitude towards PS	Positive Neutral Negative
	Activeness	Active Reactive Proactive
	Self-confidence	Confident Uncertain Unconfident
	Availability of resources	Available Unavailable
	Estimation of results	Optimistic Pessimistic
	Estimation of costs and risks	High Low
	State of mind	Emotional Reasonable

The indicators point to nine aspects of the style of teacher's problem definition, (Table 4.1). They are about the tendencies to understand a problem conforming to or differing from authoritative opinions, to attribute the responsibility of problem solving to oneself or others, to consider problem solving positively or negatively, to identify problems actively or inactively, to be confident or unconfident about oneself when facing a problem, to believe that the resources are available or unavailable, to have optimistic or pessimistic estimation of results, to believe that there are high or low costs and risks, to understand a problem emotionally or reasonably.

Decision-making is very important in teacher's problem definition, and based on the analysis of the indicators, it is assumed to consist of two opposing processes.

Table 4.9 The process of decision-making

Willingness to deal with a problem	**Vs.**	**Estimation of problem-solving results**

Attitude towards problem solving Activeness Personal interpretation Attribution of responsibility		Self-confidence Estimation of results Estimation of the availability of resources Estimation of costs and risks

There can be three different results of the decision-making process.

Table 4.10 The results of decision-making

	Optimistic estimation	**Pessimistic estimation**
Willingness to solve a problem	Decided to try	Undecided
Reluctance to solve a problem	Decided not to try	Decided not to try

After this process of problem definition, the participants will have a defined problem. By re-examining the problems and questions reported earlier, it can be found that all of these situations were unwanted by the participants as teachers; the participants understood them in different ways; and they have identified targeted problems that they were about to deal with and quasi problems that they chose to ignore for the time being.

4.2 The reported problem-solving strategies

This section focuses on the strategies used by teachers to solve particular problems, the process of strategy use, the factors affecting strategy use, and the indicators of the style of strategy use.

The reported problem-solving stories (omitted)

The strategies used in teacher's problem solving

From the narratives, it can be found that the participants used 13 kinds of strategies to solve the problems they encountered in practice and they often integrated these strategies into a comprehensive one so that they could deal with the complex changes of a problematic situation.

Table 4.11 Strategies used in the reported problem-solving narratives

Problem types	Strategies	Strengths	Weaknesses
Learning problems	Tutorial	Providing extra tailored learning opportunities	Teacher's lack of time and energy
	Punishment	Correcting misbehaviours	Risks of inflicting physical and psychological damage
	Reasonable communication	Improving teacher-student understanding	Ineffectiveness of changing student's attitude and opinions
	Emotional communication	Establishing empathy and emotional connection	Difficulty of conducting emotional communication
	Material support	Providing food, accommodation and medical expenses for impoverished students	Teacher's lack of resources
	Non-material support	Providing opportunities for student development	Risks of being unfair to other students
	Inquiry	Collecting sensible information from insiders	Difficulty of obtaining inside information
	Integration	Developing a curriculum with personalized educational objectives	Conflicts with national or local curriculum
	Organization	Organizing learning activities to develop self- and group-learning ability	Lack of time and proper texts for discussion
	Customization	Focusing teaching on learner differences	Risk of teaching behind schedule
Teaching problems	Brainstorm	Developing new methods of teaching and assessment	Risks of wasting time and making mistakes
	Exploration	Searching for new knowledge and information	Unavailability of useful knowledge and information
	Self-reflection	Developing a better understanding about oneself and the problem	High costs of triggering self-reflection
Environment problems	Exploration	Finding better and more materials for teaching and learning	Unavailability and unreliability of materials
	Organization	Finding more time for EFL teaching	Conflicts with national or local curriculum

These strategies can perform different or multiple functions. And there are

different ways of using the strategies. For example, communication can be either reasonable or emotional, public or private, explicit or implicit, honest or deceitful.

The process of teacher's problem solving

There are sequenced steps for adopting a strategy: planning, implementing, supervising, evaluating and correcting.

Table 4.12 Sequenced steps of teacher's problem solving

Planning	Select from a known list of strategies and adapt it for the current problem Devise a new strategy based on exploration or brainstorm
Implementing	Follow a strategy strictly Change the strategy or combine other strategies to deal with the change of the problem
Supervising	Make sure that the strategy is properly implemented
Evaluating	Determine the effects of the current strategy
Correcting	Revise the current strategy based on the result of evaluation Seize the opportunity of solving a difficult problem

But other participants who adopted a similar strategy may follow different steps because of the differences between particular problems. There are problems requiring immediate response and the strategies adopted by the participants were not carefully planned but hastily improvised. There are other problems that seem to depend more on teacher's decision making than careful planning.

