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How was teaching thinking adopted and diffused in Chinese primary schools? A qualitative study from principals' perspectives

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ABSTRACT

This study aimed at gaining an in-depth understanding of how *teaching thinking* was adopted and diffused as an instructional innovation in primary schools from principals' perspectives. Using Rogers' Diffusion of Innovation (DOI) theory as a theoretical lens, one-on-one semi-structured interviews were conducted with eight Chinese primary school principals. Interviews were audio-recorded, transcribed, open coded, and analysed by using constant comparison analysis. Results found:1) the principals' prior knowledge about teaching thinking and their *perceived characteristics of* the thinking skills programme (TSP) prompted the principals to adopt the TSP in their schools; 2) recruiting *seed teachers*, offering *direct thinking skills classes*, and demonstrating *cannon fodder classes* played an important role in kicking off the TSP; 3) engaging in online and on-site training, infusing thinking skills into subjects, and routinizing *lesson studies* were essential in adapting the school to teaching thinking; 4) opening training and lesson studies to all teachers, and point-to-area peer influence were effective ways of diffusing teaching thinking in schools; 5) building positive feedback mechanisms, making teaching thinking a distinct feature of the school, collaborating with external partners, and forming organizational memory were effective measures of sustaining the diffusion. Implications for adopting and diffusing instructional innovations in schools were discussed.

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Introduction

In the past 50 years, improving students' higher-order thinking skills was widely regarded as an essential objective of K-12 education throughout the world (Harpaz, 2007; Sedaghat & Rahmani, 2011). To improve students' higher-order thinking skills, schools typically adopted *thinking skills programmes* (TSPs) by either introducing existing thinking skills interventions or infusing thinking skills into subjects (Beyer, 1987; Yang, 2016). Previous studies mainly focused on designing (Adey, Robertson, & Venville, 2001; Buzan & Buzan, 2006; de Bono, 1983; Lipman, 1982; Novak, 2010), redesigning (Cargas, Williams, & Rosenberg, 2017; Larsson, 2017; Schmaltz, Jansen, & Wenckowski, 2017), implementing these thinking skills interventions, and examining their effects (Phuntsho & Wangdi, 2020; Wei, Hutagalung, & Peng, 2020, April). It is impractical for most schools to design and develop their thinking skills interventions from scratch due to time and capability constraints. Therefore, schools typically adopt existing well-designed interventions and adapt them to their

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school context (Beyer, 1987; Burden & Nichols, 2000). However, bringing the effective instructional practice to scale remains a pressing and elusive challenge for education systems around the world (Rincón-Gallardo & Fleisch, 2016). Even though these thinking skills interventions are well designed and have been proven to be effective, challenges still exist while getting them adopted in specific school contexts and diffused them inside schools at a large scale. Therefore, understanding the adoption and diffusion of TSPs in schools could help to overcome these challenges. These studies would also provide practical, evidence-based suggestions on promoting TSPs in K-12 education, and then improve students' higher-order thinking skills.

Principals, especially in Asian countries, play essential roles in the adoption and diffusion of innovations inside schools, such as making decisions and implementing strategies to promote diffusions. In the culture, which typically places great importance on the authority of leaders, principals always demonstrate strong top-down leadership in schools. Teachers usually obey and follow the principal's decisions. However, since the explicit development of thinking skills and thinking skills interventions for transfer to specific content are relatively new concepts, principals might not have enough background knowledge in this area. TSPs are actually innovations in principals' eyes and it is necessary to investigate how TSPs were adopted and diffused in schools. Moreover, even in schools which emphasize the authority of leaders, the formation of a sustainability culture still needs all teachers in the school to renovate their thoughts regularly (Rogers, 2003). Therefore, it is also necessary to have an in-depth examination of how principals help all the teachers be sincerely convinced and devote themselves to the innovations sincerely and actively, not passively obey and follow.

Rogers' Diffusion of Innovation (DOI) is a comprehensive theory of how innovations spread through the communication channel into a social system (Rogers, 2003). DOI has been used to analyse and guide the adoption and diffusion of innovations in a variety of areas (Lundblad, 2003; Zhai, Ding, & Wang, 2018). DOI provides a useful theoretical framework for understanding the dynamics of organizational change as they pertain to the adoption and diffusion of teaching innovations (Lundblad, 2003). By using DOI as the theoretical lens, this qualitative study aimed at investigating primary school principals' experiences and perceptions on the adoption and diffusion of TSPs in their schools. Specifically, this study aimed to obtain an in-depth understanding of how a TSP was adopted, adapted, diffused, and sustained in primary schools, and to uncover strategies principals viewed as essential to promote the diffusion and sustainment of a TSP in their schools.

Approaches to teaching thinking

Existing research revealed that there are two conventional approaches to teaching thinking: *the direct approach*, and *the infusion approach* (Long et al., 2019; Zhao et al., 2019; Sedaghat & Rahmani, 2011). In *the direct approach*, students learn general thinking skills, which could be generalized to other contexts, in a discrete/separate course. Many thinking tools and skills packages, such as Thinking Maps (Hyerle & Elper, 2011), Mind Mapping (Buzan & Buzan, 2006), Concept Mapping (Novak, 2010; Novak, Gowin, & Bob, 1984), and Cognitive Research Trust (de Bono, 1983), have been developed for ease of use in the classroom settings. In *the infusion approach*, teaching thinking is embedded in a variety of subjects and is permeated into all aspects of students' academic lives (Dewey & Bento, 2009). *The infusion approach* aims to develop students' ability to recognize and use common patterns of thinking, deepen their understanding of subject learning topics, and make connections between them. *The infusion approach* also establishes that content information in each subject area is also grounded in and structured by cognitive processes such as classification, comparatives, causality, and analogies. Though teachers already ask students to use reasoning skills, *the infusion approach* focuses on making these processes explicit for students.