The factors affecting teacher's strategy use

In addition to the variation and improvisation in strategy use, there are many factors affecting teacher's strategy use, such as student's response to teacher's strategies, parent's and colleague's cooperation, and the timing of strategy use.

Strategy selection and use are also affected by the teachers themselves. Young teachers may not have the resources or experience to provide adequate support to students, a married teacher with kids has less time to give students tutorial, a teacher that stresses communication with students is less likely to punish them, an EFL teacher is less likely than a class teacher to be skilled at dealing with students, and a reasonable or introvert teacher's problem solving will be different from that of an emotional or

extrovert one and vice versa.

These factors and their influence on teacher's strategy use reveal that teachers are not free to use all strategies and successful problem solving cannot be ensured only by the knowledge of different problem-solving strategies.

The duality and multi-perspectiveness of strategy evaluation

In fact, every strategy has strengths and weaknesses. Strategy evaluation should focus on both the observable effects and its appropriateness for teachers and students. Appropriateness has already been discussed in the above paragraphs. The effects of a strategy are evaluated by the teachers and their estimation of the effects is subjective to some degree. This means that the effects of a strategy can be determined differently by teachers, students, parents and public opinions. And it is possible that they make different and even conflicting evaluations about the effectiveness of a teacher's strategy use.

The indicators of the style of teacher's problem solving

By observing the differences in participant's problem-solving process, it can be found that the indicators for the style of teacher's problem solving are dependence, flexibility, controlment, objectiveness, and perseverance. They can show a problem solver's tendency to make plans dependently or independently, to implement plan strictly or improvise intuitively, to supervise the process closely or loosely, to evaluate the result by subjective or objective standards, and to continue, pause or give up problem solving when there are difficulties.

4.3 Teacher's support seeking

In the reported stories, when teachers encountered difficulties in the problem-solving process, they would ask for help or try to overcome the difficulties by themselves.

Support seeking reported by participants

Now it is time to combine these data.

Table 4.15 Teacher's support seeking

Difficulties	Lack of knowledge Lack of teaching resources Lack of inside information Making hard decisions Experiencing negative emotions Completing important tasks Failing in problem solving
Needs	Guidance of experienced teachers A database of teacher's problem solving Learning opportunities Tolerance of teacher's mistakes Understanding of teachers and education More support from friends, colleagues, parents and public opinions
Supporters	Colleagues Internet Family Friends Students Parents Oneself
Channels	Face-to-face Distance Public Private
Supports	Knowledge Teaching resources Inside information Opinions Emotional support Housekeeping Lesson rehearsals Suggestions
Acceptance	Complete acceptance Partial acceptance Rejection
Effectiveness	Effective Broadly, partially, or ostensibly effective Ineffective

Based on these data, the process of teacher's support seeking becomes clear.

Table 4.16 The process of teacher's support seeking

Steps	Actions
Difficulties	Confronting difficulties
Needs	Identifying needs
Supporters	Selecting supporters
Channels	Contacting supporters
Supports	Receiving supports
Acceptance	Accepting supports
Application	Solving difficulties with supports adaptively
Effectiveness	Evaluating effectiveness
Feedback	Providing feedback
Optimization	Optimizing problem solving and support seeking

And the differences between teacher's support seeking revealed the indicators of the style of teacher's support seeking. The teachers had a tendency to focus on a certain kind of difficulties and supports. They preferred using different standards to select supporters. They preferred contacting supporters in different ways. They tended to accept supports in different ways. They tended to react differently if support is unavailable. They preferred different standards to evaluate the effectiveness of support. They preferred to provide feedback in different ways.