Some studies have verified the existence of general thinking skills (Higgins & Baumfield, 1998; Marzano, 1998) and the effects of well-designed direct thinking skills interventions. However, the emerging consensus supported by some research evidence is that the best way to teach thinking

skills is not as a separate subject but through "infusing thinking skills into the teaching of subject knowledge" (Wegerif, 2002). The two approaches have been combined in use during teaching practice.

Traditional Chinese classes tried to achieve the goal of fostering students' thinking ability implicitly, in which thinking skills were hidden behind subject contents. However, the effectiveness of this kind of teaching thinking depends on students' "self-seeing" to some extent (Li & Wegerif, 2014). Gifted students could easily find the thinking skills behind the knowledge and apply them into new scenarios, while less talented students might not be able to do these.

This study advocated a *hybrid approach* to teaching thinking, in which thinking skills are taught explicitly in separate, direct thinking skills classes and implicitly embedded in the subject contents as well (Long et al., 2019, Zhao et al., 2019). Not only aiming at improving students' thinking skills, this hybrid approach but also aims at supporting students to achieve a deeper understanding of subject knowledge (Long et al., 2019, Zhao et al., 2019). Compared to the traditional way of teaching thinking in China, this hybrid approach of teaching thinking is undoubtedly an innovation.

Theoretical framework

DOI was adopted as the theoretical framework of this study because it can help researchers understand the adoption and diffusion process of innovations. DOI is a comprehensive theory of how inventions and new ideas spread through the communication channel into a social system (Rogers, 2003). There are four elements in the diffusion of innovations: innovation, communication channel, time, and a social system (Rogers, 2003). Innovation is defined as an idea, practice, or object that is perceived as having new values by an individual or other unit of adoption (Rogers, 2003).

According to Rogers (2003), an individual's decision about innovation is not an instantaneous act, but a process of a series of different actions over time. Rogers (2003) further generalized the process of innovation decision making into a five-stage model: (1) *knowledge*, when a person is exposed to an innovation's existence and gains an understanding of how it functions; (2) *persuasion*, when a person forms a favourable or unfavourable attitude towards the innovation; (3) *decision*, when a person engages in activities that lead to a choice to adopt or reject the innovation; (4) *implementation*, when a person puts a new idea into use; (5) *confirmation*, when a person seeks to reinforce innovation-decision already made. The model is shown in Figure 1.

DOI has been relatively mature and has been applied to various fields, including marketing, medicine, social media, and education (Zhai et al., 2018). Newer research on the diffusion of innovation in education focused more on the diffusion of emerging technologies and educational

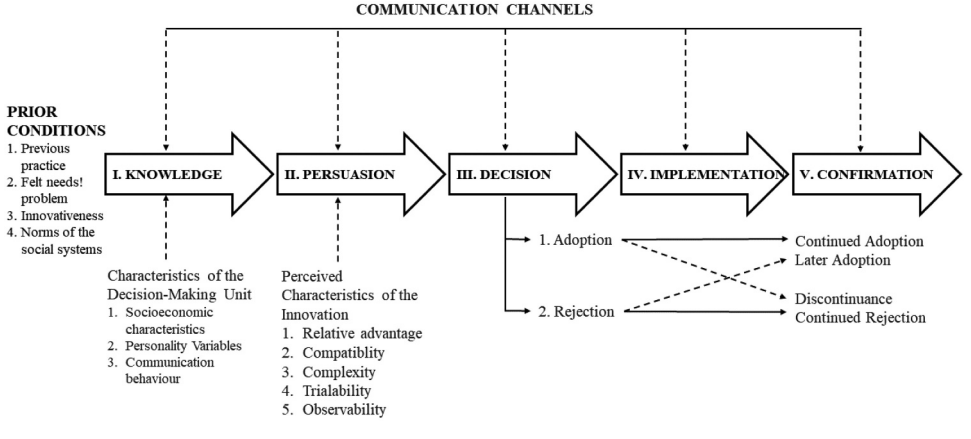

Figure 1. The process of innovation diffusion (Rogers, 2003).

policy, such as exploring the feasibility and potential use of new technologies (Doyle, Garrett, & Currie, 2014), and examining the factors that influence the successful diffusion of pedagogical innovations (Zhai et al., 2018). DOI has been used as a theoretical lens to guide the investigation on what played essential roles in the diffusion of innovations in the educational context.

Since the hybrid approach of teaching thinking proposed in this study is thought to be an innovation in primary schools in China, DOI sheds light on understanding how it has been adopted and diffused in schools, which could also have been thought to be a social system. Particularly, this study addressed the following questions:

(1) Why did these elementary school principals adopt the TSP into their schools?
(2) What strategies had been perceived to be successful in promoting the diffusion of a TSP in their schools?
(3) What strategies had been used by the principals to sustain a TSP in their schools?

Method

This study adopted a qualitative case study approach. A qualitative case study approach allows the researcher to conduct an intensive and in-depth analysis for achieving a full understanding of the multiple aspects of a phenomenon in a natural setting and arrives at a holistic and comprehensive understanding of meanings constructed in the context (Punch, 2013; Yin, 2017).

Research context

The Alliance of Thinking Schools (ATS), a community of practice on teaching thinking for K-12 teachers in China, was selected as the context of this study (Long et al., 2019, ; Zhao et al., 2019; Long et al., 2020). The ATS focused on improving teachers' capabilities of teaching thinking via providing specialized guidance and creating interschool communication opportunities. The ATS guided two types of teaching thinking: (a) *the direct teaching approach*, in which some teachers were guided to teach school-based, direct thinking skills classes; and (b) *the infusion approach*, in which teachers were guided to apply thinking tools and skills taught in the direct thinking skills classes into their subject instruction.

Participants

Purposive sampling was used in this study as the aim was to recruit appropriate participants who could offer useful information to the research questions (Suri, 2011). This qualitative case study focused on having a comprehensive and in-depth analysis on the phenomenon studied, so the participants who could provide fruitful information on the phenomenon, and possessed insights based on their experiences, were required (Yin, 2017). For this reason, eight principals (five principals and three deputy principals) from eight primary schools in a variety of areas in China were invited to participate in this study (see Table 1). Their participation in this study was voluntary. The variety in the geographical regions, teaching quality, and overall performance of the schools could provide more information about how a TSP was adopted and diffused in schools with various conditions and cultures in different areas in China.

Data collection

The main data was collected in May 2019 through one-on-one semi-structured interviews, which were conducted face-to-face (A3), via phone (A2, A4, A6, A7, and A8), or through WeChat (A1, A5). The interviews focused on the principals' motivations to adopt the TSP, experiences in the adopting, adapting and diffusing of the TSP, as well as their perceived effective strategies to enhance the diffusion

Table 1. The participants' profile.

Principal				School				
Principal ID	Position	Gender	Years of teaching experience (by 2019)	School ID	Description	The time of adopting the TSP	Is the TSP still running in the school? (by 2021)	Principal's evaluation of the diffusion (full score: 10)
A1	Principal	Male	24	S1	An average primary school in a new town in Guangzhou, which is a megacity in South China	March 2014	Yes	8
A2	Principal*	Male	22	S2	A top primary school in Weifang, which is a third-tier city in East China	September 2015	Yes	9
A3	Principal	Female	24	S3	An average primary school in a suburb in Guangzhou, which is a megacity in South China	September 2014	Yes	8
A4	Principal	Female	35	S4	An average primary school in downtown Beijing	September 2014	Yes	9
A5	Principal**	Female	20	S5	An average primary school in Yinchuan, which is a capital city in Northwest China	March 2017	Yes	5
A6	Deputy Principal	Female	21	S6	A top primary school in downtown Shenzhen, which is a megacity in South China	September 2017	Yes	8
A7	Deputy Principal	Male	20	S7	A top primary school in Xi'an, which is a capital city in Northwest China	September 2016	Yes	8
A8	Deputy Principal***	Female	17	S8	An average primary school in Xi'an, which is a capital city in Northwest China	March 2014	Yes	8

*A2 was promoted to the director of local education bureau **A5 quit the position in 2019 ***A8 was promoted to principal of another school in 2020

of the TSP as an instructional innovation. The participants were informed about the aim of this study as well as about its confidentiality and anonymity. Interviewing questions were developed following Rogers' framework. Some of the detailed questions were presented in Table S1 in the Appendix. All interviews were conducted in Chinese. The length of the interviews varied from 45 to 60 min. All the interview data was audio or text recorded. The translation was carried out after data analysis.

To ensure that the TSP has really been well diffused and sustained in these eight schools, we paid a follow-up interview with these principals through WeChat in January 2021. During the follow-up interview, the participants were asked to (a) clarify what counts as a successful adopted educational innovation, (b) score the extent to which they think that the TSP is successfully diffused and sustained in their schools, and (c) reconfirm the strategies they proposed in the initial interview (also see Table S1 in the Appendix).

Data analysis

The audio recorded interview data were transcribed, then subjected to open coding and Vivo coding (Saldaña, 2015). All initial codes followed closely the concepts used by the participants to ensure their strong link with the data and to enhance the validity of this study (Punch, 2013).

Axial coding was conducted to group the initial codes using a "bottom-up" strategy (Saldaña, 2015). The themes were identified following the inductive approach, based on the collected empirical materials. No coding scheme was used, which could be defined as a priori before data analysis. Some specific codes were added as the analysis was processing to indicate the recurrence of certain themes and register a maximum diversity of meanings. The themes were: (1) awareness of the needs of teaching thinking; (2) adoption of the TSP; (3) strategies of adapting teaching thinking in schools; (4) strategies of diffusing the innovation of teaching thinking; and, (5) the long-term mechanisms of sustaining teaching thinking.

All the data and codes for each scheme were sorted into each theme (Saldaña, 2015). Each unit of data coded according to each theme was then cut and put together as a category, and then constant comparisons were conducted in each category to search for similarities and differences (Glaser & Strauss, 1967). Subcategories were identified according to the similarity of the codes.

To ensure the highest possible quality of the research, researcher triangulation, constant comparison, and table-based data presentation were adopted (Patton, 2002). Researcher triangulation was adopted by having two researchers independently analyse the data and compare the findings to ensure internal validity (Patton, 2002). After reading the transcripts of the interviews repeatedly, two researchers coded the conversations. Next, all the meanings distinguished by each researcher were compared to verify the accuracy of each category and to refine the guidelines for distinguishing them. The constant comparison of the results of the work of the two researchers who analysed the same fragment of data enabled a process of data analysis based on the guidelines of the constant comparative method (Punch, 2013). The analyses were conducted with NVivo software, which enabled the constant comparison of meanings and categories as well as facilitated confirming them with the data.