Table 4.17 The indicators of the style of teacher's support seeking

Focus	Lack of knowledge Lack of teaching resources Lack of understanding Lack of cooperation Lack of emotional support
Choice	Convenience Experience Competence Intimacy Frankness
Communication	Face-to-face Distance Public Private
Effectiveness	Cognitive Practical

	Emotional
Feedback	With Without Socializing Learning
Optimization	Content Method

4.4 Understanding and supporting TPS

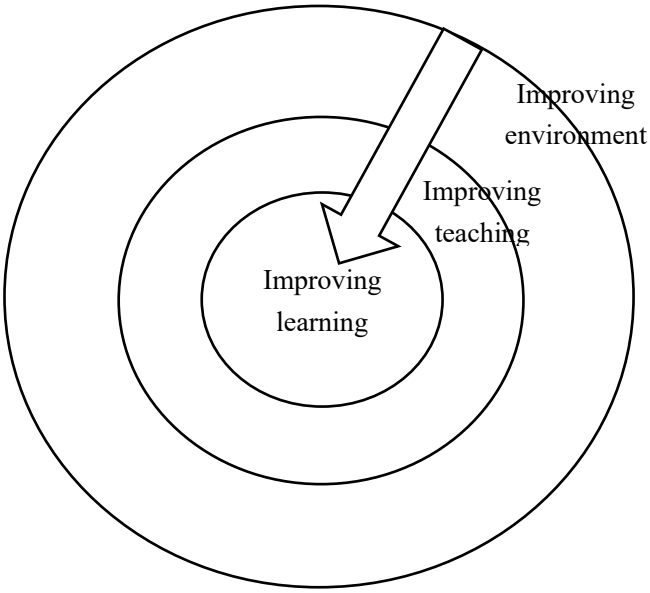
Based on these results, it is possible to arrive at a deeper understanding about teacher's problem solving.

Teacher's definition of problems

Different from mathematical or cognitive problems, it is a teacher's dissatisfaction rather than the unknown or the difficulty that really makes a situation a problem because the latter two may be irrelevant to teacher's goals and will not become their target of problem solving. A problem exists when a teacher thinks that he/she must do something to improve a situation because that's what they believe a teacher should do. The teacher can have a clear or unclear goal. He/she can know how to solve the problem or not. And the process can be difficult or easy for him/her.

The reported problems were categorized by participant's primary problem-solving goal. Based on the connection between problems types and problem solver's proudness and regret, it is assumed that improving learning lies at the core of teacher's goals, improving teaching is the intermediate goal, and improving environment is the peripheral goal. From this perspective, teacher's problems are always related to students and their learning. And the illustration of these goals presents a "map" for teacher's learning and professional development. And teachers can plan their own "route" on the "map".

Figure 4.2 Teacher's problem-solving goals



When teachers define a problem, they are trying to understand it and make a decision about it. A problem (situation) is constantly developing and the teacher continues to redefine it.

While different problem types have been studied separately, it is still necessary to study them as a whole because they are interconnected diachronically and synchronically. When teachers confront a problem, they are also confronting its interconnections with other problems. When they solve it, they also need to deal with these interconnections.

Teacher's problem solving

Different problem-solving strategies that teachers actually used were found. But it is difficult to learn and use these strategies because strategy use is affected by many factors. But by adapting other's strategies, teachers can develop their own strategies that are more appropriate for their problems, their students and themselves.

Improving student's learning is teacher's primary goal. Solving this kind of problem does not mean to find an answer to a question or to devise a strategy that can lead to the answer. The answer or strategy must be used in practice to take effect. For teachers, the problem is solved when student's learning is improved as expected. And problem solving for improving student's learning is in essence a cooperation between

teachers and students on learning, which can be led by the teacher or the student. In other words, problem solving is teacher's attempt to change a dissatisfied situation into a satisfied one. This practicality of teacher's problem solving makes strategy development and implementation integral.

It seems that teachers do not set an upper limit to their problem-solving goal when the goal is improving student's learning. This means that teacher's problem solving can centre around students besides separate problems, and it can be a long-term process that ends with student's graduation. So, a teacher can consider multiple problems about a student as a consecution and deal with them continuously. Thus, teacher's problem solving can end with gradual results (i.e. partly solved), while mathematical and cognitive problem solving ends with either-or results.

Teacher's problems are often related to a variety of other problems (or difficulties) such as poverty, leftover children's lack of family love, emotional damage of divorce on students, parent's lack of parenting skills, the quality of education in lower secondary schools, language and culture diversity. Thus, teacher's problem solving can go beyond teacher's responsibilities and expertise and get out of their control and this is why they need external support.

Teacher's problem solving is transient because every problem and every problem-solving attempt is unique. And only after a problem is solved, the effective strategy can be identified as a solution for the problem. But before a similar problem is solved by the same solution, it is only a strategy. This means that the effectiveness of a strategy cannot be predicted.