Results

Awareness of the needs of teaching thinking (knowledge stage)

All the participants indicated that they had prior knowledge about teaching thinking from previous experience. Most of them acknowledged it from lectures (A1, A2, A3, and A4).

> I listened to a lecture given by a professor when I was attending a professional development programme. I was impressed by his thoughts about teaching thinking and contacted him for a deeper understanding. (A1)

Attending open houses of other schools was another meaningful way of acknowledging teaching thinking (A3, A5, and A8). A2 and A3 had personal experience in teaching thinking before they served as principals. Some others (A6, A7) acknowledged it from their principals or former principals.

> The former principal introduced Mind Mapping to us. He thought it was a way of assisting our thinking by visualising the process of thinking. If it could be used in education, it would be nice (A6).

> Our principal . . . he was probably the first principal who put teaching thinking into practice in our city (A7).

Most principals stated that they realized the benefits of teaching thinking soon after knowing it, and were willing to adopt the TSP. For example, A6 shared that although the former principal recommended the teachers to use Mind Maps, some of them, including herself, "had employed this not due to the requirement of the principal, but interest" (A6).

The principals acknowledged the value of teaching thinking in a variety of ways. Their understanding of the benefits that it could bring into schools helped the participants to decide on

adopting the TSP in their schools. However, besides the realization of the value of teaching thinking, the principals also had different experiences which promoted them to decide to adopt the TSP in their schools. For example, A1 shared that the TSP renovated with his own K-12 learning experiences:

"I was an ordinary student until the last year in high school. I made a learning plan for myself at that time. Only after half a year, I became a top student in my school, and performed excellently in the college entrance examination . . . After I got to know the TSP, I realized that what I had used was much similar to what is advocated in the TSP, but very simple" (A1).

A8 was "shocked" when she saw the impressing performance of the students from the schools which adopted the TSP earlier than her school:

"At that time (the first time I knew the TSP), I was shocked, how did these schools cultivate the kids? They were so confident, so strong in oral communication, so excellent in logical thinking, how did they make it? . . . There had been lots of things I had never known, such as the TSP" (A8).

Some principals (A1, A4, A8) shared that they were "disappointed" with the so-called "educational innovations" recommended by the local government. Compared with the TSP, these innovations were theoretical, rather than practical, which could not bring essential changes to their schools. As A3 explained:

"In Beijing, there are lots of options for educational innovations. A school could not introduce too many at the same time . . . As a principal, I decided to choose one which could enable all teachers to gain professional development. The TSP is just this kind of innovation . . . My school is not a 'top' school. I believed the TSP could improve my school in a stable and sustainable way" (A3).

In sum, no matter the differences on the principals' experiences and perceptions when they got to know the TSP, they became aware of the needs of their schools on introducing the TSP based upon its value such as being practical and effective.

Adoption of the TSP (persuasion and decision stage)

The persuasion stage occurs when an individual has a negative or positive attitude towards the innovation, but "the formation of a favourable or unfavourable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection" (Rogers, 2003, p. 176). After knowing teaching thinking, the participants seek more relevant information to determine whether it could be adopted in their schools. As principals, they made this decision based upon their *perceived characteristics* (e.g., *relative advantages, compatibility, complexity, trialability*, and *observability*) *of* the TSP.

Relative advantages

Relative advantage is "the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 2003, p. 229)". Most principals emphasized the *benefits* of the thinking tools when they considered whether to adopt the TSP. They described that thinking tools could "visualise individual ideas, help to realise and reflect thinking process" (A3), "help students generate many new ideas" (A6) and then "further help construct knowledge more intuitively and deeply" (A5). Principals also perceived teaching thinking could "improve students' learning ability" (A1), and it was "operational, not that theoretical" (A1). These perceived benefits stimulated them to think deeply about the meaning of teaching thinking. As A1 described,

> After listening to the lecture, I realised that teaching thinking is significant and can improve students' learning ability. What is more, these strategies are operational, not that theoretical (A1).

The principals' *perceived benefits* of the TSP thus gave advantages to the TSP and supported them to make the decision to adopt it.

Compatibility

Compatibility is "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 2003, p. 15)". To reduce the uncertainty of expected consequences, the principals evaluated the *compatibility* of introducing the TSP into their schools.

Some principals shared *the approval of the executive team* strengthened the adoption decision:

> My partners highly trusted me and worked together to support it (A1).

> If you can get a little external support, plus a little internal consensus, this programme will be easier to push (A6).

A3 and A7 put more emphasis on teachers' acceptance and initiative learning ability:

> Our teachers are open to new ideas. They are all trying some ways of improving themselves (A3).

> "The most important issue is that some of our teachers are excellent learners and they enjoy teaching very much" (A7).

However, A1 was more concerned about whether his teachers could accept this innovation:

> One concern is that some of the teachers might not accept new ideas; another concern is that teaching thinking might be formal rather than substantive (A1).

In A1's opinion, the teachers' possible resistance to teaching thinking was his main concern about adoption.

A4 was concerned about whether their school had enough funds to support the implementation of the TSP.

> We needed some money to support the running of the TSP. Before we received the special fund (for TSP) from the government, we cut our regular teaching budget to support it (A4).

In sum, the principals mainly focused on *the approval of the executive team, teachers' willingness and acceptance*, and *the availability of financial support* when considering the *compatibility* of introducing the TSP into their schools.

Complexity

Complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers, 2003, p. 15)" and is negatively correlated with the rate of adoption. Although the complete ideas advocated in the TSP is not that simple, TSP encourages teachers to begin with using thinking tools such as Thinking Maps, Mind Maps, and Concept Maps. The principals shared it was convenient and not difficult to understand and to use the *thinking tools* advocated in the TSP. As A3 described,

> I spent one night reading the book *Mind Mapping This Way*, and then tried to use Mind Mapping software according to the guidance attached in the book. I found that it was not as difficult as we thought before (A3).

It can be seen that the relatively low threshold of teaching thinking gave principals much confidence in adopting the TSP into their schools.

Trialability

Trialability "is the degree to which an innovation may be experimented with on a limited basis (Rogers, 2003, p. 16)". Also, trialability is positively correlated with the rate of adoption. Since most participants did not know how to implement teaching thinking in their school though they knew its indispensability in education, *the trialability of the TSP* thus gave advantages to the TSP. As A3 described,

> After observing thinking classes in other schools, I asked some administrators to try first. We learned to teach direct thinking classes from the instructional videos and the biweekly online workshops held by the ATS (A3).

Other principals also pointed out that the strategies advocated in the TSP were "operational, not that theoretical" (A1), which increased their perceived feasibility of the TSP.

The trialability of the TSP supported the principals to decide on adopting the TSP conveniently. The participants perceived the convenience that the TSP would bring to their schools, and this provided *decision convenience*.

Observability

Observability is "the degree to which the results of an innovation are visible to others (Rogers, 2003, p. 16)". As Parisot (1997) argued, peer observation is the key motivational factor in adoption and diffusion. In this case, most principals (A1, A3, A4, A5, A7 and A8) observed thinking classes demonstrated by teachers from other schools before they made the decision. As A5 and A8 shared,

> I observed some thinking classes in a middle school in 2016 and some thinking classes in the First Teaching Ability Competition in 2017. After that, I began to learn something about teaching thinking (A5).

> The first time I got to know teaching thinking was in 2013. I took five backbone teachers with me to attend an exhibition of thinking classes in Guangdong province. It was very shocking and refreshing for us (A8).

As the ideas of teaching thinking are relatively abstract, the demonstration of thinking classes organized by the ATS improved its observability and gave newcomers an intuitive cognition of teaching thinking, which help principals make the adoption decision.

Strategies of adapting schools to teaching thinking (implementation stage)

The process for adapting the schools to teaching thinking could be divided into three phases: *the preliminary preparation phase, the kick-off phase*, and *the promotion phase*. A variety of strategies have been utilized to adapt schools to teaching thinking in each of the phases.

Preliminary preparation phase

Once a school joined the ATS, principals organized timely training to prepare teachers for forthcoming TSP implementation. The major themes found concerning the preliminary preparation were *online training for efficient learning* and *on-site training for in-depth learning*.

Strategy 1: online training for efficient learning

Principals stated that online training is convenient and efficient for their teachers to learn about teaching thinking. They shared that their teachers participated in online training in ways such as "watching videos provided by the ATS" (A4) or "attending the weekly live remote training hosted by the ATS" (A8). The online training was thought to be able to help teachers "get a clearer and clearer understanding of teaching thinking" (A8).

Strategy 2: on-site training for in-depth learning

The participants shared that on-site training was also necessary to initiate the TSP in their schools. The on-site training, organized by the school and given by experts, deepened teachers' understanding of teaching thinking. The combination of online and on-site training provided flexible style for preliminary preparation of teaching thinking.

Kick-off phase

After organizing some online and on-site training, the step-by-step implementation of the TSP would be critical. However, it is not always that easy to kick off a new educational reform in a school. One challenge that the principals faced was teachers' hesitation or resistance. A1 shared that "At the beginning, some elderly teachers just waited and saw; they did not apply thinking tools or skills in their teaching." A5 also explained that "traditional teaching model is not easy to change; theories

learnt has not been accepted from the heart and fully understood." The principals had utilized a variety of strategies to overcome this challenge. The significant strategies found in this phase were: (a) Recruiting seed teachers, (b) offering school-based direct thinking skills classes, and (c) demonstrating "*Cannon fodder classes*".

Strategy 1: recruiting seed teachers

Seed teachers were pioneering teachers recruited to teach the thinking classes and then helped other teachers to initiate their thinking classes. These teachers were interested in teaching thinking, and most were excellent teachers in their subjects.

> We recruited seed teachers to teach school-based, direct thinking skills classes and formed a research group (on teaching thinking). Subject teachers, especially Chinese teachers and maths teachers, were preferred, followed by other interested teachers (A4).

> We selected a dozen of seed teachers in our school at that time, and these teachers taught direct thinking skills classes one period per week. Every semester, they gave open classes to demonstrate how to infuse thinking skills into subjects (A8).

From the seed teachers' open classes, other teachers had more in-depth knowledge about teaching thinking and then learned to introduce it into their classes.

The principals emphasized the effectiveness of the seed teacher strategy. They indicated that influenced and motivated by the seed teachers' effort and performance, more and more teachers had introduced thinking skills into their instruction.

> No more teachers would follow until they found that seed teachers had made visible progress and enjoyed it very much (A5).

> Seed teachers taught (direct thinking skills classes) first, and others came to observe and attended the lesson study . . . more teachers joined in gradually (A6).

The "seed teacher" strategy enabled some teachers to act as pioneers implementing teaching thinking. Then more teachers came to do it based upon the observation and motivation of their trials and performances. In this way, the innovation of teaching thinking had been gradually diffused in schools, just as the seeds bloomed.

Strategy 2: offering direct thinking skills classes

According to the participants, *school-based direct thinking skills classes* were the foundation and the starting point of teaching thinking. In *the direct thinking skills classes*, students learn general thinking skills in a discrete/separate course.