During the problem-solving process, there are a lot of factors in the situation that cannot be controlled by the teacher or anyone else. Thus, the relationship between strategy and problem is probable. A strategy can have a high or low probability to be effective with a problem, and it is possible to estimate the probability.

Problem solving can give meaning to teachers and exert profound influence on them and their students. It can reveal the unrealized deficiencies or the dilemma confronting teachers, offer learning opportunities, strengthen their beliefs or opinions,

trigger self-reflection, change their attitude, or help them to build a strong emotional bond with students. And even failed problem-solving attempts can bring positive influence on teacher's learning and professional development.

There are implications of the success and failure of participant's problem-solving attempts. Their success implies that teacher's problem solving is more likely to succeed by:

- building a teacher-student relationship featuring mutual respect, understanding and love
- discovering and appreciating student's merits
- understanding and supporting students
- teaching based on individual differences
- organizing activities that motivate learning
- learning by exploration
- thinking independently and innovatively
- devising and following a reasonable plan with step-by-step process
- being brave to improvise in problem solving when it is necessary
- changing strategy timely and flexibly with the development of a problem
- keeping problem solving under supervision
- making self-reflection

Their failure implies that it is less likely to succeed with:

- the ignorance of a problem or a student
- the lack of knowledge and experience needed for problem solving
- the lack of alternative strategies or the lack of flexibility in strategy use
- the lack of self-reflection
- teacher's indulgence to the students
- the lack of understanding of students or the lack of communication with them
- the lack of resources (e.g. time) needed for teacher's problem solving
- the lack of cooperation
- student's and parent's disrespect, distrust, misunderstanding or opposition to

the teacher

- the lack of support against teacher's stress or anxiety

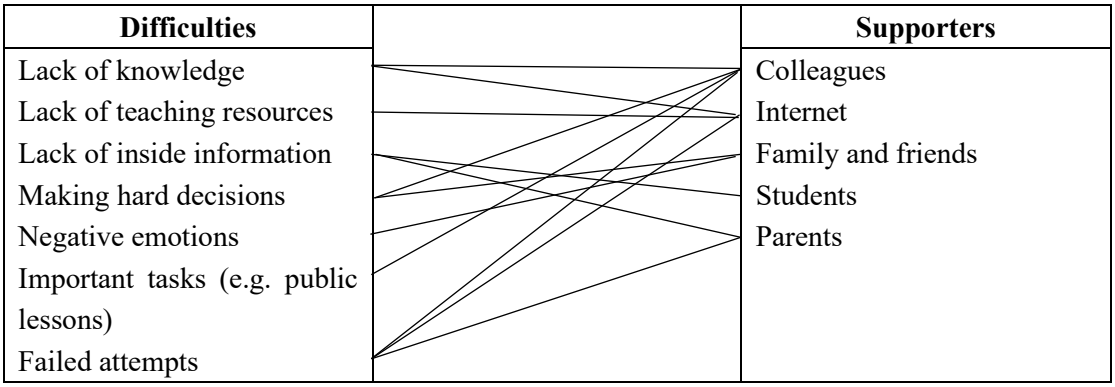
And, teachers believe that there are some problems, such as when student's addiction to cell phone games or their idolization of movie stars affect learning, that cannot be solved, but their influence can be reduced. These problems originate from the conflicts between work and play, maturity and adolescence, and the socialization and individualization by education.

Teacher's support seeking

Teacher's support seeking is the communication initiated by teachers to acquire resources needed for overcoming the problem-solving difficulties.

Teachers have established connections between the difficulties and the supporters they turn to.

Figure 4.3 Connections between problem-solving difficulties and supporters



In fact, teachers have established connections between problems, goals, difficulties, needs, channels and supports. And these connections constitute a support system for teacher's problem solving.

Table 4.19 The support system for teacher's problem solving

Teacher as problem definer	**Teacher as problem solver**	**Situations**	**Teacher as support seeker**	**Connections**	**Supporters**
Problems	*Goals*	*Difficulties*	*Needs*	*Channels*	*Supports*
Learning	Improving	Lack of	Knowledge	Face-to-face	Knowledge

problems Teaching problems Environment problems	learning Improving teaching Improving environment	knowledge, resources, understanding, cooperation, emotional support	Resources Understanding Cooperation Emotional support	communication Distance communication	Resources Understanding Cooperation Emotional support

Teachers use ICT frequently to support their problem solving. They use it to acquire, adapt, produce, store, and exchange resources. They also use ICT as a problem-solving tool. So, ICT introduces a digitalized support system for today's teachers.