> We need to offer direct thinking skills classes first, in which students get to know thinking tools and skills. Students cannot apply these tools and skills into subject learning until they learn them in direct thinking skills classes (A4).

Similarly, A7 suggested that "teachers should get to know thinking tools and skills through direct thinking skills classes." The school-based direct thinking skills classes aimed at making sure teachers understand that thinking tools were easy to learn and use. Then, infused thinking classes could be gradually implemented.

Strategy 3: demonstrating "cannon fodder classes"

"*Cannon fodder classes*" were the first several thinking classes taught by the principals themselves, being observed and criticized by teachers, when the schools kicked off the programme.

> At the very beginning, teachers were reluctant to be the first to teach direct thinking skills classes. So, I demonstrated one after I thought I understood it thoroughly (A3).

> From training to case preparation, from lesson studies to lesson refinement, I have been discussing with teachers and tried to lead them with my reflections (A1).

Through observing, criticizing, and learning from their principals' "*cannon fodder classes*," teachers were no longer reluctant to this innovation.

Promotion phase

Based on the work in the preliminary and kick-off phases, principals used the following strategies in the promotion phase.

Strategy 1: infusing thinking skills into subject instruction

The principals shifted the focus to infusing thinking skills into subject instruction in the promotion phase.

> When thinking tools are truly infused into instruction, it is not just a way of summarising knowledge, but a process of deepening students' understanding of knowledge (A2).

> What we are trying to infuse into a class is not only a thinking tool. Teachers are encouraged to apply critical thinking skills while teaching specific knowledge (A5).

All the statements revealed that infusing thinking tools or skills into subject instruction enhanced teaching thinking practice and promoted the diffusion. Additionally, A3 suggested a combination of teaching thinking and comprehensive practical activities, then "the Comprehensive Practical Activities became very distinctive."

Strategy 2: routinizing lesson studies

Besides more practice for new teachers to "experience the convenience and effects of the thinking tools" (A2), more discussions about teaching thinking were encouraged. All principals emphasized the importance of regular lesson studies on teaching thinking. As A4 explained,

> It is essential to share everyone's experiences with it. How did they use these thinking tools? And how did they infuse thinking tools or skills into subjects? Lesson studies and sharing are critical because they will encourage everyone to think and complement each other (A4).

A7 also indicated that the teachers in her school were encouraged "to learn with each other, reflect, and to exchange with each other."

Diffusion teaching thinking inside schools (implementation stage)

After the TSP had been accepted and implemented by the seed teachers, it continued to diffuse inside schools. Influenced by the effort and performance of the seed teachers, more teachers in the same school were involved in this innovation. *Opening training and lesson studies to all teachers*, and *point-to-area peer influence* helped promote the diffusion of teaching thinking inside schools.

Opening training and lesson studies to all teachers

Opening training and regular lesson studies were perceived as a direct means of diffusing the TSP. A6 emphasized all teachers should be involved in training,

> I think training is indispensable. We need to get everyone to know where the programme is from, and what kind of support would be provided. The key is to get all the teachers to know about it (A6).

At the same time, for further development, A7 thought more effort should be put into lesson studies:

> If our goal is to promote (teaching thinking) throughout the school, I think more efforts should be put into regular lesson studies (A7).

Point-to-area peer influence

The formation of the seed teachers not only contributed to the introduction and implementation of the TSP but also contributed to the subsequent spread of radiation. The point-to-area peer influence is the most effective way to promote the diffusion process, when "encountering with some teachers who are reluctant" (A6), for "everyone to participate in (the innovation)" (A8).

Mechanisms to maintain sustainability (confirmation stage)

Fortunately, the TSP was productive in each school. The principals shared that the main achievement was teachers' more in-depth understanding of teaching thinking. Teachers' understanding shifted from "just simply using some thinking tools or a form of changing students' thinking" (A2), to "thinking about the relationship between knowledge" (A2), and "placing (teaching thinking) in students' everyday learning" because "the cultivation of thinking is the cornerstone to improve the quality of learning, thinking skills are the source of creativity" (A5). Another achievement was that teachers' "research consciousness has enhanced, and their research ability and learning ability have improved . . . their learning styles, thinking patterns, and problem-solving ability have changed" (A2), and "we were all activated" (A3). Positive changes appeared in students who were receiving thinking skills classes. A4 shared that "students get used to show their thinking via visual diagrams" and "The quality of their thinking has been improved as well as their academic performance", while A5 was encouraged by "the sparks of thought" that frequently emerged in their classes.

To confirm and sustain the achievement of innovation, some mechanisms were necessary to maintain the sustainability of teaching thinking in schools. Four major themes were constructed for summarizing the mechanisms: (a) building positive feedback mechanisms, (b) making teaching thinking a distinct feature of the schools, (c) collaborating with external partners, and (d) forming organizational memory.

Building positive feedback mechanisms

The principals mentioned that positive feedback mechanisms were essential to keep teachers implementing *teaching thinking* continuously. This positive feedback came from teachers' *sense of accomplishment, recognition from supervisors*, and *opportunities for career development*.

A1 focused on the *sense of accomplishment*, while A3 focused on the *recognition from supervisors and peers* in the district. As they shared,

> It is necessary to continuously refine achievements from practice so that the school and the teachers have a sense of accomplishment. (A1).

> What made us excited is that one semester after we adopted the TSP, supervisors from the district came to our school for regular lesson studies. They were quite sure that we had made noticeable progress. All our teachers were encouraged, and so they kept going on (A3).

The principals also shared that the *opportunities for career development, such as* attending conferences and teaching competitions, together with the certificates and awards from these, positively stimulated teachers to engage in teaching thinking.

> Promotion is competitive. We give teachers (who joined the TSP) some opportunities to teach at a national-level platform. Consistently through such stimulation, teachers' enthusiasm slowly rises. (A3).

> We sent our teachers to participate in the activities organised by the ATS . . . Our teachers' professional development accelerated. What is more important, they won some certificates, which are very important for their promotion (A4).

> Some teachers applied thinking tools in teaching competitions. It became a highlight of their classes. Then they won the first prize or the grand prize. This encouraged them to continue and more teachers to try. (A6)

Making teaching thinking a distinct feature of the school

A1 shared "integrating thinking skills with other activities and elective courses" could enhance school culture development. Similarly, A4 suggested "setting teaching thinking as a core goal of classroom teaching helped the school develop its feature." Making teaching thinking a distinct feature of the school helped to form a school culture which focused on the development of thinking skills. In this culture, teachers "put more effort into teaching thinking" (A4), then to maintain the sustainability of teaching thinking.

Collaborating with external partners

The principals stated that the collaboration with the external partners outside schools helped to solve many problems that could not be solved by themselves, and the ATS could "provide professional guidance" (A6, A8).

The ATS is not only a critical external partner in which principals and teachers could gain materials and professional guidance from experts, but also provides opportunities for them to communicate and collaborate with other external partners, especially other schools, through the cross-regional activities.

A1, A3 and A6 also admitted that the ATS is indispensable and can compensate for the lack of administrative support to some extent.

> (The ATS) allows our teachers to grow with more peers. Such a platform is particularly valuable while the local administrative support is absent (A1).

> Every time I offered opportunities for teaching on the ATS platform to different teachers. They will not be deeply impressed until they do it by themselves on such a platform. This experience helped a lot (A3).

The cross-regional communications enabled by ATS, and the mechanism for teachers to demonstrate and communicate, both provided support for administrations.

Form organizational memory (confirmation stage)

All the principals indicated that they hoped the TSP could be sustained in their schools, even after they leave sometime in the future. As a result, they suggested that *forming organizational memory* was necessary for the sustainability of teaching thinking in their schools.

A2's school is a large public school with more than 350 teachers, so he focused on the vital role the department leaders played in forming organizational memory. Once their organizational memory was formed, they could lead all the teachers to sustain the innovation of teaching thinking. As he shared,

> I think the department leaders are essential. Everything will not change even a new principal is appointed (if department leaders want to continue) (A2).

A3 and A4 hoped to form organizational memory through continuous efforts and through getting all teachers involved so that the next principal would follow suit. As they explained,

> At least when I am in this school, I will stick to teaching thinking and make it a tradition of the school. When the next principal comes in, all our teachers will continue to do this, and the new principal will not abandon it (A3).

> Plan for the long-term development and continue the in-depth study until teachers and students fully recognise our ideas. When the new principal comes in, he or she will find this is the only right way (A4).

From these statements, the principals admitted that the adapting and diffusion of innovation would be time-consuming. The continuous effort to form an organization memory could contribute to the diffusion in the long run.

Reflection on the adoption, diffusion and sustainment (re-confirmation stage)

During the follow-up interview in January 2021, we got to know that the TSP were still well sustained in these eight schools, though A2 was promoted to the director of local education bureau in 2020, A8

(deputy principal in 2019) was promoted to the principal of another school in 2020, and A5 quit her principal position in 2019.

Criteria of a successful educational innovation

Eight principals held similar criteria for a successful, adopted educational innovation. The most common three are: (1) whether it promotes teachers' professional development; (2) whether it enhances students' learning; and (3) whether it improves the teaching quality. In addition, A7 emphasized whether it could "increase the efficiency" and "ease the burden of teachers and students" while A5 emphasized on "reaching consensus among teachers." Based on their own criteria, all principals except A5 believed that the TSP was successfully diffused and sustained in their (previous) schools. Under the full mark 10, A2 and A4 gave nine, while A1, A3, A6, A7, and A8 gave eight. As A6 and A7 explained,

> The whole school have a consensus on teaching thinking, and we are all in action. Some teachers used the ideas and methods actively after being influenced by others. This gave us many surprises (A6).

> Though there is still a long way to go for the comprehensive and in-depth promotion of the TSP, it has opened a window for all the teachers and students to see the goals in the distance (A7).

Although A5 gave a relatively low score to her work, possibly due to her leaving the principal's office, she was still confident with the TSP. As she noted:

> I cannot define it as a success up to now, but changes are obvious. With the aid of the thinking tools, the sparks of thought frequently emerged in our classes, and teachers have a sense of accomplishment (A5).

Reflection on the strategies of diffusion and sustainment

All principals agreed on the strategies that we excavated from the initial interviews. Beyond these, A1 and A5 emphasized the essential role of "systematic design" of the TSP. As they noted:

> I think all these strategies are still working. Of course, the more we've engaged in practice, the more I feel a systematic design is needed. We can set up a pioneering team to put forward some basic framework of instructional design, strengthen the integration with the current instructional resources and exams, and promote it with unified standards (A1).

> We need to promote it in a planned way rather than 'a gust of wind' or pursue 'immediate results'. A superficial programme without connotation will not go far (A5).