But there are some limitations. Teachers used ICT more for finding resources and knowledges, but less for discussion and collaboration. Though there are many online platforms where teachers can find resources, the platforms are homogeneous, and most of them focus on teaching resources and content knowledge. The quality of the online resources is uneven. And online resources for overcoming difficulties in student management often provide general principles that are difficult to turn into step-by-step plans. When teachers need support, it seems that the school is often too small, and the Internet too big. And sometimes, teachers may not know how to ask specific questions and "get unspecific answers" (PI31).

Asking mentors or using the chat group for help are also typical ways of seeking support. But it seems that teachers have not established an effective mechanism for their communications.

Based on the understanding of teacher's support seeking, the principles of building an ICT-assisted support system for teacher's problem solving were proposed.

- Teachers should be placed at the centre of the system. They should build the system with available resources and use it to support their and other's problem solving.
- The system should be able to satisfy diverse needs for teacher's problem solving. It should provide connections to all kinds of resources including those provided by professionals such as technicians, psychiatrists and lawyers.
- The system should be able to function in accordance with various problem-

solving styles.

- The system should be able to operate within a mechanism that facilitate the effectiveness and efficiency of teacher's support seeking. The mechanism should work for the establishment, application, maintenance and development of a system.
- The system should make full use of popular ICT to improve convenience and reduce costs for support seeking.

Part V Discussion (omitted)

Part VI Conclusion

This research adopted a descriptive, bottom-up approach to improve the understanding about teacher's problem solving and support seeking. It took teacher perspective and a holistic view and stressed the differences between problems and individuals facing them.

Earlier studies on problem solving often focused on the assessment and training of problem-solving skills. But teacher's problems are different. Teachers are facing a particular group of problems related to their goals of improving student's learning, their teaching and the environment surrounding them and their students. These problems are real-life situations connecting themselves and others, which are dynamic, interconnected with other situations diachronically and synchronically, open to multi-perspective interpretations, and unpredictable and uncontrollable to some degree.

Teachers seldom identify themselves as problem solvers. For them, solving these problems is an integral part of teaching and being a teacher. It is a challenge that can give meaning to their and their student's life and work. Teacher's problem solving is not achieved by finding a solution, but by helping their students to make progress in learning, by building a lifelong bond with students and parents, by finding meaning from the success or failure of problem-solving attempts, or by defining themselves as the kind of teacher or person they want to be through making hard decisions or choices.

Strategy development and implementation are critical for successful problem solving, but they are not enough. There are a lot of factors that can affect teacher's problem solving and it is difficult to control them. When teachers encounter the difficulties caused by the factors, they will try to overcome them by seeking supports. ICT-assisted support seeking empowers teachers with more resources they need for problem solving. And it is very important for teachers to build an integrated support system for themselves and their colleagues. ICT can help teachers with the

establishment, application, maintenance and development of a system by enhancing effectiveness and efficiency, improving convenience, reducing costs, and conforming to individual TPD, TPS and TSS styles.

This research has investigated the process, product and style of teacher's problem definition, problem solving and support seeking. The results can be used by teachers to develop or improve their support systems. In the future, it is necessary to make large-scale survey to examine these results and conduct experiments to test the effectiveness of the support system.

Table 6.1 The process, product and style indicators of teacher's problem definition, problem solving and support seeking

	Process	**Product**	**Style indicators**
Problem definition	Representing situation Gaining understanding Making decision	Learning problems Teaching problems Environment problems Quasi problems	Attitude (PS) Activeness Self-confidence Interpretation Responsibility Estimation State of mind
Problem solving	<u>Planned:</u> Making a plan Implementing it Supervising the process Evaluating effects Correcting the plan <u>Unplanned:</u> Noticing a problem Making observation Deciding to help Taking immediate actions	Tutorial Punishment Communication Support Inquiry Integration Organization Customization Brainstorm Exploration Self-reflection	Dependence Flexibility Controlment Objectiveness Perseverance
Support seeking	Confronting difficulties Identifying needs Selecting supporters Contacting supporters Receiving supports Accepting supports Solving difficulties Evaluating effectiveness	Knowledge Teaching resources Understanding Cooperation Emotional support	Focus Choice Communication Effectiveness

	Providing feedback Improving PS and SS		

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List of tables (omitted)

List of figures (omitted)

Appendix (omitted)