Discussion

The decisive role of top-down leadership in the diffusion

In this study, the principals' descriptions of their acknowledgement of teaching thinking confirmed the previous findings of the DOI theory. Rogers (2003) highlighted the decisive role of innovation agents in the process of diffusion. Innovation agents typically made adoption decisions, introduced the innovations to others in the social system, and investigated efforts to promote the diffusion (Rogers, 2003). In this study, the principals played the role of the innovation agent and demonstrated strong top-down leadership. They recruited seed teachers, organized research groups and regular lesson studies, and provided various institutional guarantees for the sustainable promotion of teaching thinking. Notably, they taught "*cannon fodder classes*" to demonstrate direct thinking skills classes, which helped break the inner barriers for the teachers to try the innovation and kick off the TSP.

In Chinese schools, innovations are typically dominated by principals. Chinese culture is thought to place great importance on the authority of leaders, such as principals in schools. In this sense, when principals introduce innovation in a school, teachers usually obey and follow. However, in this

case, principals dominate innovations by leadership and making an example for teachers, rather than authority. Moreover, since most people are not tended to "stick their neck out," early adopters are always under great pressure. It always takes much courage to be the first person to conduct an innovation. Through observing and criticizing the "*cannon fodder classes*" demonstrated by the principals, teachers found the value of teaching thinking. More importantly, they gained confidence when they found they might be able to teach better than principals did. This prompted them to accept the principals' adoption decision.

Perceived characteristics as decisive factors for adoption

The principals' perceived characteristics of the TSP are highly related to their adoption decision of the innovation. In this study, what mainly prompted the principals to introduce the TSP systematically and to promote innovation within the school were their perceived relative advantages of the thinking tools and the TSP. The principals agreed that the thinking tools, such as Thinking Maps, Mind Mapping, and Concept Mapping, were easy to use. The perceived ease-of-use motivated the teachers to have first trials to implement teaching thinking in their classrooms. These thinking tools are based on visual representations of patterns of content for generative, cognitive and conceptual thinking. The visual depiction of content knowledge may explain the perceived ease of use and reflect explicit thinking without students or teachers needing to present their ideas verbally. Visual tools may offer one way of sustaining the "quiet" mind of the learner with having to openly verbalize one's thinking in a classroom setting (Hyerle, 2009). The convenience is also related with the trialability of the TSP, thus perceived it as operational.

The direct approach and *the infusion approach* of teaching thinking were used at the same time. This is different from most previous studies that simply distinguished one from another. Previous research revealed that *the direct approach* has its unique, but the limited value and *the infusion approach* is more effective (Wegerif, 2002), but they were seldom used at the same time. In this study, the combination of these two approaches improved the teachers' perceived feasibility. *The direct approach* enabled the teachers and students to gain general thinking skills, while *the infusion approach* integrated these thinking skills as thinking tools in subject instruction to help students achieve coherent understanding. In this way, the gap between the direct teaching of thinking skills and infusing them into subjects is bridged.

School culture is the guarantee of sustainability

The ultimate goal of an organizational change initiated by a change agent (i.e., principals) is to let all members in the social system (i.e., teachers) renovate their thoughts regularly (Rogers, 2003). Organizational change might be seen through the lens of three orders of change, respectively: *improving existing practices, significant school-wide changes*, and *most members being actively involved* in transforming the organization vision and practice. The principals in this study adopted teaching thinking intending to bring the third-order change into their schools. Thus, as described by Rogers (2003), *influences from peers* are most important during the innovation diffusion. The principals placed great importance on forming organizational memory and creating a "thinking" school culture with which peer influence is created. The vision of organizational memory and the school culture transforming overtime may be essential to the sustainability of the teaching thinking innovation.

Limitations and future research

Although this study provided an in-depth understanding of how a TSP was adopted and diffused in eight primary schools, it still yields to some limitations. First, only school principals were interviewed. Opinions of other stakeholders, such as the local administrative departments, teachers, students, and parents, will be recruited in future research to gain a more comprehensive understanding of the

diffusion of teaching thinking. Second, this study only focused on the adoption and diffusion of a TSP in primary schools. How TSPs were adopted and diffused in middle and high schools will be included in future research. Third, only interviewing was used for data collection. Triangulation using multiple sources of data will be applied in future research. Last, Roger's model is a linear model, which could not reveal an iterative process of decision making during the diffusion of innovation, even though the eight principals in this study made their decisions without going back.

Conclusion and implications

This study investigated how a TSP was adopted and diffused as an innovation in primary schools in the Chinese context from the principals' perspective. Using Rogers' DOI framework, this study provided some crucial indicators of adopting a TSP and the strategies of diffusing and sustaining it in schools. The interviews with eight school principals revealed that the principals' prior knowledge about teaching thinking and their *perceived characteristics* of the TSP together triggered principals to adopt the innovation. Recruiting *seed teachers*, offering *direct thinking skills classes*, and demonstrating *cannon fodder classes* played an essential role in kicking off the TSP in schools. Engaging in online and on-site training, infusing thinking skills into subjects, and routinizing lesson studies were essential to adapt the school to teaching thinking. Opening training and lesson studies to all teachers and point-to-area peer influence were the principals' perceived effective strategies to promote the diffusion of a TSP in schools. Building positive feedback mechanisms, making teaching thinking a distinct feature of the schools, collaborating with external partners, and forming organizational memory were effective mechanisms the principals used to sustain the diffusion of a TSP in schools.

This study extended existing research, which mainly focused on designing and implementing thinking skills intervention and evaluating their effects, by highlighting how a TSP was adopted and diffused in primary schools in the Chinese context and uncovering strategies that principals used to promote the diffusion and sustainment of a TSP in their schools. The findings could help other schools planning to adopt TSPs or other innovations. This study also made a unique contribution to the area of DOI by enriching its application scenarios.

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